CHINA'S EMERGING SEMICONDUCTOR INDUSTRY

The Impact of China's Preferential Value-Added Tax on Current Investment Trends

Thomas R. Howell
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Prepared by
Dewey Ballantine LLP
for the
Semiconductor Industry Association

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FOREWORD

This study is the latest in a series of reports that the Semiconductor Industry Association and Dewey Ballantine have published to provide a greater understanding of the types of policies that governments around the world are adopting to advance their semiconductor industries. By documenting these policies, the SIA hopes to encourage countries to support their industries through open markets, academic research, workforce education, and other policies consistent with the rules of the World Trade Organization (WTO). Appropriate government policies can further the healthy development of semiconductor industries around the world, and further the spread of the benefits of semiconductor technology to consumers in all markets .

An SIA delegation visited China in 1994, at a time when comparatively little was known about China's semiconductor industry and market, and the government institutions and policies that were fostering the development of the industry. This initial contact has broadened into a wide range of relationships between the U.S. industry and China, including regular informational exchanges and delegation visits, and many direct commercial relationships. Most SIA members now have operations in China, which include activities in manufacturing, design, assembly, test, packaging and sales.

As with it does with all major semiconductor markets, SIA has studied government policies affecting microelectronics in China, and as appropriate has identified policies and measures which may distort or inhibit international trade and investment. Significantly, most of the issues raised by SIA in the 1990s with respect to China were addressed by mutual agreement between the Chinese government and its trading partners through the WTO accession process. In the case of issues arising regarding the protection of intellectual property rights, there has also been a positive policy effort by the Chinese government. SIA strongly supported China's entry into the WTO, and the adoption by the United States Government of Permanent Normal Trade Relations with China, which became a reality in 2001.

This study examines current Chinese policies for promoting the semiconductor industry, as well as policies in Taiwan which are likely to affect the evolution of the Chinese industry. China's recent achievements in microelectronics are acknowledged and detailed. While not condemning promotional efforts in this sector in China as a general matter -- many major countries promote this industry -- the study does indicate which policies have the potential for distorting international trade and investment, in particular the differential Value-Added Tax (VAT). While China has made great strides in opening its market as part of its WTO accession, including joining the Information Technology Agreement (ITA) and eliminating its tariffs on semiconductors and other information technology goods, China's program of rebating a substantial portion of its VAT to domestic producers, while continuing to charge the full VAT on imports, is contrary to the World Trade Organization's national treatment requirement, the bedrock on which much of world's trade regime rests. The WTO is crystal clear that imported products be treated no less favorably than domestic products for purposes of internal taxation. The report reviews the VAT policy in the context of China's wider program to promote semiconductor investments, recent Taiwan industry investment patterns, and the WTO's legal requirements to assess the impact of potential trade distortions caused by the VAT rebate policy.

In May, the World Semiconductor Council (WSC), composed of the semiconductor industries from Europe, Japan, Korea, Taiwan, and the United States, noted that "Discrimination has the effect of limiting market access, distorting patterns of trade and investment, and negates the benefits China promised to provide when it joined the WTO." The WSC specifically called "for China to lower its VAT rate to 3% for all semiconductors, regardless of origin." It is SIA's hope that by providing the economic analysis of the VAT's impact on trade and investment patterns, this report will encourage China to follow the WSC's recommendation to lower its VAT on all semiconductors.

This report also highlights a number of policy measures in China and Taiwan which, although not necessarily inconsistent with WTO rules, nevertheless pose challenges for U.S. policymakers at both the federal and state levels. These include tax holidays, tax incentives for individuals, and manpower and education programs which have proven very successful in attracting investment and talent to China and Taiwan. An appreciation of the effect of such measures should inform any assessment of the U.S. policies needed to ensure that the United States retains world leadership in this critical industry.

SIA welcomes China's participation in the WTO and looks forward to the Chinese Semiconductor Industry Association (CSIA) becoming a member of the World Semiconductor Council (WSC). China's participation in the WSC in cooperation with the other major semiconductor regions will foster the growth of the world semiconductor industry, and enhance the benefits for consumers in all world markets.

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EXECUTIVE SUMMARY

A massive expansion of semiconductor manufacturing capacity is currently under way in China. New wafer fabrication facilities being established in Shanghai, Songjiang, Beijing and Suzhou reflect an ambitious attempt by the country's leaders to replicate Taiwan's success in building a leading edge semiconductor industry on a larger scale on the mainland. While China has historically proven unable to develop an internationally competitive semiconductor industry, the present effort directs substantially more resources toward this goal. The government is implementing promotional policies which succeeded in Taiwan and is drawing heavily on Taiwanese capital, technology, and managerial and engineering talent to build the new manufacturing facilities. At present, by conservative estimate, 19 new wafer fabrication facilities are operational, under construction, or planned in mainland China under Taiwanese majority ownership and management. Although these plants will not initially utilize state of the art process technology, their managers plan to capitalize on technology transfers from multiple foreign partners to approach technological near-parity with the global leaders.

The preferential VAT creates a cost advantage for mainland-based production. While a number of factors underlie the influx of Taiwanese capital and talent to the mainland semiconductor industry, the single most important motivator is a measure implemented by the Chinese government in 2000 which creates a major cost advantage for mainland-based semiconductor production. Pursuant to this measure, all imported integrated circuits (ICs) are subject to a 17 percent value-added tax (VAT) while ICs which are designed or manufactured domestically qualify for a rebate of that portion of the VAT which exceeds 3 percent. The VAT preference gives mainland-based producers a dramatic cost edge over comparable operations based in Taiwan and elsewhere with respect to ICs sold in China, currently the world's fastest growing major market for semiconductors. In effect, China is using a tax measure -- the discriminatory VAT -- to capture manufacturing investment, design activity, and talented people that would otherwise be located in Taiwan or elsewhere outside of China.

Taiwanese capital and expertise are transforming China's semiconductor industry. The fusion of Taiwanese capital and expertise with China's resources and vast potential market is fostering the emergence of a dynamic "greater Chinese" semiconductor industry bearing little resemblance to the technologically lagging industry that existed through the end of the 1990s. The new Taiwanese semiconductor manufacturing plants in China will operate as "foundries," following a business model which was pioneered in Taiwan and which is currently dominated by two Taiwanese firms, Taiwan Semiconductor Manufacturing Corporation (TSMC) and United Microelectronics Corporation (UMC). Foundries do not produce their own brands of semiconductor products for sale in the market, but manufacture the designs of other semiconductor firms in return for a service fee or other compensation. Use of the foundry model has enabled Taiwanese firms to build technological alliances with leading semiconductor firms throughout the world; to absorb, refine and improve semiconductor process technology; and ultimately, to emerge as some of the world's most efficient semiconductor manufacturers. With its new promotional effort China is now preparing to capture similar benefits for itself as Taiwanese foundries spring up on the mainland. Moreover, Taiwan's highly successful government promotional efforts in microelectronics will increasingly serve to foster the development of the mainland semiconductor industry, reflecting Taiwan's new strategy of becoming the “headquarters” for China-based manufacturing operations -- providing design, R&D, training, and managerial functions.

Longstanding constraints on Chinese development in microelectronics are disappearing. Factors which have long impeded China’s aspirations in microelectronics have eroded, including multilateral controls on technology exports to China, Taiwan’s legal restrictions on mainland investment, and China’s own regressive command-economy trade, investment, and industrial policies. China’s current promotional measures in microelectronics resemble government incentives found in market economies -- tax incentives, preferential loans, equity infusions, establishment of high technology industrial zones -- and with the exception of the discriminatory VAT, closely parallel measures which have been implemented with spectacular success in Taiwan. The Taiwan-invested semiconductor foundries appearing on the mainland more closely resemble multinational corporations than the state-owned enterprises and 50-50 joint ventures that have traditionally comprised China’s semiconductor industry.

Implications

In the near term, China’s growing semiconductor industry and market provide major export opportunities for U.S. makers of semiconductor manufacturing equipment, materials, and devices. China imports about 85 percent of its total consumption of semiconductor devices and nearly all of its advanced semiconductor manufacturing equipment, with U.S. firms accounting for a substantial proportion of total imports. If Taiwan’s example is a guide, the new mainland foundries will provide efficient manufacturing services to U.S. semiconductor firms, reducing their costs and risks and increasing their market opportunities both in China and in other world markets. China’s implementation of liberalized trade and investment rules, coupled with its creation of a modern infrastructure to support semiconductor operations, benefits the entire U.S. semiconductor industry chain. Many U.S. semiconductor equipment, materials, design and device makers have established or will establish operations in China.

Some U.S. policymakers and analysts warn that China’s rapid advances in microelectronics pose a national security threat to the United States. However, there is nothing approaching a consensus in the United States that China will ever constitute a national security threat. China’s capabilities in microelectronics and other commercial technologies with military applications are unlikely to pose a threat to the United States for the foreseeable future, given the overwhelming superiority of U.S. military power. No U.S. ally regards China as an actual or potential threat to their own security or to regional stability.

However, while China’s acquisition of more sophisticated capabilities in microelectronics probably does not, standing alone, threaten U.S. national security, the complete loss of U.S. leadership in semiconductor technology and manufacturing to any country or region -- China, Japan, Europe or elsewhere -- clearly *would* have serious national security consequences, given the increasingly central role played by microelectronics in modern warfare. For this same reason, in the 1980s U.S. policymakers were extremely concerned about the potential loss of leadership in microelectronics to Japan. Japan was (and is) a staunch ally of the U.S. and its acquisition of advanced microelectronics technology -- even if given military applications -- did not constitute a direct security threat to the U.S. However, U.S. policymakers concluded that leadership in this critical field should not reside outside the United States, regardless of where that might be, even with traditional U.S. allies. That concern remains equally valid at present. It follows that government measures in any part of the world that induce the large scale migration of microelectronics capital, technology, and talent from the United States deserve careful scrutiny by U.S. policymakers.

The true challenge posed by China's promotional effort to the United States and the U.S. semiconductor industry is that China's growing "gravitational pull" will draw capital, talented people, and ultimately, leading edge R&D and design functions away from the United States as China is now doing with respect to Taiwan. Should this occur, the United States would confront the erosion of the basic institutional and human infrastructure necessary to sustain world leadership in microelectronics. Government policy measures which contribute to or accelerate this process are problematic. In this regard, several aspects of China's new developmental effort in microelectronics should be of concern to U.S. policymakers.

- ***China's discriminatory Value-Added Tax (VAT) is inconsistent with its WTO commitments.*** China's current VAT policy creates a discriminatory preference in favor of domestic products and against imported products in a manner which is inconsistent with Article III of the General Agreement on Tariffs and Trade (GATT), the principal WTO agreement. GATT Article III prohibits application of internal taxes (including a Value-Added Tax) in a manner which affords protection to domestic production *or* which results in a level of taxation for imports which is "in excess of" those applied to domestic production. China eliminated its tariff on semiconductor imports when it joined the WTO, but the discriminatory VAT functions, in effect, like a 14-percent tariff. China's use of a WTO-inconsistent measure to attract investment that would otherwise take place elsewhere is a matter of serious concern, particularly in an industry of strategic importance like semiconductors. Specific concerns include:

    - ***Distortion of investment patterns.*** China's VAT policy causes investment decisions to be made on the basis of a government measure which creates a distortion, rather than on the basis of market factors. It invites comparable measures by other governments seeking to capture high technology investment, and is inconsistent with the principles underlying the WTO Agreement on Trade-Related Investment Measures (TRIMs).

    - ***Overcapacity and dumping.*** New foundries are being built in China, in substantial part, because investors fear being shut out of that market rather than because market conditions support new additions to capacity. Many observers warn that too much new capacity is being established in China, and, as in similar episodes involving Japan and Korea, the result could be major dumping in world markets.

    - ***Intellectual property concerns.*** The foundry business is based on strong guarantees by foundry operators that they will protect the intellectual property of the firms whose designs they manufacture and not knowingly produce pirated versions of those designs. However, if the new foundries on the mainland experience massive overcapacity, they will have a continuing economic incentive to manufacture pirated designs -- knowingly or inadvertently, through lack of the necessary diligence -- in order to sustain their capacity utilization rates. This concern is heightened by the fact that China has a decidedly mixed record with respect to the protection of intellectual property.

The U.S. government should raise the VAT issue with China bilaterally and insist that China eliminate the discrimination against imported semiconductor devices by lowering the VAT on imports.

- ***China is emerging as a major competitor for talented manpower.*** A country's success in international semiconductor competition depends in large part on its ability to attract and retain the most talented entrepreneurs, engineers, and researchers in the field. The United States has traditionally been the world leader in this respect, but it is now being challenged by other countries. The system of individual income taxation in Taiwan and China enables semiconductor personnel to receive company stock and options as compensation in a manner which results in little or no actual income or capital gains tax being paid when the stock is sold -- with the result that Taiwanese and Chinese firms have a competitive advantage (the lure of rapid personal accrual of substantial wealth) with respect to competition for talent that other firms cannot match. China and Taiwan are offering other incentives to individuals in the microelectronics field, such as support for establishing a new business, and while they are not the only countries to do this, they have enjoyed the greatest degree of success. While the migration of a considerable number of talented people to China and Taiwan is inevitable, it is not in the interest of the United States to lose its leadership as a desirable location for leading talent in the microelectronics field to China, Taiwan or any other country or region. The U.S. government may not be able to match some of the incentives being offered by China, Taiwan, and other countries, but through increased federal spending on cutting-edge microelectronics R&D, particularly in the universities, it can ensure that the U.S. remains fully competitive in the intensifying global struggle over the limited pool of sophisticated talent.

- ***No U.S. policy response exists with respect to the largely tax-free business environment for semiconductor manufacturing and design firms in China/Taiwan.*** China is replicating Taiwanese policies which virtually exempt semiconductor firms from payment of corporate income tax. Such tax rules were a primary factor underlying massive semiconductor investments in Taiwan in the 1990s and are now being implemented in China. While it is virtually inconceivable that the United States would match such policies, the fact remains that differences in national tax policies are becoming an important factor underlying locational decisions in the semiconductor industry, and absent a U.S. policy response, such differences will increasingly determine where semiconductors are designed and produced. Some form of U.S. policy response is required.

Conclusion

Maintaining U.S. leadership in microelectronics is critically important to the economy and national security of the United States. Government policy measures in any country or region which induce significant migration of the U.S. microelectronics infrastructure -- capital, enterprises, individuals -- warrant careful scrutiny by U.S. policymakers. Several aspects of China's current developmental effort in microelectronics are problematic because they could erode the U.S. microelectronics infrastructure and contribute to an eventual loss of U.S. leadership in this field.

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APPENDICES

Certain Chinese ministries were reorganized in spring 2003. The Ministry of Commerce was created to assume certain responsibilities of the Ministry of Foreign Trade and Commerce (MOFTEC) and the State Economic and Trade Commission (SETC), which are being disbanded. The State Development and Reform Commission assumed most responsibilities of the former State Development Planning Commission. The Ministry of Information Industry (MII) had assumed responsibilities from the Ministry of Posts and Telecommunications and the Ministry of the Electronics Industry (MEI) previously, in 1998. In the study the ministries are shown under their old names, but observe that the responsibilities and the names of some of these agencies have changed.

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The Impact of China's Preferential Value-Added Tax on Current Investment Trends

I. OVERVIEW: CHINA'S NEW PROMOTIONAL EFFORT IN SEMICONDUCTORS

This study examines government policies which underlie the current dramatic expansion of semiconductor manufacturing capacity in China. At a time of stagnant global semiconductor demand, by conservative estimate a total of 19 new semiconductor foundries exist or are planned in China (Figure 1).[1] The timing of construction of some of the planned fabs may be stretched out in light of stagnant global demand, but most or all of the planned fabs are likely to be operational by 2008. While the first operational foundries feature technology which lags behind the global state of the art (0.25 micron design rules, 8-inch wafer diameters), China's leading producers have closed most of the technology gap with the West that existed a decade ago (Figure 2), and are narrowing the gap that remains. The managers of the new facilities expect to receive assistance from foreign partners which will bring them close to parity with the global leading edge in or after the year 2005.[2] The Shanghai-based Semiconductor Manufacturing

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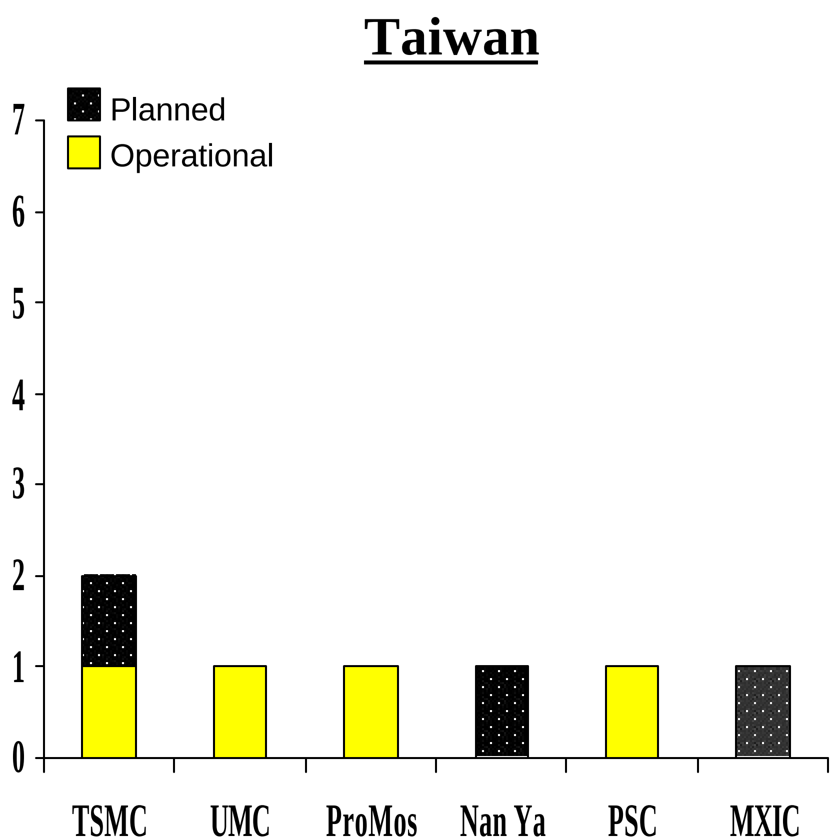
1 In industry parlance a "foundry" is a manufacturing facility which manufactures semiconductors designed by another firm on a contractual basis. The foundry receives a fee from the designing firm for "manufacturing services," and the designing firm's design is produced without that enterprise needing to incur the costs and risks associated with manufacturing operations. Because foundry operators most commonly do not design or sell their own products, they are free to focus on manufacturing efficiency, achieving high yields and rapid turnaround. The total of 19 fabs is based on interviews with the management of the companies constructing the fabs and with the administrators of the High-Tech Parks in which the new fabs are being built. Two of the new foundries were operational in September 2002 and six more were under construction or slated to enter the construction phase during 2003. The estimate of 19 new Taiwan-invested foundries is conservative because in instances in which the number of planned fabs acknowledged by an enterprise was inconsistent with the figure cited by Hi-Tech Park officials, the enterprises' figure -- always a lower number -- was used. Thus the 19-fab figure assumes only one new wafer fabrication facility will be built by Taiwan Semiconductor Manufacturing Corporation (TSMC) in China, because that is the only facility the firm has publicly acknowledged it will build. But its plans reportedly include a second 8-inch fab and 2 12-inch fabs, and it has already purchased enough land at its alpha site in Songjiang to accommodate all of these and more. Interview with official of Shanghai Songjiang Industrial Zone (Songjiang, September 2002).

2 A report in the May 2003 issue of *Semiconductor International* observed that "[SMIC] Fab 1's progress has significantly narrowed the technology gap between China and leading global players from four to five generations to just one or two generations. Within only 1 year, Fab 1 rapidly advanced from 0.35 micron process technology to 0.18 micron and finer-line technologies, qualifying numerous logic, mixed-signal and memory products. In line with Fab 1's rapid technology progression, product yields have already attained world-class standards, reaching defect levels comparable to other top foundry fabs. Maria Lester, "2003 Top Fabs," *Semiconductor International* (May 2003). SMIC is receiving technological assistance from IMEC of Belgium, Infineon Technologies (Germany), Chartered Semiconductor (Singapore) and Toshiba and Fujitsu of Japan. It has received 0.14 micron technology from Infineon and may be commissioned by Elpida Memory (Japan) to manufacture DRAMs with 0.11 micron design rules. SMIC plans to be manufacturing 150,000 wafers/month on a 12-inch fab by 2005. N. Jinbo, "Chinese LSIs Approaching a Crucial Moment, New Fabs Become a Turning Point," *Nikkei Microdevices* (February 2003).

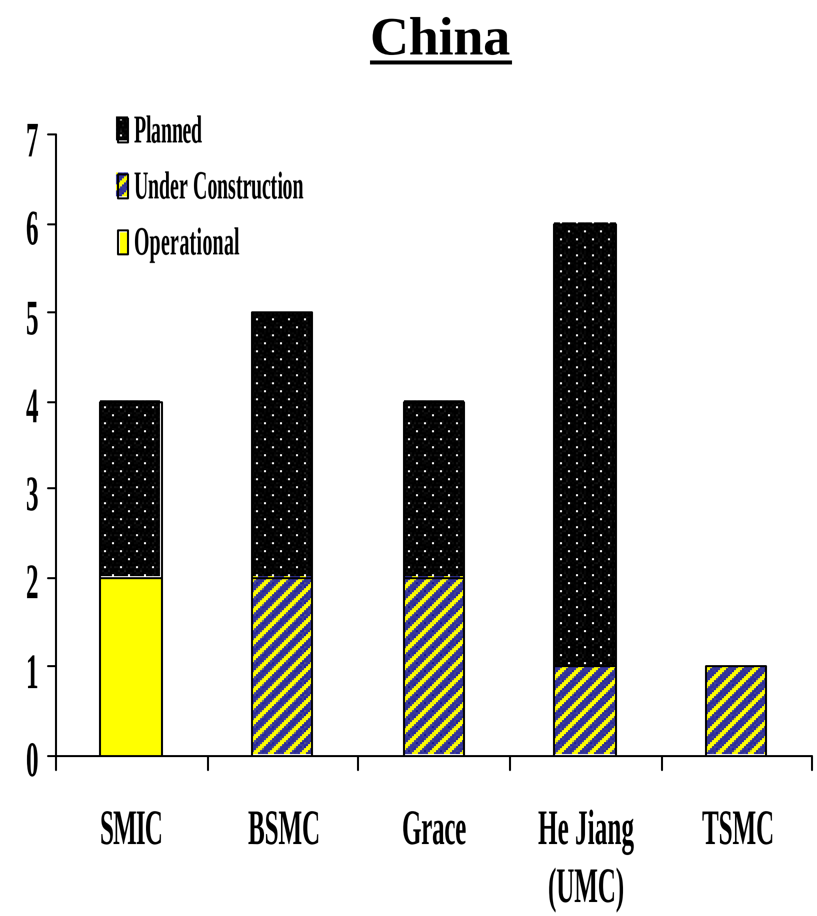
Figure 1

Taiwan-Invested Wafer Fabrication Lines Established/Planned Since 2001

(Status as of September 2002)

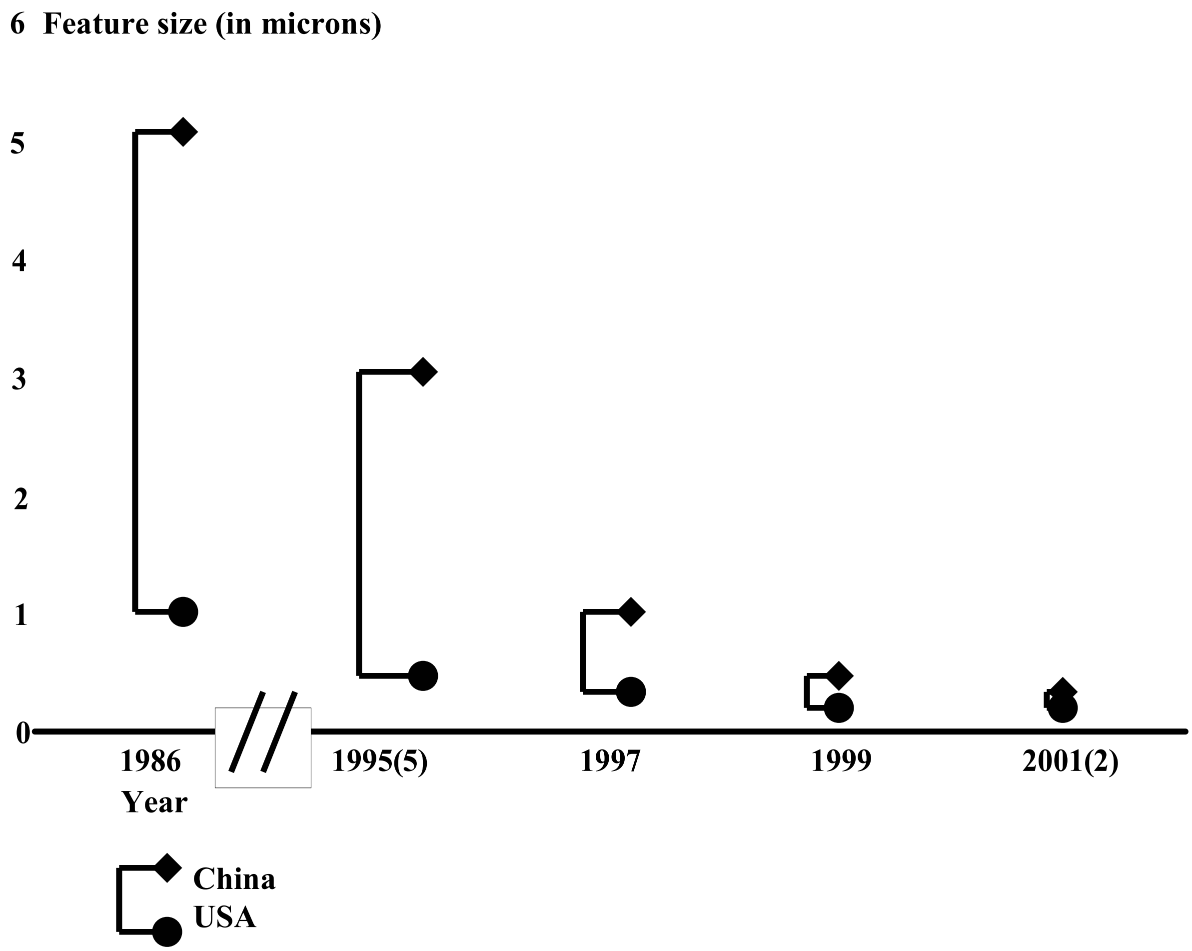


12"-Wafer Fabs



19 Fabs Total

Figure 2
Reproduction of Figure from GAO Study Depicts Chinese Progress in Closing Semiconductor Technology Gap



Note: Complete data for the period between 1986 and 2002 were not available. The time scale was altered to show the years where data were available. Data for 2002 based on estimate. Data points for the years listed are as follows: China—5.00, 3.00, 0.80, 0.35, and 0.18 micron; United States –1.00, 0.35, 0.25, 0.18, and 0.13 micron.

Source: GAO analysis of data provided by semiconductor manufacturing facilities in China; the director of the Computer Aided Life Cycle Engineering Electronics Products and Systems Center, University of Maryland, Intel Corporation; and the International Technology Roadmap for Semiconductors.

Source: General Accounting Office, Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review (April 2002) GAO-020620.

International Corp. (SMIC), for example, reportedly plans to build a 12-inch wafer fabrication facility in Beijing in 2004.[3]

Initially at least, all of the new facilities will be Taiwanese majority-owned, managed and run by Taiwanese semiconductor industry veterans (augmented by smaller numbers of Americans, Japanese and Europeans), and largely staffed by indigenous Chinese. An exodus of Taiwanese high-tech talent to the mainland is under way, and according to some estimates as many as 300,000 Taiwanese, mostly managers, are now residing in China, mainly in the Yangtze Delta region around Shanghai.[4] This vast migration of Taiwanese high technology talent and investment capital has given rise to such popular terms such as "Shanghai Fever" and "high-tech-industry-moving-westward fever" (*gaokeji canye xijing re*).[5] The outlook for the Taiwan-invested mainland foundries is bullish -- a recent Japanese account predicted that "The day when [Shanghai-based SMIC] will become Number One in the world in DRAM [dynamic random access memory] production is not far off."[6] SARS, which temporarily slowed the flow of people and investment from Taiwan to the mainland, is not expected to have significant long term effects.[7]

Historically China's semiconductor industry has lagged far behind the global industry leaders. The rapid establishment of numerous new Taiwanese semiconductor foundries on the Chinese mainland reflects a new strategic effort by the government of China to replicate Taiwan's success in microelectronics on a much larger scale in China itself, drawing heavily on Taiwanese capital, managerial talent, and technological expertise. To date Taiwanese government efforts to slow or even regulate the flow of people, capital and technology to the mainland have not proven effective. Indeed, Taiwan's own promotional efforts in microelectronics, which have created one of the world's most dynamic semiconductor industries, will increasingly support the development of the mainland semiconductor industry, reflecting Taiwan's objective of retaining a key role for itself in semiconductors as the "headquarters" for mainland-based manufacturing operations -- performing functions such as high-end R&D, design and distribution.

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3 "All the New Chip Action is in China These Days," *Business Times Singapore* (May 16, 2003). The technology will reportedly be obtained from Germany's Infineon, which established the world's first 12-inch fab in Dresden. "New Fabs Lead to New Funds," *Electronic News* (May 12, 2003).

4 "Taipei's Tech Talent Exodus," *Time Asia* (May 21, 2001).

5 Min Yau, "Chaos and Resentment Everywhere in Taiwan," *Jiefangjunbao* (May 21, 2001); Suisheng Zhao, *Coping with the Chen Shui-ban Administration Beijing's Wait-and-See Policy and Two-Pronged Strategy* (paper delivered May 31, 2000, Conference "Assessing Chen-Shui-Ban's First Year: The Domestic and International Agenda, George Washington University).

6 "Micro Report on LSI Manufacturing," *Nikkei Microdevices (Internet version)* (May 2003).

7 "SARS May Hamper Mainland-Bound Investments," *Taipei Times* (April 23, 2003); "Capital to Foster Semiconductor Business," *China Daily* (June 17, 2003); "Foreign Capital Inflow into Beijing Relatively Unaffected by SARS," *Xinhua* (08:44 GMT, May 22, 2003).

Ten years from now you won't be able to separate Taiwan and China. Both will complement each other in semiconductor manufacturing.[8]

Implications for the United States

The short run implications for the United States of China's new direction in microelectronics are largely positive. The new foundries being established on the mainland are buying significant amounts of U.S. semiconductor manufacturing equipment.[9] U.S. sales of semiconductors in China are increasing and China's growing demand for semiconductors is one of the bright spots in an otherwise stagnant pattern of global demand. China is implementing numerous policies to facilitate entry of foreign semiconductor firms to serve its growing market, including the provision of incentives and the establishment of modern industrial sites and supporting infrastructure. The new mainland semiconductor foundries will predominantly serve foreign firms, including many U.S. firms, significantly reducing their costs and investment risks and facilitating their participation in China's market.[10] In the wake of its entry into the WTO China has liberalized trade and investment rules and is jettisoning command-economy policy tools in favor of more market-oriented, Western style policy measures, creating a regulatory and commercial environment much more conducive to inward foreign investment.

Nevertheless, the ongoing fusion of Chinese and Taiwanese capabilities in microelectronics is raising a number of concerns in the United States. China is viewed as a potential military rival by some U.S. policymakers, and its acquisition of advanced microelectronics technology is seen as threatening. Others worry that an emerging "greater Chinese" semiconductor industry, combining Taiwan's formidable managerial talent, capital, and technology with China's resources, could pose a dangerous competitive challenge for the

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8 David, Wang, Senior Vice President of Applied Materials Inc., cited in "Asian Foundries Examine Prospects -- Taiwanese Look to Exploit China Opening," *Electronic Buyers News* (April 8, 2002).

9 Applied Materials, a leading U.S. maker of semiconductor manufacturing equipment, has been selling equipment in China since 2000 valued annually at over $100 million. Its target for the period 2005-2007 is $1 billion in China sales. Applied Materials now has 300 employees in China at four sites, Beijing, Tianjin, Shanghai and Wuxi. N. Jinbo, "Chinese LSIs Approaching a Crucial Moment, New Fabs Become a Turning Point," *Nikkei Microdevices* (February 2003). In May 2003 Kulicke & Soffa Industries, Inc., a U.S.-based producer of semiconductor manufacturing equipment, announced that Shanghai-based Global Advanced Packaging Technology Co. Ltd. had placed a blanket order for 140 Maxum Ball Bonders, which are used to produce semiconductor packaging. "Kulicke & Soffa Announces Order for 140 Maxum Ball Bonders," *Business Wire* (May 22, 2003).

10 For example, Germany's Infineon Technologies AG plans to utilize China's SMIC to produce DRAMs, which requires a huge capital investment. Harold Egges, Chief Executive of Infineon's Memory Products Group, explained that "the extension of our cooperation with SMIC [means] we can grow our DRAM business without having to invest in production facilities. At the same time we are strengthening our regional presence in the promising market of China and aiming overall at a leading market position in Asia-Pacific." "China Foundry Latest to Use Chip Maker's DRAM, 300mm Technologies -- Infineon Empowers Asian Fabs," *Electronics Engineering Times* (March 31, 2003).

U.S. semiconductor industry over the longer term. These and other possible longer term implications of China's emerging capabilities in microelectronics deserve consideration.

National security implications. Microelectronics technology plays a central role in modern warfare and is a key factor underlying U.S. global strategic superiority, a fact which was underscored during the recent wars in Iraq and Afghanistan. It is manifestly not in the national security interest of the United States to relinquish its present leadership in the field of microelectronics to any country, region, or combination of countries.

A number of policymakers and analysts view China's recent strides in microelectronics as a national security threat to the United States because China's progress in this sector will enhance its military capabilities.[11] There is no question that achieving a greater proficiency in the design and manufacture of semiconductors will enhance China's efforts to modernize its armed forces. But the notion that this will pose a threat to the U.S. assumes both that the U.S. and China will become strategic rivals and that China's progress in commercial microelectronics will enable it to mount a serious challenge to the United States in the military realm. There is no consensus within the United States with respect to either of these assumptions and there are grounds for questioning the validity of both points.

With respect to the potential for strategic rivalry, episodes of U.S.-China friction have occurred at intervals, usually centering around the status of Taiwan, but the U.S. and China are also cooperating closely on a broad range of highly sensitive national security issues, including international terrorism and North Korea's nuclear program. Whether or not the relationship will deteriorate into an adversarial one over the longer term is unknown and probably unknowable. As Michael Ledeen, Vice Chairman of the U.S.-China Security Review Commission observed in 2002, "nobody is smart enough to know whether China will be a friend or foe 10 to 20 years from now."[12] But no major U.S. ally regards China as a potential adversary or as a threat to regional or global stability.[13]

A related question is whether China's acquisition of advanced microelectronics capabilities would constitute a significant security threat to the United States in the event that the U.S.-China relationship became confrontational. A recent assessment of Chinese military capability by a task force chaired by former Secretary of Defense Harold Brown notes China's "impressive and growing civilian science and technology base" particularly in telecommunications and electronics. Its conclusion, however, was as follows:

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[11] For a summary of this perspective see The Report to Congress of the U.S.-China Security Review Commission, *The National Security Implications of the Economic Relationship Between the United States and China* (July 2002); Michael Klaus, "Red Chips: Implications of the Semiconductor Industry's Relocation to China," *Asian Affairs* (January 2003).

[12] "New China, Old Worries," *Electronic Engineering Times* (April 1, 2002).

[13] General Accounting Office, Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review (April 2002), GAT-02-620, p. 17.

This Task Force finds that although China is in the midst of a comprehensive modernization program, the Chinese military is at least two decades behind the United States in terms of military technology and capability. Moreover, the Task Force judges that if the United States continues to dedicate significant resources to improving its military force, as expected, the balance between the United States and China, both globally and in Asia, is likely to remain decisively in America's favor beyond the next twenty years.[14]

Chinese advances in microelectronics will concededly enable it to upgrade its defense capabilities in many large and small ways, but it does not follow that the strides China makes will enable it to emerge as a military power capable of confronting the United States, assuming, for sake of argument, that it one day it may seek to do so.[15] The leverage that microelectronics technology provides in modern defense systems reflects the *integration* of semiconductor devices into individual military systems and the integration of those systems with each other. Possession of semiconductor devices or manufacturing equipment, standing alone, does not confer that capability. As one member of the U.S. armed forces recently put it "just being able to make semiconductors doesn't mean you can build an aircraft carrier." Chinese defense systems integration lags far behind that of the United States and there is little reason to believe that the ability of Chinese firms to produce more sophisticated semiconductors will translate into an ability to produce defense systems in any way comparable to those of the United States in the foreseeable future.

In any event, whatever view one holds as to China's potential as a strategic rival, its acquisition of advanced microelectronics technology and capabilities will occur whether the U.S. acquiesces in the process or seeks to curtail it.[16] China has demonstrated that it can obtain advanced semiconductor manufacturing equipment and process technology from foreign sources -- if not from the United States, then from the European Union, Japan, and Singapore.[17]

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14 Harold Brown, Joseph W. Prueher, and Adam Segal, *Chinese Military Power* (Council on Foreign Relations, May 2003). Similarly a 2002 by the Rand Corporation took note of China's growing microelectronics capability and concluded that "China's overall technological capabilities will still significantly lag those of the United States by 2020. Capabilities in militarily significant areas may be somewhat stronger than average technological levels, but the long development times for military systems mean that the weapons China deploys in 2020 will largely reflect the technologies available in 2010 or earlier." Roger Cliff, *The Military Potential of China's Commercial Technology* (2001).

15 Asked by the Commission whether a technologically advanced China represented an immediate military threat to the United States, former Defense official Donald Hicks commented, "I don't see them as a military threat now, and I don't see them as a military threat for some time." "New China, Old Worries," *Electronic Engineering Times* (April 1, 2002).

16 The loose system of consensual multilateral technology controls embodied in the Wassenaar Arrangement has largely ceased to constitute an impediment to Chinese technology acquisition. China will get advanced microelectronics technology, if not from the United States then from Europe, other countries in Asia, and increasingly, through its own developmental efforts. See Appendix 3.

17 See Appendix 4, "The Erosion of Export Controls on Semiconductor Technology for China."

China as a competitive threat. Significant head-to-head competition between Chinese and U.S. firms in semiconductors is unlikely in the foreseeable future. Most of the new capacity being established on the Chinese mainland consists of Taiwanese-owned foundries whose manufacturing services will be available to semiconductor producers and designers in any country, Chinese or foreign, as is the case with foundries currently based in Taiwan. Rather than attempting to develop independent brands and products to compete with those of Western companies, the mainland-based Taiwanese foundries are seeking a subordinate role *within* the business plans and competitive strategies of foreign companies, in effect, as subcontractors providing manufacturing services. Collaboration with those foundries is already the business strategy of a large and growing number of western companies. A Japanese analyst for a semiconductor industry journal recently commented with respect to China's growing semiconductor capability that

> *Rather than blindly regarding China as a threat, taking China on as a partner and seizing its big market as a business opportunity is the way for Japan to survive from now on… [Japan should] use China as a business partner to produce goods. Concretely, that will involve commissioning Chinese fabs with OEM and foundry production; giving China technical support and earning royalties from that; and utilizing China's design capabilities and some of its developmental capabilities. It will be a matter of collaborating with China in building production plants.*[18]

Problematic aspects of China's promotional effort. If commonly-raised fears about Chinese advances in microelectronics are exaggerated or misplaced, several very real concerns are raised by China's current promotional efforts in semiconductors which have received less attention. China has deployed a number of powerful policy incentives to attract inward investment and talent, and these are having a dramatic effect on locational decisions by individuals, investors, and enterprises in the global semiconductor industry. The new Chinese measures reflect an intensifying global competition between countries and regions through use of such incentives to attract microelectronics-related investments.[19] The longer term challenge posed to the U.S. industry by the expansion of Chinese semiconductor manufacturing capability is that China's growing "gravitational pull" will draw capital, people, and ultimately, leading

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18 F. Murata, "Current State of China's Semiconductor Industry -- Rapidly Becoming the World's IC Center; Japanese Companies Should Form Strategic Tie-Ups with Chinese Companies as Partners in Growth," *Tokyo Semiconductor FDP World* (May 2003).

19 "A global battle is raging to attract new chip foundries, with each country trying to outdo the next by offering better incentives while slinging mud at the others." Tom Murphy, "Who's Offering the Best Deal? Battle for Foundries Heats up with Huge Incentives for Investors," *Electronic News* (April 8, 2002). See generally Thomas R. Howell, "Competing Programs: Government Support for Microelectronics," In Charles W. Wessner, (ed.), *Securing the Future: Regional and National Programs to Support the Semiconductor Industry* (Washington, D.C.: National Academies Press, 2003).

edge R&D and design functions away from the United States as China is now doing with respect to Taiwan.[20]

> *The engineering decisions are being made in Taiwan and now even in China… Chip makers in the United States can learn to manage the shift of design and manufacturing of equipment to Asia so long as they can build up the sales and marketing presence in local markets. But if too many U.S. chip companies stop investing in chip manufacturing at home, the industry risks losing its technology edge.*[21]

Such a development would adversely affect U.S. economic well-being and national security were it to occur with respect to any country or region of the world, and China is no exception.[22]

The extent to which government policy measures and incentives are playing a central role in the competition for investment, technology and talent warrants scrutiny. Specific concerns:

China's discriminatory Value-Added Tax. As part of its promotional effort in microelectronics, China has implemented a value-added tax which discriminates against imported semiconductors in favor of domestically designed and manufactured devices. This measure, more than any other factor, is inducing Taiwanese investment in semiconductor manufacturing facilities in China. *China's VAT policy is inconsistent with its WTO commitments*, and the use of such WTO-inconsistent measures in a manner which significantly distorts investment patterns in a key industry cannot be allowed to stand without seriously weakening the multilateral system which sets the basic ground rules limiting government intervention in international competition. In commercial and public policy terms, the discriminatory VAT is problematic for several reasons:

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20 The President of Shanghai's Semiconductor Manufacturing International Corporation (SMIC) goes so far as to predict that the world's semiconductor manufacturing center will shift to mainland China in the next 5-10 years. "Tech of Chipmaker SMIC to Catch up with TSMC, UMC in 2004," *Taiwan Economic News* (December 5, 2001). A recent Japanese analysis made a similar prediction: "China is advancing by leaps and bounds toward becoming the IC center of the world… From now on the world's semiconductor capacity and technology development will gradually shift to China." F. Murata, "Current State of China's Semiconductor Industry -- Rapidly Becoming the World's IC Center; Japanese Firms Should form Strategic Tie-Ups with Chinese Companies or Partners in Growth," *Tokyo Semiconductor FDP World* (May 2003).

21 Anthony Cataldo, "Maturing Chip Industry Looks at 10% CAGRs," *Electronic Engineering Times* (June 30, 2002).

22 In 1986 a Department of Defense task force warned that trends suggesting Japan was moving toward global leadership in microelectronics posed a national security threat to the United States, despite the fact that Japan was a U.S. ally. The concern was that notwithstanding Japan's close relationship with the United States, leadership in microelectronics, which was one of the most important enabling technologies in modern warfare, should not reside outside the United States. Defense Science Board, *Task Force on Semiconductor Dependency* (Office of the Under Secretary of Defense for Acquisition, November 30, 1986).

- ***Distortion of investment patterns.*** China's VAT policy causes investment decisions to be made on the basis of a government measure which creates a distortion, rather than on the basis of market factors. It invites comparable measures by other governments seeking to capture high technology investment.

- ***Overcapacity and dumping.*** New foundries are being built in China, in substantial part, because investors fear being shut out of that market rather than because market conditions warrant new additions to capacity. Many observers warn that too much new capacity is being established in China, and, as in similar episodes involving Japan and Korea, the result could be major dumping in world markets.[23]

- ***Intellectual property concerns.*** The foundry business is based on strong guarantees by foundry operators that they will protect the intellectual property of the firms whose designs they manufacture and not knowingly produce pirated versions of those designs. However, if the new foundries on the mainland experience massive overcapacity, they will have a continuing economic incentive to manufacture pirated designs -- knowingly or inadvertently, through lack of the necessary diligence -- in order to sustain their capacity utilization rates. China has a decidedly mixed record with respect to the protection of intellectual property, and the proliferation of semiconductor foundries in this milieu thus raises the concern that some of the foundries will manufacture pirated designs.

- The U.S. government should raise the VAT issue with China bilaterally and insist that China eliminate the discrimination against imported semiconductor devices.

The "talent magnet" phenomenon. China is currently drawing large numbers of skilled semiconductor managers and engineers from other countries, including the U.S., reflecting numerous new incentives provided to individuals as well as the perception that better professional opportunities are now to be found in China.[24] To date the United States has enjoyed the most success in attracting and holding talented people in the microelectronics field, an important factor underlying its leadership in the industry. It is not in long term interest of the United States to cede to China, Taiwan, or any other country or geographic region its own

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23 "Is this buildup, [industry] researchers ask, another semiconductor industry disaster in the making?" "Expansion in China, Taiwan Could Create Another Chip Capacity Glut," *Electronic Engineering Times* (January 6, 2003). Commenting on the Chinese capacity expansion program Chia Song Hwee, President and CEO of Singapore's Chartered Semiconductor Manufacturing Pte. stated in March 2003 that "There is more capacity than the industry needs today," adding that the industry was heading toward a "long awaited shakeout." "Fab Costs, Capacity Cut See Pointing to Consolidation -- Shakeout Looms for Foundries," *Electronic Engineering Times* (March 17, 2003).

24 David Shen, CEO of a Chinese IC design firm, commented in January 2003 that "When I graduated I was very eager to go to the United States to get a higher degree. But now when students graduate here, they see a very good job market, especially for an IC designer. They don't have much trouble finding a good job. In the United States, even if you have an EE degree or a computer science degree, it's not easy to find a job now." "Homegrown Talent Works to Dismantle Obstacles to China's Progress," *Electronic Engineering Times* (January 13, 2003).

current leadership position with respect to attraction and retention of talent in the field of microelectronics.

Maintaining the U.S. position of leadership in attracting and retaining talented microelectronics personnel is a multidimensional process involving elements such as macroeconomic policies, immigration rules, and the U.S. system of education. But a key role is played by federal R&D spending, which helps to ensure that the United States remains at the cutting edge of basic microelectronics R&D and thus attractive to the most talented students, researchers, and teachers. In recent years federal funding for university-based research in sciences relevant to information technologies has declined. The number of graduates from U.S. universities with electrical engineering degrees has also declined since the mid-1980s. Graduate students are moving away from the semiconductor industry "into other areas, such as nanotechnology… and the professors have been going where the money is."[25] The U.S. needs to substantially increase such outlays, particularly for university-based semiconductor R&D.

Tax holidays as an investment incentive. China is replicating one of Taiwan's most powerful promotional tools in the semiconductor industry, the creation of an environment for semiconductor enterprises in which they are virtually exempt from corporate income taxation. The virtual elimination of taxation on enterprises is an extremely powerful form of investment incentive which is not, and probably cannot be, replicated in the United States. Moreover the tax holidays and other tax incentives offered by China and Taiwan are not clearly inconsistent with existing WTO or other multilateral rules. Yet absent some form of policy response, the existence of such powerful incentives in China, Taiwan and elsewhere will accelerate the locational shift of semiconductor manufacturing and design activities outside of the United States.

Taiwan in China

The notion that China could become one of the world's principal centers of semiconductor production in the foreseeable future may seem far-fetched given the fact that China's semiconductor industry presently accounts for only 1.5 percent of world production, supplies only about 15 percent of its own market, and lags several years behind the global state of the art technologically. But China's underdeveloped status in microelectronics is a product of certain longstanding impediments that are rapidly fading, such as multilateral export controls on semiconductor technology transfers to China and China's own command-economy industrial policies. Moreover, China is poised to make rapid advances in microelectronics because of Taiwan's growing influence, both as an example of successful industrial development and as a source of capital, managerial expertise, and skilled manpower:

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25 John Kelly, Novellus Systems, in Charles W. Wessner, Ed., *Securing the Future: Regional and National Programs to Support the Semiconductor Industry* (Washington, D.C.: National Academy Press, 2003), p. 169.

- ***Taiwanese industrial policy has succeeded in developing one of the world's most dynamic semiconductor industries.*** Taiwan has deployed an array of government policy measures which have supported the growth of a highly competitive, entrepreneurial private sector in microelectronics. Taiwan has pioneered an increasingly influential business model -- the foundry -- in which domestic firms, with government backing, assume the cost and risk of semiconductor manufacturing. Under the foundry model, a producer manufactures the designs of other semiconductor producers in return for a service fee, assuming the burdens and risks associated with investment in manufacturing facilities.[26] Taiwan accounts for roughly 63 percent of the world's foundry production. As of mid-2000, according to some estimates, Taiwan was the focus of as much as half of the world's forecast investment in new state-of-the-art semiconductor manufacturing facilities.[27]

- ***China is implementing the Taiwanese developmental model for the semiconductor industry on a larger scale.*** Chinese central, regional and local governments are now applying policy tools and business models -- including the foundry concept -- derived from Taiwan's example to develop China's semiconductor industry on a larger scale (Figure 3).[28] Like Taiwan, China is creating a virtually tax-free environment for enterprises and extending major tax benefits to key personnel in the semiconductor industry. Modern high-tech industrial parks patterned on Taiwan's Hsinchu Science-Based Industrial Park have been established in Shanghai, Suzhou and Beijing, and are planned in other cities and regions.[29] Like Taiwan, China is spinning off government

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26 The composite investment cost estimates prepared for this study set the investment costs for a 12-inch wafer, 0.09 micron fab in the U.S. at $2.4 billion. These cost estimates, based on a composite of estimates from SIA member companies, reflect the cost of physical structures and equipment. (See Figure 2 infra) The increasing costs and risks associated with building a single state-of-the art semiconductor wafer fabrication facility -- over $2 billion and rising -- is forcing all but a small and dwindling number of U.S. and foreign semiconductor producers to forego direct investments in current-generation semiconductor manufacturing operations. Japanese analysts have recently observed that even with respect to that country's large electronics firms, investments on this scale are "utterly out of the question for a single company." "Next Generation Semiconductor Project – METI Tells Firms to Discard Own Plants," *Nikkei Sangyo Shimbun* (June 12, 2002).

27 A year 2000 Japanese survey of planned investments in the 12-in wafer fabrication facilities indicated that over half of the planned facilities were being established by Taiwanese firms. "Investments in 300mm Plants Heating Up," *Nikkei Microdevices* (June 2000). See also "TSMC-UMC Duopoly Could Spell Trouble as Capacity Shortage Loans," *Electronic Buyer's News* (August 19, 2002).

28 Chinese government planners are now "putting into practice what was successful in Taiwan: China is following the Taiwan model to build its chip industry, enlisting overseas Chinese from Europe, the U.S., Singapore and Taiwan to invest, buil*d* and cash in on its market…Following the Taiwan model is beginning to bear fruit for China [in semiconductors]." "Report on 'Myth, Reality' of Taiwan Chip Makers Investing in China," *Taipei Times* (January 1, 2001).

29 "Industry, Government, and Universities United in Enthusiasm and Talent for LSIs and LCDs," *Nikkei Microdevices* (March 2001). A number of "Chinese Hsinchus" are described in Section V.D of this paper. Shanghai's Zhangjiang Hi-Tech Park, the site of new foundries being established by Grace and SMIC, "in many ways emulates the construction plan of Taiwan's Hsinchu Science Park." *Chung-Kuo Shih-Rao* (November 20, 2000). The same could be said of several other special zones, such as the Suzhou Industrial

Figure 3
Comparison of Taiwanese and Chinese Promotional Measures In Microelectronics

Item	Taiwan	China
Strategic Government Economic Plans	Six Year Plans	Five Year Plans
Special promotional legislation	Statute for Upgrading Industries (SUI)	Some Policies for Encouraging the Development of the Software Industry and the Integrated Circuit Industry (Circular 18)
Enterprise tax exemption	5-year tax holiday	5-year tax holiday
Semiconductor infrastructure	Government-provided infrastructure in designated high technology parks	Government-provided infrastructure in designated high technology parks
Locational tax incentives	Special tax incentives for enterprises located in designated high technology parks	Special tax incentives for enterprises located in designated high technology parks
Capital gains tax	None	None
Government-provided equity	Government equity investments in start-up microelectronics enterprises (TSMC, UMC, Vanguard)	Government equity investments in start-up microelectronics enterprises (SMIC)
Preferential loans	Low-interest loans from government banks	Low-interest loans from government banks
Privatization of government research labs	Spinoffs of government research institutes to create private enterprises (UMC, Innova, Winbond)	Spinoffs of government research institutes to create private enterprises (Huada, Shanghai Fudan Micro)
Principal form of semiconductor manufacturing investment	Foundries	Foundries
Border measures	None	Preferential VAT for domestically-made ICs (6% domestic, 17% import)

research organizations to create new private firms, promoting a venture capital industry, and undertaking passive government minority equity investments in some privately-owned semiconductor enterprises.[30]

- ***China's differential value-added tax is exerting a powerful pull on Taiwanese semiconductor producers to transfer manufacturing operations to China.*** China levies a value-added tax (VAT) on imported semiconductors of 17 percent, but provides VAT rebates to domestic semiconductor designers and manufacturers that result in an effective VAT rate of 3 percent on devices made and sold in China. This policy, which creates an artificial cost advantage for domestically designed and manufactured devices, places enormous pressure on the Taiwanese semiconductor industry to establish manufacturing operations on the mainland or risk being shut out of China's large and growing market. The differential VAT underlies the current rush of Taiwanese investment to China.[31]

- ***A substantial proportion of Taiwan's semiconductor manufacturing is moving to mainland China.*** Present trends suggest that during the next decade the preponderance of Taiwan's new semiconductor investment will be on the Chinese mainland, and that the manufacturing operations will draw with them ancillary design, packaging, testing and assembly operations.[32] Large numbers of senior Taiwanese semiconductor managers and engineers are relocating from Taiwan to China to run new Taiwan-invested foundries on the mainland. The new Taiwanese foundries represent vehicles for the large scale transfer of Taiwanese managerial and

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Park, Beijing Economic-Technical Development Area, and Beijing's Zhongguancon Science Park. Taiwan's Irving T. Ho, who served as the first director of Hsinchu Science-Based Industrial Park, subsequently became an adviser to several industrial parks in China. "Hsinchu Industrial Park Founder Comments on Park's 20-Yr. History," *Taipei Central News Agency* (13:32 GMT, December 11, 2000). A Japanese observer who toured China's leading Hi-Tech Parks in early 2002 observed that "Everything [is] moving at a breakneck pace…a Japanese observer living there told me that 'a year ago, this was a row of houses, but now a main thoroughfare several kilometers long has been completed and is ready for traffic'…There seems to be little doubt that the technical levels and industrial scope of the infrastructure to support the semiconductor industry will be growing rapidly in the days to come." "Japanese Microelectronics Expert Reports on Tour of High-Tech Parks in China," *Nikkei Microdevices* (January, 2002).

30 See Section V.G.2, infra.

31 See Section III, infra.

32 Despite conditional easing of mainland investments in 8-inch wafer fabrication facilities, Taiwan still prohibits its companies from setting up integrated circuit packaging, testing, and design operations in China. However, "the restrictions have proven useless" as Taiwanese firms set up operations controlled through offshore subsidiaries. Siliconware Precision Industries Co., Taiwan's third largest packager, has already began production at its packaging business in Wuxi, Jiangsu Province. Other firms, like Taiwan's Advanced Semiconductor Engineering, Inc., Taiwan's second-largest chip packager, are making preparations to building packaging plants in China as soon as the current ban is lifted. Kevin Chenel and Hung Yu-Fung, "Affiliated Industries May Follow Chipmakers to China," *Taipei Times* (September 12, 2002). See Section IV, infra.

technological skills to mainland China, much as U.S. know-how was transferred to Taiwan through jointly-invested U.S.-Taiwan projects in the 1980s.

- ***Taiwanese industrial policies will increasingly support mainland-based semiconductor operations.*** The government of Taiwan is adjusting to the migration of much of its semiconductor manufacturing to China by implementing policies seeking to retain "headquarters" functions in Taiwan, including R&D, design, finance, logistics and marketing.[33] Given that such functions must by definition be integrated with mainland manufacturing operations, Taiwan's successful industrial policies will increasingly operate to enhance the international competitiveness of the Chinese semiconductor industry.

Understanding Taiwan's "Move to the Mainland"

It is now apparent that an increasing and perhaps predominant proportion of new Taiwanese semiconductor investments in the future will occur on the mainland. Yet as recently as mid-2000 Taiwan's government and industry were planning a massive investment drive on the island itself, envisioning a total of 30 new Taiwanese wafer fabrication lines by the year 2010, most of them to be located in new or existing "science-based industrial parks" in Taiwan.[34] No wafer fabs were planned for the Chinese mainland. In fact, although new 12-inch wafer fabs are being built in Taiwan, Taiwan-based semiconductor investments have not materialized on the scale envisioned in 2000.[35] Instead, as Figure 1 indicates, Taiwanese semiconductor enterprises are building or plan to build at least 19 new fabs -- all of them foundries -- in China over the next 6-8 years. Spokesmen for the companies indicate that while the initial lines are using 8-inch wafer technology, future lines will employ 12 inch wafers, and the new 8-inch lines will be converted to 12-inch lines as soon as this is feasible.[36] In effect, the Taiwanese investment drive

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[33] The most dramatic example of its new policy direction is the Si-Soft Project, pursuant to which the government opens a new "semiconductor design park" to complement existing high-technology parks; spends $250 million on R&D for optoelectronics, embedded processor design, and wireless microelectronics technologies; and massively expands its university-based microelectronics training programs -- adding 85 new university faculty positions per year for three consecutive years. Tax measures place increased emphasis on R&D, training, and on maintaining "operational headquarters" in Taiwan. In addition, "operational headquarters" established in Taiwan are exempt from tax on managerial and R&D services in selected industries including semiconductors. An R&D and training tax credit has been raised from 25-50 percent to 50-100 percent. The Executive Yuan's Development Fund is increasing its support for venture capital funding for IC design and distribution firms. Generally see Section IV.B.3, infra.

[34] Interviews with Taiwan Ministry of Economic Affairs (Taipei, July 2000), Electronics Research and Service Organization (ERSO) (Hsinchu, July 2000).

[35] Four new 12-inch wafer fabs are operational in Taiwan and six more are planned -- a substantial amount of capacity, but well short of the twenty-one 12-inch fabs originally planned.

[36] According to a recent Japanese report, Shanghai's Semiconductor Manufacturing International Corp. is building a 12-inch wafer fabrication pilot line within its operational 8-inch line. "Latest Construction

envisioned in 2000 has not been significantly abandoned or scaled back, but its geographic locus has partially shifted from Taiwan to China.

The fusion of Taiwanese capital and managerial and technical expertise in microelectronics with China's vast resources and the support measures of Chinese government institutions may be one of the most significant developments in the entire history of the global semiconductor industry. Yet the factors underlying this development are poorly understood. It is a very recent trend which has taken by surprise even Taiwanese industry insiders like Morris Chang, founder of TSMC.[37] Moreover, the trend does not reflect any strategic decision by the Taiwanese government planners who have guided the successful development of the island's semiconductor industry to date -- indeed, these planners are now searching for policy tools that will enable them to apply brakes to the industry's move to the mainland and ensure that at least some key elements of the semiconductor industry remain in Taiwan.[38] A number of Taiwanese managers involved in moving semiconductor operations to the mainland have explained that the move to China is a "commercial decision" based on business considerations. From the perspective of individual companies and managers that may well be true, but traditional market-based factors commonly cited do not, in fact, suffice to explain the broader trend:

- ***Semiconductor manufacturing operations in China do not have a significant cost advantage over production in Taiwan.*** The influx of Taiwanese investment and expertise into semiconductor projects on the mainland is often attributed to assumed major cost advantages associated with operations based in China versus Taiwan.[39] It is true that Taiwanese makers of computer peripherals and consumer electronics products have achieved major cost savings by moving their operations from Taiwan to China. But, in semiconductor manufacturing, from a pure investment and operating cost perspective there is only a small cost difference between Taiwan and China (Figure 4).[40]

Plans, Status of 300mm Fabs," *Tokyo Semiconductor FDP World* (October 2002). Structures presently being built by the Taiwanese foundries to house 8-inch lines are being constructed to support eventual 12-inch lines. Interviews with Taiwanese foundry executives (Shanghai's 2002).

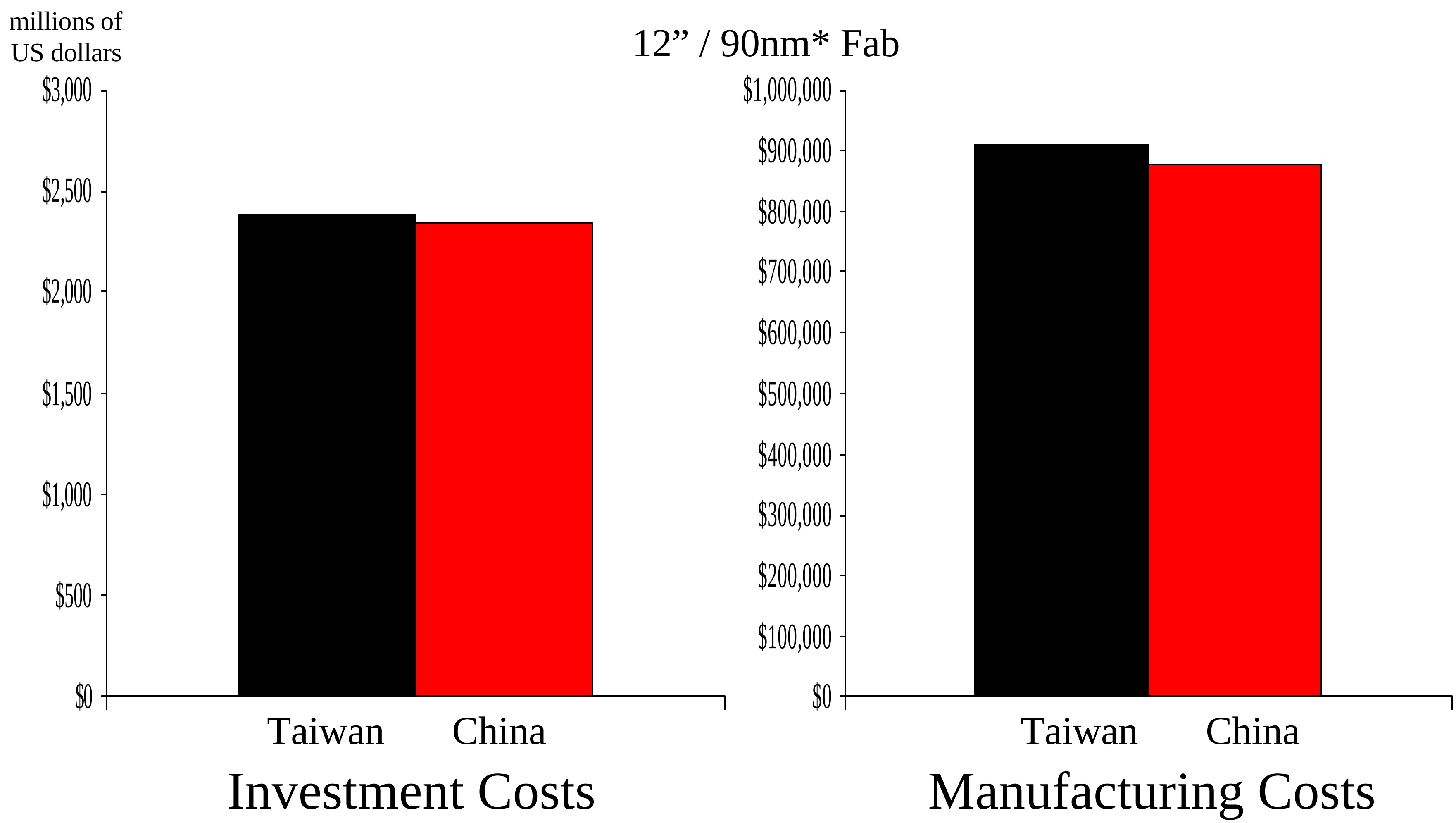
37 As recently as late 2000 Mr. Chang did not foresee significant Taiwanese investment or involvement in the mainland semiconductor industry. In December 2000 he said that TSMC would not set up plants or make investments in China "in the near future." "Taiwan Firm Says PRC Cannot Surpass Taiwan in Microchip Technology, *"Taipei Central News Agency (09:07 GMT, December 11, 2000)*. See also "From Taiwan, a Fear of Chinese Technology," *New York Times* (October 3, 2001). UMC Chairman Robert Tsao made similar comments in 2000. "Taiwan's Semiconductor Giant 'in no Hurry' to Invest in Mainland China," *Taipei Central News Agency* (November 17, 2000).

38 See Section IV.B., infra., summarizing interviews with Taiwanese government semiconductor Industry planners (Taipei, September 2002)

39 According to one Taiwanese source in 2001, the construction cost for a wafer fab in China was 35 percent lower than in Taiwan, water was 60 percent less and bulk gas, 30 percent less. "Report on 'Myth, Reality' of Taiwan Chip Makes Investing in China," *Taipei Times* (January 7, 2001).

40 The derivation of these cost estimates is set forth in Appendix 2. These comparative estimates do not take into account the impact on cost of various investment incentives which are made available by governments

Figure 4
Taiwan v. China:
Cost Differences Cannot Explain Shift



Source: Member survey; assumptions

- ***Construction cost.*** There is almost no cost difference between locating a facility in Taiwan or China with respect to building and equipping new wafer fabrication facilities.[41] The total investment cost for a 200mm fab using 0.13 micron process technology is $1.96 billion in Taiwan compared to $1.93 billion in China. For a 300mm fab using 0.09 micron technology, the estimated investment cost is $2.38 billion in Taiwan compared to $2.34 billion in China (Figure 5).[42]

- ***Operating Costs.*** Operating costs for an 8-inch fab using 0.13 micron process technology are estimated to be 9 percent lower in China than in Taiwan (Figure 6). This differential is forecast to shrink to 6 percent with respect to 12-inch wafer, 0.09 micron operations (Figure 7).[43]

Almost all of the manufacturing cost difference between Taiwan and China is accounted for by labor costs.[44] But because labor costs account for a smaller proportion of total cost in semiconductor manufacturing than is the case with respect to most other kinds of manufacturing operations, China's lower labor costs do not, by themselves, give China a decisive locational advantage over Taiwan. "Cost is not the major issue," said a TSMC spokesman in 2001.[45]

- Taiwan is not running out of resources over the near term. Popular accounts of Taiwan's new mainland investments in semiconductor foundries sometimes conclude that these investments are being driven by the limits of Taiwan's resources -- land, people, water, electricity. It is true that over the long run such resource constraints are a factor that will

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in China and Taiwan. But incentive policies are similar in both locations with the exception of China's differential value-added tax, which has a decided impact on relative costs.

41 Appendix 2, Tables 1 and 2.

42 China has a small advantage with respect to the construction of physical structures. But because equipment costs, which represent about 80 percent of total investment costs, are virtually identical for Taiwan and China, the total investment costs are very close. Investment costs for China are 98 to 99 percent of investment costs for Taiwan.

43 Appendix 2, Tables 3-6. The composite cost data indicate that with respect to total manufacturing cost Taiwan is about 5 percent higher than China for a 200mm wafer fab using 130nm process technology, and 4 percent higher for a 300mm wafer fab using 90nm technology. With respect to operating costs only, labor costs explain 98 percent of the cost difference between Taiwan and China for a 200mm wafer fab and 80 percent of the cost difference for a 300mm fab. The composite cost estimates do not take into account regional differences in manufacturing infrastructure (including toolmaker support) that affect overall costs of doing business in a particular location. In China, outside of the Shanghai area, for example, infrastructure conditions are less than optimal. Higher costs due to lack of adequate infrastructure may more than offset the labor cost advantages that have been identified with respect to China.

44 The labor cost data for Taiwan and China do not reflect the cost of stock payments and amenities (housing, transportation, etc.) not directly associated with employee compensation costs. The payment of employees with stock is a feature of the mainland foundries as well as Taiwan-based firms. The mainland operations are incurring substantial costs with respect to employee amenities like housing, schools and recreational facilities. If anything the net effect of these factors is to narrow China's labor cost advantage over Taiwan.

45 Tseng Jin-hau in "Report on Myth, Reality of Taiwan Chipmakers Investing in China," *Taipei Times* (January 2001).

Figure 5
Wafer Fab Investment Costs

	130nm, 200mm Fab			90nm, 300mm Fab		
	U.S.	Taiwan	China	U.S.	Taiwan	China
Physical Structures	408	402	379	518	490	453
Equipment	1,570	1,557	1,553	1,906	1,894	1,889
Total	1,977	1,959	1,932	2,424	2,384	2,342

Capacity Assumption:
8,000 wafer starts per week for 130nm/200mm fab and 6,000 wafer starts per week for 90nm/300mm fab.

Figure 6
Manufacturing Cost Comparison for 130nm, 200mm Wafer Production

	U.S.	Taiwan	China
Direct Labor	100	43	16
Indirect Labor	100	47	22
Production Silicon	100	101	101
Test Silicon	100	101	101
Masks	100	102	103
Chemicals and Gases	100	100	101
Water	100	90	86
Other Operating	100	98	97
Total Operating	100	84	77
Equipment Depreciation	100	99	99
Building Depreciation	100	99	93
Total Manufacturing	100	90	86

Assumptions
1. 8,000 wafer starts per week.
2. All production subsidies excluded
3. All labor differences due entirely to wage differentials, not productivity differentials.
4. Equipment depreciated using straight-line method over 5 years.
5. Building depreciated using straight-line method over 20 years.
6. All costs stated on a total annual cost basis.

Figure 7
Manufacturing Cost Comparison for 90nm, 300mm Wafer Production

	U.S. *($ '000)*	Taiwan *($ '000)*	China *($ '000)*
Direct Labor	33,519	15,431	6,414
Indirect Labor	56,400	27,343	12,569
Production Silicon	***	***	***
Test Silicon	***	***	***
Masks	***	***	***
Chemicals and Gases	***	***	***
Water	***	***	***
Other Operating	478,805	464,827	459,055
Total Operating	568,724	507,601	478,038
Equipment Depreciation	381,200	378,700	377,700
Building Depreciation	25,900	24,500	22,669
Total Manufacturing	975,824	910,801	878,407

Assumptions

1. 6,000 wafer starts per week.
2. All production subsidies excluded
3. All labor differences due entirely to wage differentials, not productivity differentials.
4. Equipment depreciated using straight-line method over 5 years.
5. Building depreciated using straight-line method over 20 years.
6. All costs stated on a total annual cost basis.

encourage investments outside of Taiwan, including in China, but they do not suffice to explain the current trend:

- With respect to ***land***, while Taiwan's Hsinchu Science Park is full and has no room for addition semiconductor wafer fabs, Taiwan's Tainan Science-Based Industrial Park has land available for the new wafer fabs.

- The need for additional ***manpower*** does not explain the move to the mainland. TSMC, the largest semiconductor manufacturer in Taiwan, has recently downsized its work force. China's work force may constitute a major source of skilled labor in the long run, but most of the skilled workers needed to oversee the new mainland fabs cannot be found in China at present. Without exception, the new Taiwanese fabs on the mainland are being staffed by large numbers of Taiwanese and other foreign expatriates, relocated at substantial cost, and offered compensation packages superior to those in Taiwan.

- Although Taiwan is experiencing periodic shortages of ***electricity and water***, these resources have been rationed by the government in a way which gives priority to semiconductor manufacturing, and shortages of this kind have not significantly disrupted production. Taiwan's government is investing substantially in new electric power and other infrastructural projects.

- Taiwanese producers are not simply "following market demand." The world semiconductor industry is experiencing a protracted slump in demand which has depressed operating rates of Taiwan-based semiconductor manufacturers, who serve global markets. The fact that Chinese semiconductor demand is forecast to grow rapidly even as global markets stagnate commonly prompts the comment that Taiwanese semiconductor firms are moving to the mainland to take advantage of the growth in that market.[46] According to some, they are simply "following their customers" -- Taiwanese makers of PC equipment, consumer electronics products, and telecommunications equipment who have already relocated to the mainland since the mid-1990s. But the Chinese semiconductor market can be served from Taiwan, which is geographically proximate to China and is as close or closer to many Chinese end users than the new mainland foundries themselves.[47] As one Taiwanese observer commented, if Taiwanese firms were moving to China out of a need to get "closer to China's market… [then] Taiwan and Japan should stop thinking about selling their products in European and American markets [and] Europe and the U.S., for the same reason, should not expect their chips to dominate East Asian

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[46] China's electronics industry is growing at an annual rate of 20 percent, and while producers in most of the world's regions are suffering from excess capacity, China lacks sufficient semiconductor manufacturing capacity to supply more than about 15-20 percent of its own growing demand. According to some forecasts, China will be the world's largest consumer of semiconductors by 2010. "China Features an Economic Saving," *Semiconductor International* (September, 2002).

[47] In 2001 TSMC's Morris Chang explained that his firm did not need to move production to the mainland in order to "follow his customers" -- he pointed out that "75 percent of my customers are overseas right now, in Europe, the U.S. and Japan." "Report on 'Myth, Reality' of Taiwan Chip Makers Investing in China," *Taipei Times* (January 1, 2001).

markets because of the distance problems"[48] In fact, while some competitive advantages accrue from being located in close proximity to end users, that fact does not explain the wholesale shift of Taiwanese investment to the mainland that has occurred since mid-2000.

Impact of China's Differential Value-Added Tax

The principal factor underlying the relocation of much of Taiwan's semiconductor manufacturing capability to China is the Chinese government's implementation of a Value-Added Tax rate which discriminates in favor of domestically-made semiconductors against comparable imported devices. In 2000, pursuant to its Tenth Five Year Plan, China's Central government launched a comprehensive new promotional effort in the semiconductor sector, the key elements of which were spelled out in State Council Circular 18 (June 2000), *Some Policies for Encouraging the Development of the Software and Integrated Circuit Industry*. Among other measures, Circular 18 provides that domestically-based IC manufacturers are entitled to a refund of that portion of China's 17-percent value-added tax (VAT) which exceeds 6 percent (a number that was later reduced to 3 percent) for products designed and/or manufactured in China. All imported semiconductors, by contrast, must pay VAT at the full 17 percent rate with no refund. As an added benefit for mainland-based manufacturing, semiconductor manufacturing equipment and raw materials may be imported VAT-free for qualifying domestic enterprises.

Numerous semiconductor executives and industry observers point to China's differential VAT as a powerful factor underlying Taiwanese investment in mainland foundries.[49] One of SMIC's outside directors, Tsuyoshi Kawanishi, recently emphasized the competitive edge which China's differential application of the VAT accorded his company. When asked to list advantages to foreign chipmakers of using his firm's foundry services. He noted that among other factors:

> *China offers the tax advantages. Chips made outside of China are subject to a value-added tax of 17% when sold in the local market, while those produced within China are only taxed at 3%. Right there, using SMIC brings a 14% tax savings.*[50]

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48 Huang Tien-Lin, 'Taiwan's Tigers Turning Into Pawns," *Taipei Times* (February 8, 2003).

49 Interviews with executives at Taiwan-invested semiconductor foundries (Shanghai, September 2002).

50 "Interview with Tsuyoshi Kawanishi," *Nikkei Sangyo Shimbun* (March 28, 2002). See also interview with SMIC President in which he makes the virtually identical observation, "Interview with SMIC President Richard Chang", *Nikkei Microdevices* (February 2002). As noted in Section II, infra, the VAT preference for semiconductor manufacturing may be increased, with producers paying an effective VAT of only 3% instead of 6%. Harvey Chang, CFO of Taiwan's TSMC, indicated recently that because of China's discriminatory application of the VAT, TSMC was coming under pressure from its customers to establish a manufacturing presence in China: "Our U.S. customers, who have either joint ventures or wholly owned

China's VAT preference encourages investment in domestic semiconductor manufacturing by sharply increasing the rate of return investors can expect from their semiconductor investments. Assuming that the effective VAT rule for semiconductors is clarified at 3 percent, the Chinese government's reduction of the VAT on *domestic* ICs by 14 percentage points (from the normal 17 percent to 3 percent), has the same effect as a 14-percent import duty on foreign-produced semiconductors.[51] Given the current market conditions in China, such protection against imports provides an effective price umbrella under which domestic manufacturers can significantly raise prices *and* capture additional sales volume from imports. Price increases go "straight to the bottom line" and volume increases raise capacity utilization, which reduces average unit costs. Under reasonable assumptions regarding Chinese foundries' costs and prices, with the differential VAT domestic producers' profits can increase from two to five times. Because of China's largely tax-free environment for domestic semiconductor manufacturers, these increased profit rates translate directly into proportional increases in investors' rates of return (Figure 9).

Article III of the General Agreement on Tariffs and Trade (GATT), to which China is now a signatory, prohibits (a) the application of internal taxes to imported products which exceed those assessed against domestic products, and (b) use of internal taxes in a manner which "afford[s] protection to domestic enterprises." China's differential VAT does both. It is an example of a WTO-inconsistent policy used to distort investment patterns in a manner which disadvantages at least one WTO member (Taiwan) and possibly others, to the advantage of the WTO member (China) imposing the discriminatory tax. China's use of a WTO-inconsistent measure to draw in investment that might not otherwise take place would be an issue of concern for policymakers in any industrial sector in which it occurred, but concern is heightened when such a measure is employed in a strategic sector like semiconductors. The U.S. government should engage in bilateral discussions with China seeking the elimination of the discriminatory VAT as a priority matter. (The economic and legal implications of China's preferential VAT are addressed in greater detail in Section III of this report.)

The Challenge Posed by Tax Holidays

Both Taiwan and China provide so many tax "holidays" and incentives that leading semiconductor manufacturers operate in an environment in which their corporate income is subject to little or no taxation. The Taiwan Semiconductor Manufacturing Corporation (TSMC), Taiwan's largest semiconductor maker, for example, accumulated so many tax credits and tax

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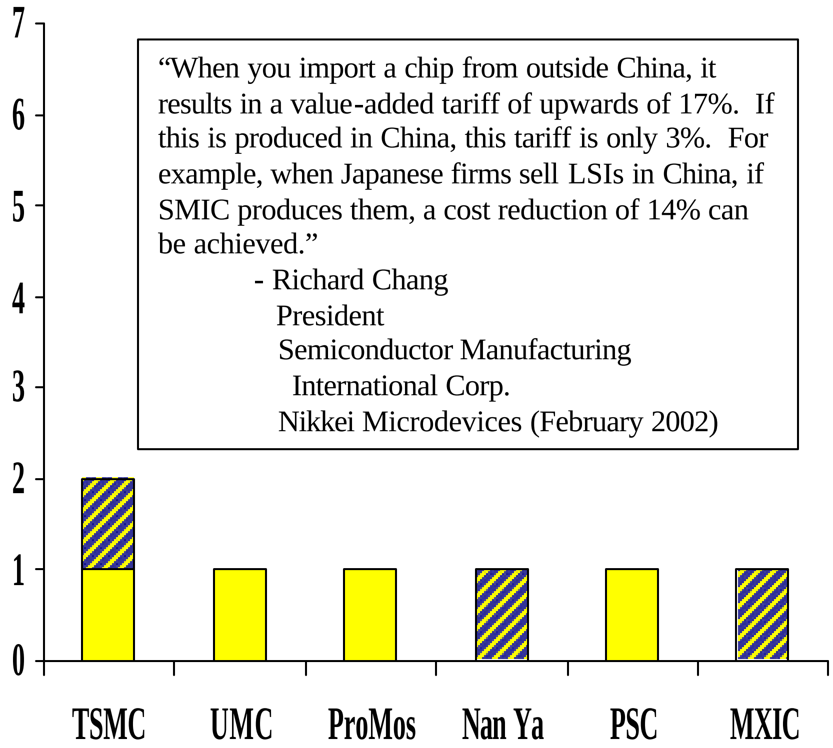
subsidiaries in China, have indicated to us that sooner or later we have to be there, because it costs them a lot in taxes to import our goods." "Taiwan to China," *CFO Asia* (July 2002).

51 Although there is some uncertainty over whether the current VAT policy calls for a 3-percent or 6-percent VAT on domestic semiconductor manufacturing, the government intends to set the level at 3-percent and research suggests that investors are basing their decisions on the belief that the VAT will indeed be set at 3-percent. Investment decisions are based on expectations, not eventual actual outcomes, and thus the 3-percent rate is the more appropriate VAT to consider.

FIGURE 8
CHINA'S DIFFERENTIAL VAT IS DRAWING TAIWANESE INVESTMENT TO THE MAINLAND

Taiwan-Invested Wafer Fabrication Lines Since 2001

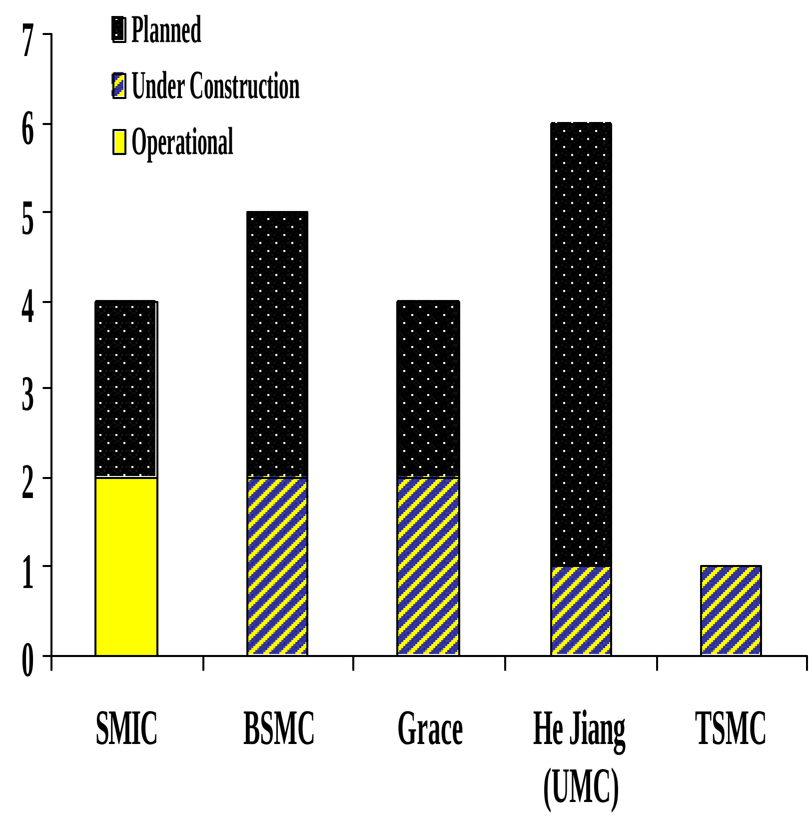
<u>Taiwan</u>



"When you import a chip from outside China, it results in a value-added tariff of upwards of 17%. If this is produced in China, this tariff is only 3%. For example, when Japanese firms sell LSIs in China, if SMIC produces them, a cost reduction of 14% can be achieved."
- Richard Chang
President
Semiconductor Manufacturing International Corp.
Nikkei Microdevices (February 2002)

7 Fabs

<u>Taiwan-Invested Fabs In China</u>



19 Fabs

Figure 9

Summary of Effects of Chinese Policies on Net Profit

Note: These numbers are illustrative only, based on a reasonable hypothetical.

Chinese Semiconductor Preferences					
VAT Preference[1]	Tax Holiday[2]	Soft Debt[3]	Description	Net Profit (millions USDs)	Ratio to Base Case
None	None (15% tax)	None	Base case, assuming no preferences	**89**	**1.0**
3%*	None (15% tax)	None	VAT preference: ***price effect only**	**179**	**2.0**
3%**	None (15% tax)	None	VAT preference: **price **and volume** effect	**375**	**4.2**
3%	**Tax Free**	None	VAT preference price effect, with zero enterprise tax	**211**	**2.4**
3%	**Tax Free**	**3pp preference**	VAT preference price effect, with zero enterprise tax, soft debt	**225**	**2.5**
3%**	**Tax Free**	**3pp preference**	All effects	**456**	**5.1**

Notes:

1. "3% VAT preference" indicates domestic ICs pay a net (post-refund) VAT of 3% rather than 17% normal (and imported IC) VAT.
2. Tax holiday assumes that the enterprise pays zero tax. All other scenarios assumes enterprise pays current rate normally applied to FIEs.
3. Assumes SMIC received $480 million in government loans (as suggested by evidence) at 3 percentage-points below market (pure assumption for illustrative purposes)

holidays that its after-tax income was equal to or even higher than its pre-tax income from 1994 through 2000 (Figure 13).[52] The fact that Taiwanese semiconductor enterprises usually pay no corporate income taxes has made available a larger pool of retained earnings for capital investment and R&D. Taiwan's tax policies are now being replicated by China. Tax holidays are in many respects more advantageous than direct subsidies, given the terms and conditions that governments often attach to grants, loans and other forms of direct financial contribution to industry. The cumulative effect of China's tax holidays and its preferential Value-Added Tax is a substantial net benefit to enterprise profitability for operations located in China (Figure 9).

There is no U.S. counterpart to the tax holidays now found in China and Taiwan. Some U.S. state and local governments offer tax abatements to firms that locate in designated industrial and high technology zones, but no state or locality can provide an exemption from federal corporate income tax or capital gains tax. The U.S. federal government has enacted certain tax measures that are advantageous to the semiconductor industry and other high technology sectors, most notably the research and development tax credit. But it is unrealistic to expect that the U.S. government would ever be prepared to grant the semiconductor industry -- or any other sector, for that matter -- a complete exemption from federal taxation for a duration of five or more years, as commonly occurs in China and Taiwan. It is also unlikely that the U.S. can use WTO rules or U.S. trade remedies to induce Taiwan, China and other countries offering tax holidays to eliminate those policies.[53]

To the extent that tax holidays being employed in Taiwan and China distort international investment patterns to a degree sufficient to warrant a U.S. policy response, two courses of

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52 TSMC enjoys tax holidays for income generated from facilities established in Taiwan's Hsinchu and Tainan Science-Based Industrial Parks. The tax holidays are authorized by the park administrative bodies, which operate under special statutory authority, the *Statute for The Establishment and Administration of the Science-Based Industrial Parks*. Pursuant to the *Statute for Upgrading Industries*, TSMC receives tax credits ranging from 5 to 20 percent of investments, depending on the type and origin of assets, which can be applied to taxes otherwise payable within five years of the acquisition date of the asset. The same statute also grants TSMC the right to credit up to 20 percent of its investment in "emerging, important and strategic industries" against tax payable within five years after the expiration of the first three years of investment. Taiwan Semiconductor Manufacturing Company Limited, Securities and Exchange Commission Form 20-F, for the fiscal year ended December 31, 2001, filed May 9, 2002, p. 74.

53 While the tax holidays offered to strategic industries in Taiwan and China may be regarded by some as market distortions, it is not clear that legal disciplines exist for such measures in the WTO system. The tax holidays are clearly "subsidies" as that term is defined under WTO rules. ASCM Article I.1(a)(1)(ii). But they do not fall into one of the narrow categories of subsidy "prohibited" under WTO rules. The tax holidays may constitute "actionable" subsidies if they are found to have caused "injury" to the industry of a WTO member, "nullification and impairment of benefits accruing to other members, or "serious prejudice" to the interests of another member. But "adverse effects" sufficient to render a subsidy actionable have proven difficult to establish in WTO Dispute Resolution proceedings, and would be particularly difficult to show here -- indeed, in traditional terms, it could be argued that foreign semiconductor firms are helped, not hurt, by the tax holidays. Moreover, to be actionable a subsidy must be "specific" to an enterprise or industry or group of enterprises or industries, a test which may not be met here. Because the tax holidays in Taiwan and China are available to a number of sectors besides the semiconductor industry, a question would be presented as to whether the measures are sufficiently "specific" to be actionable. ASCM Article 5; ASCM Article 2.

action are open which are not mutually exclusive. First, the U.S. can seek to negotiate a multilateral accord establishing ground rules with respect to the extent to which any country may use tax exemptions in order to attract investment in key industries.[54] The other available response is to analyze the relative tax burdens associated with semiconductor manufacturing and design in the United States as compared to China and Taiwan, and, to the extent that a disparity exists that is so large that it significantly influences locational decisions with respect to investments, U.S. tax policies should be modified to reduce the disparity.

The "Talent Magnet" Phenomenon

China is beckoning to overseas Chinese students, entrepreneurs, engineers and scientists "to return to serve their motherland and carry out their own research to contribute to the rejuvenation of the Chinese nation."[55] Hu Qili, China's former Minister of Information Industries, observed in 2000 that "talented people are the most important asset of the semiconductor industry… as well as the decisive elements for survival and development amid acute competition."[56] The government is offering an array of incentives to Chinese and non-Chinese individuals with backgrounds in the semiconductor industry to relocate to China. The rapidly-growing Chinese market, and the perception of boundless opportunities for individuals, is an even more powerful incentive. For whatever motive -- patriotism, incentives, pursuit of opportunity, or some combination of these -- tens of thousands of people are responding.[57]

The U.S. has an abiding national interest in maintaining technological leadership in microelectronics, particularly with respect to basic and applied R&D and process technology. To the extent China/Taiwan or any other country or region becomes a more powerful magnet for top-flight talent than the United States itself, the U.S. could lose its leadership in this critical industry. That challenge cannot be addressed by efforts to impede Chinese development -- likely to prove futile in any event -- but through close attention to U.S. domestic policies affecting critical factors having an impact on this industry, such as adequacy of resources for basic research, the U.S. education system, immigration policy, and the investment environment.

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[54] Such an effort would be complicated by factors such as differences in national regimes of taxation and the importance of the tax holidays to existing constituencies. In addition, as China's preferential VAT policy indicates, the existence of a multilateral accord does not necessarily prevent implementation of measures which, at least in the view of some of the parties to that accord, are inconsistent with its terms.

[55] He Guoqiang, Member of the Political Bureau, Chinese Communist Party Central Committee, "He Guoqiang Encourages PRC Scientists in Other Countries to Return Home," *Xinhua* (12:42 GMT, February 14, 2003).

[56] Hu Qili, "Seize Opportunity to Develop China's Semiconductor Industry," *Renmin Ribao* (April 19, 2000).

[57] Liu Jie, "Back Home for Business," *China Daily* (04:04 GMT, January 2, 2003); Rune Tempest, "China Tries to Woo Its Tech Talent Back Home," *Los Angeles Times* (November 25, 2002).

Tax policy toward individuals plays a significant role in recruiting talent in Taiwan and China. Taiwan's tax rules for individual income tax enable employees to receive company stock as compensation with little or no tax liability, which has given Taiwanese semiconductor companies a dramatic edge in competing for the most talented managers and engineers.[58] In China, stock options and stock given to individuals as compensation are taxable, but in practice are frequently not taxed, reflecting the difficulty experienced by Chinese tax authorities in tracking such income.[59] In addition, Chinese policymakers have taken increasing note of the inducement effects which reduced individual income tax rates have on skilled high technology workers.[60] China's Hi-Tech Parks, for example, extend their own tax breaks to semiconductor managers and engineers, which include practices such as the refund of a portion of individual income tax for use in connection with the purchase of a house or a car.[61]

Although tax incentives and other inducements affect decisions by individuals, the most powerful motivating force influencing locational decisions in the semiconductor industry is the relative quality of the available professional opportunities. Governments can affect this equation, to a limited extent, by providing "sweetening" incentives to key individuals, such as tax breaks, cash payments, and amenities such as provision of housing and cars on preferential terms, but they ultimately have a more powerful impact through programs which stimulate research, development, design and education, particularly at the cutting edge of the semiconductor industry. The most talented individuals are drawn to the areas where state-of-the-art work is being undertaken. Maintaining U.S. leadership as the most attractive location for leading people in this field will require sustaining and increasing federal funding for basic semiconductor research, particularly in U.S. universities. At present, federal funding of microelectronics-related R&D in the United States is declining.[62]

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58 Employees receiving stock as compensation are taxed on the par value of the stock, not the market value, so that a share of stock with a par value of $1 and a market value of $100 would be taxed as $1 of income. Taiwan has no capital gains tax so that no tax is due when capital gains are realized, apart form a small securities transaction tax. *Taiwan Tax Law*, Chapter I, Section 1, Article 4. Recent reports indicate that Taiwan's Ministry of Finance may revise this polcy to tax income derived from the exercise of options on the basis of the exercise price, rather than par value. *AFX Asia* (August 4, 2003).

59 In China the marginal tax rate on "wages and salaries" over 100,000 yuan is 45 percent, but the flat tax rate on many investment-related items, including transfer of property, is 20 percent. *Individual Income Tax Law*, Article 3.

60 "Favorable tax revenue support should be provided to foreign S&T talent engaged in creative enterprise. The Finnish government tax rate for high income foreigners with high technology is only 58 percent that of the local people. As a direct effect of the high level of taxation in Canada, Canadian talent is streaming into the U.S. pool." Chen Zhaofeng, "A Study of the Disposition of Foreign S&T Talent Resources Under the New Economic Conditions," *Keji Guanli Yanjiu* (December 2, 2001).

61 Interviews with Hi-Tech Park officials in Shanghai and Beijing (September 2002).

62 Charles W. Wessner (ed.), *Securing the Future: Region and National Programs to Support the Semiconductor Industry* (Washington, D.C.: National Academies Press, 2003), pp. 50-54.

Conclusion

The development of a modern semiconductor industry in China will not represent a national security threat to the United States or competitive threat to the U.S. semiconductor industry in the foreseeable future. The real challenge posed to U.S. policymakers and the U.S. industry by the expansion of Chinese semiconductor manufacturing capability is that over the longer term China's growing "gravitational pull" will draw capital, people, and ultimately, leading edge R&D and design functions away from the United States as China is now doing with respect to Taiwan. To the extent this gravitational pull reflects the effects of government policy measures, the U.S. needs to identify and implement a series of appropriate responses.

Figure 10
Known Semiconductor Manufacturing Operations in China

Enterprise	Location	Ownership	Startup	Wafer Size	Design Rules (microns)	Wafers/month
Huajing	Wuxi	State	1989	4"		17,000
Wuxi CSMC Huajing (leases 2 lines from Huajing)	Wuxi	CSMC (Hong Kong) (51%) Huajing (State) (49%)	1999	6" 5"	0.5 3.0	9,000 12,000
Huayue	Shaoxiang	State	1980	4" 5"	3.0-4.0 3.0	5,000 5,000
Shougang NEC	Beijing (Badachu)	NEC (Japan) Shougang Iron & Steel (State)	1991	8"	0.25	
Motorola MOS 17	Tianjin (Xiqing)	Motorola (100%)	2001	8"	0.25	12,000
Advanced Semiconductor Manufacturing Corp. (ASMC)	Shanghai	Philips, Northern Telecom, Shanghai Gov't	1993	8" 6" 5"	0.25 0.60 1.50	5,000 40.000 30,000
Shanghai Belling	Shanghai	Alcatel, Shanghai Bell, Shanghai Gov't	1988	8" 4"	0.35 1.2	10,000 7,000
Shanghai Huahong NEC	Shanghai	NEC (Japan), Huahong (State)	1997	8"	0.35	7,000
Semiconductor Manufacturing International Corp. (SMIC)	Shanghai (Zhangjiang)	Private, diverse ownership	2002	8"	0.25	85,000
TSMC	Songjiang	TSMC (100%)	2003	8"	0.25	

Enterprise	Location	Ownership	Startup	Wafer Size	Design Rules (microns)	Wafers/month
Grace Semiconductor Manufacturing Corp.	Shanghai (Zhangjiang)	Private, diverse ownership	2002	8"	0.25	50,000
Zhuhai Nanke IC Company	Zhuhai	Taiwanese		6"	0.5	20,000
Chengdu Guoteng Communications	Chengdu			6"	0.5	15,000
ON Semiconductor	Leshan (Sichuna)	ON Semiconductor (51%) Leshan Radio (49%)	2002	6"	0.25	
Mitsubishi Stone	Beijing	Mitsui, Mitsubishi, Stone Group (State)	1996	8"	0.28-0.35	
Shenchao Semiconductor	Shenzhen			8"		
Wuxi Microelectronics Research Center	Wuxi	State		5"		2,000
SIM-BCD (bipolar)	Shanghai	Shanghai Institute of Metallurgy, BCD Semiconductor (Bermuda)	2001	6"	1.0-4.0	20,000
Beijing Semiconductor Manufacturing Corp. (BJSMC)	Beijing (BDA)	SMIC, Beijing, Municipal Gov't, Shougang Iron & Steel	2003	8"	0.25	
He Jiang	Suzhou (SZIP)	Invest League (Br. Virgin Islands), other private	2003	8"	0.25	60,000
Nanjing Semiconductor Manufacturing Corp. (NJSMC)	Nanjing New and High Tech Industrial Development Zone	Nanjing High Tech Park Development Corp., Michigan Holding Company (Samoa)	2004	6"		30,000

Figure 11
Microelectronics: China Embraces Taiwan's Model

Policy/practice	China 1994	Taiwan 2000	China 2002
Principal form of leading semiconductor enterprises	State-owned enterprise	Private, gov't holds passive minority share	Private, gov't holds passive minority share
Business model of leading semiconductor firms	Integrated device maker	Foundry	Foundry
Policy toward foreign direct investment	Heavily restricted	Liberalized	Liberalized
Promotion of IC design industry	Emphasis on state-owned research institutes	Privatization of gov't research institutes Financial assistance to private companies	Privatization of gov't research institutes Financial assistance to private companies
Government as direct investor in leading firms	100% gov't ownership of semiconductor enterprises	Government passive minority equity stake	Government passive minority equity stake
Tariffs on semiconductors	6-30 percent	0	0
Industrial parks	Over 100 "Hi-Tech parks"	1 flagship park (Hsinchu), 2-3 others emerging (Tainan, Nankang)	1 flagship park (Zhangjiang), 2-3 others emerging (Suzhou, Beijing)
Major financial incentives to individuals	None	Major tax benefits	Major tax benefits
Government controls enterprise decisionmaking	Yes	No	No
Government promotion of venture capital sector	No	Yes	Yes

II. INDUSTRIAL POLICY: THE CHINA-TAIWAN CONVERGENCE

China's current promotional effort in microelectronics is being spearheaded by capital and managerial talent from Taiwan. The new 8-inch foundries being established on the mainland are majority-owned by Taiwanese interests. In addition, China is quite openly imitating the industrial policies utilized by Taiwan to develop its own semiconductor industry. In the 1980s and 1990s those policies drew foreign and overseas Chinese capital, technology and talent into Taiwan's semiconductor enterprises. China's replication of those policies is one element in its successful effort to draw significant segments of Taiwan's microelectronics infrastructure into the Chinese mainland.[63] The one major new Chinese policy measure with no Taiwanese parallel, the differential VAT, is using the leverage of China's large internal market to accelerate the physical transfer of Taiwan's semiconductor operations to the mainland.

Taiwan's past and present industrial promotion policies are relevant to an examination of Chinese policies in this sector for two reasons. First, Taiwan's past promotional policies offer a guide to China's own developmental strategy -- indeed, China's current promotional effort more closely represents that of Taiwan in the 1990s than its own policies during that decade (Figure 11). Second, the ongoing integration of the two industries will increasingly make "Taiwanese" policies de facto "Chinese" policies. In an effort to preserve a role for itself in the semiconductor industry, Taiwan is implementing policies designed to produce a de facto division of labor with China, with the island serving as a "headquarters" -- performing design, R&D, logistics, finance and managerial functions for semiconductor manufacturing operations based in mainland China. This so-called "Roots in Taiwan" strategy means that promotional policies implemented by the government of Taiwan will enhance the international competitiveness of semiconductor enterprises in mainland China itself.

A. Failure of the "command" model in Chinese microelectronics (1956-99).

Implementation of China's present promotional effort in the semiconductor industry (and similar efforts in other high technology sectors) has required policymakers to abandon doctrines and policy tools which have driven Chinese economic policy since the Communist Party assumed power in 1949. In prior decades Chinese planners sought to introduce selected aspects of successful foreign high tech systems into China's command economy, but with consistently disappointing results. But within the past five years, Chinese planners appear to have concluded that the command-economy model itself is the problem -- at least in high technology -- and that basic elements of this system, such as state control of major enterprises, must be jettisoned if China is ever to build a globally competitive semiconductor industry. In retrospect it is evident

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63 "[G]overnment programs and business plans have targeted major advancements in China's chip industry during the past 40 years, but most of these effort(s) have failed… But government and business leaders are also quick to say that they believe that China has finally found the right -- and somewhat ironic -- formula for success. A major new twist in that formula is the utilization of talent, management skills, and funds from rival Taiwan. In fact, three of China's six major chip ventures are now run by Taiwanese executives." Mark LaPedus, "China's Latest Chip Plan Adds Help from Taiwan," *Semiconductor Business News* (March 30, 2001).

that China has been moving toward this transition incrementally since the 1970s, with the example of Taiwan providing the decisive impetus at the end of the decade of the 1990s.

Chinese enterprises began making semiconductors in the 1950s, but the industry remained primitive by Western standards through the mid-1980s.[64] Political upheavals in the 1960s and 1970s impeded the industry's evolution.[65] The broad program of national economic reform which began in 1978 under the leadership of Deng Xiaoping sought to upgrade the microelectronics sector, but without much initial success. Chinese promotional policies were characterized by pervasive and heavy-handed government direction with respect to research, investment and enterprise decisionmaking, yet the measures taken were duplicative, poorly coordinated, and dispersed resources "in all directions."[66] Reflecting the disappointing results of the Sixth (1981-85) and Seventh (1986-90) Five Year Plans, at the end of the 1980s the Chinese semiconductor industry lagged many years behind the global state of the art.[67]

Beginning in the late 1980s, based on extensive study of the social and commercial dynamics underlying Silicon Valley and Route 128 in the United States, more sophisticated government measures were introduced. The principal tools of industrial policy, however, remained state-owned enterprises and government research institutes, implementing objectives set by central planners:

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64 The first transistor was created in China in 1956, and the first integrated circuit in 1965, a diode transistor logic (DTL) device (Texas Instruments and Fairchild Semiconductor achieved this in 1958). By the mid-1970s China had about 40 small scale LSI production lines, but these lagged many years behind the state of the art. Chu Dechao, Wuxi CSMC Huajing, "Overview of the Semiconductor Market in China," *Tokyo Semiconductor FDP World* (November 2000). A Technical Assessment Report sponsored by the U.S. government in 1979 summarized the state of the Chinese semiconductor industry as follows: "In 1979, the state of integrated circuits in China was about where the United States had been in 1963; processing was done with 25 to 30mm-diameter silicon wafers, and often these wafers were processed even after they were broken, indicating a shortage of good silicon material. An understanding of many of the issues that had been addressed by Western integrated circuit facilities came only by reading foreign literature. Frequently, the details of process steps were not well understood, and homemade remedies were developed for such things as sodium contamination, particulate problems, metallurgical alloying issues, and others, among the multitude of problems that had been solved earlier by the Japanese, US, and even European semiconductor facilities." Foreign Applied Sciences Assessment Center, *Chinese Microelectronics* (Science Applications International Corporation, 1989).

65 Chinese leaders now acknowledge that the Cultural Revolution inflicted "'reformation' on sci-tech personnel [and] did great harm to human resources." Wang Chunfa, Deputy Director, Chinese Association for Science and S&T Policy, interviewed in *Renmin Ribao* (August 21, 2002).

66 *Jingji Guanli* No. 6 (1990).

67 The most advanced Chinese wafer fabs of the mid-1980s utilized 3-inch wafers and had a yield of only a few thousand wafers per month. Chu Dechao, Wuxi CSMC Huajing, "Overview of the Semiconductor Market in China," *Tokyo Semiconductor FDP World* (November 2000).

- ***The Torch Plan,*** launched by the State Council in 1988, sought to establish "Silicon Valleys" across China in the form of High Technology Development Zones (HTDZs), and to promote the formation of new high technology enterprises.[68]

- ***The 863 Plan,*** personally backed by Premier Deng Xiaopeng, was an effort to elevate China's technological level in key sectors including microelectronics.[69] Groups of experts were sent to the U.S., Europe and Japan to study high technology development and foreign experts were invited to China to make presentations. On the basis of the information gathered, specific R&D tasks were undertaken by scientific academies and research institutes.[70]

- ***Specific projects to upgrade semiconductor enterprises*** were launched by the national leadership to create manufacturing facilities that were more advanced than existing operations. Pursuant to "Project 908," Huajing, a state-owned enterprise based in Wuxhi, was provided with assistance in establishing a 6-inch, 0.9 micron wafer fab in the early 1990s.[71] Under "Project 909," the government provided financial support for the establishment of an 8-inch fab by Shanghai Huahong NEC,[72] the establishment of an 8-inch silicon monocrystal production line, and the founding of several IC design houses.[73]

Impediments to progress. Chinese industrial policy measures of the 1980s and 1990s sought to incorporate certain positive aspects of Western high technology systems (such as the industry clustering dynamic observable in Silicon Valley) into China's command-economy system without fundamentally transforming the system itself. Such promotional measures served to improve China's capabilities in microelectronics, but none of them, individually or collectively, did much to close the technological gap with the West. A number of major obstacles -- some of them intrinsic to the Chinese economic system, some of them externally imposed -- served to prevent technological catch-up:

- Inability to create world class semiconductor enterprises. Chinese planners were frustrated by their inability to foster indigenous semiconductor enterprises comparable with those

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68 *Guangming Ribao* (March 23, 1991); *Zhonyguo Keji Luntan No. 4* (July 1992); *Shanxi Ribao* (September 12, 1992).

69 In March 1986 four researchers from the Chinese Academy of Sciences sent a letter to the Central Committee of the Communist Party proposing a major national effort to promote science and technology (the "863" designation is a reference to this March 1986 genesis). Deng vigorously backed this initiative, reportedly exclaiming that "postponing it is inexcusable." Xu Dechao, CSMC, "The 863 Plan that Encouraged the Growth of China's High-Tech Industry," *Tokyo Semiconductor FDP World* (August 2001).

70 *Beijing Keji Bao* (January 5, 1991); *Keji Ribao* (January 25, 1990).

71 Chen Shuxin, "Project 908 Exports Certified," *Zhongguo Dianzi Bao* (January 23, 1998).

72 "How to Develop Integrated Circuits Industry," *Renmin Ribao* (May 15, 2000).

73 "Ground Broken for Shanghai Huahong Microelectronics Ltd.'s VLSI Project 909," *Zhongguo Dianzi Bao* (November 29, 1996).

of the global leaders. Between the 1960s and 1980s a number of wholly state-owned semiconductor companies were established by the Chinese government, aimed largely at domestic markets and military applications.[74] But even the most successful of these enterprises, Huajing and Huayue, never approached the scale or level of competitiveness of a typical Western multinational semiconductor enterprise.[75] In the mid-1990s the Chinese government began encouraging the formation of 50-50 joint ventures (JVs) between domestic entities and foreign semiconductor firms with the hope that the foreign firms would supply needed process technology, training, managerial skill and capital. The JVs proved more successful than the wholly state-owned firms, but even the most advanced Chinese-foreign JVs lagged behind the technological levels of integrated device manufacturers (IDMs) elsewhere in Asia.[76]

- ***Chinese restrictions on inward foreign investment***. Chinese planners recognized that they had little hope of developing a globally competitive semiconductor industry without substantial inward foreign investment and technology transfer, and in the 1990s a major effort was mounted to attract foreign firms, utilizing financial and tax incentives and the offer of entry into the local market.[77] However, this effort was severely hampered by the abiding desire of Chinese officials to control and in some cases micromanage foreign investment.[78] Foreign

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[74] Huajing, the largest wholly state-owned wafer fab in China, is located in Wuxhi. Huajing received semiconductor process technology from Toshiba in 1982 and at the time was regarded as "the flagship enterprise of China's semiconductor industry," a status which it retained through 1997, when it was eclipsed by Shanghai Huahong NEC. Huajing has subsequently received significant technology transfers from Toshiba, Infineon and Lucent. Huayue, established in 1980, mainly produces bipolar devices for TV and other consumer products. Other significant SOEs manufacturing semiconductors include Jiangyin Changjiang, Shanghai Huaxu, Guangdong Xinhui Guifeng, and Tianshui Yonghong. Chu Dechao, Wuxhi CSMC Huajing, "Overview of the Semiconductor Market in China," *Tokyo Semiconductor FDP World* (November 2000).

[75] Most of the state-owned enterprises were subsidiaries of the China Electronics Corporation, a vast conglomerate which until 1999 was an arm of the Ministry of the Electronics Industry and whose "performance in the market [was] far below our expectations," according to the recent comments of one of its senior executives. Liu Xuehong, Vice President of CEC, in Li Weituo, "CEC Craving Overseas Listing," *China Daily* (December 11, 2002). Some of the SOEs continue to operate today, generally with 6-inch and smaller wafer technology, but they are far from globally competitive -- and it is unlikely that additional enterprises of this kind will be formed. In late 2001, Jiang Shang-zhou, a senior Shanghai industrial-development official, acknowledged that "The state has invested a lot of funds in these [semiconductor] SOEs, but the achievement is not as much as we expected…. So we will no longer make direct investment in this industry." Cache of http://www.siliconstrategies.com/story/OEG20011004S0113; "China's drive for IC foundry market unnerves Taiwan," *Electronic Engineering Times*, (November 4, 2001).

[76] The JVs are credited with elevating the country's technology and process levels above those achieved by the old state-owned enterprises, but are still seen as trailing significantly with respect to the global state of the art. Interview with Foreign Economic Relations & Trade Commission (Shanghai, September 2002).

[77] "In order to attract technology from overseas we are prepared to give over a considerable part of the market to foreign investors." Interview with State Economic and Trade Commission (Beijing, June 1994).

[78] Chinese policymakers worried that unrestricted foreign investment would result in foreign "monopolization" of the market, and utilized a variety of controls and restrictions -- including informal administrative measures -- to prevent such an outcome while encouraging technology transfer.

establishment of 100-percent owned local subsidiaries in the semiconductor industry was prohibited, and foreign firms were encouraged to enter into 50-50 joint ventures with Chinese semiconductor enterprises, a proposition many foreign firms found unattractive. Market access was negotiated as a frank quid pro quo involving technology transfer in return for a portion of the domestic market.[79] Foreign firms complained that clear-cut transparent rules governing the terms of inward investment did not exist, making large scale investments risky.

- ***Western technology controls***. During the Cold War the U.S. and its allies maintained restrictions on the export of semiconductor technology and equipment which effectively ensured that China could not achieve technological parity with the global leaders. These restrictions were relaxed somewhat at the end of the Cold War under the multilateral Wassenaar Arrangement, but still constituted a significant developmental impediment.

- ***Trade restrictions.*** Prior to accession to the WTO, China imposed tariffs on imports of semiconductors, and import quotas were enforced against many electronics products.[80] "Trading rights" -- the privilege of conducting import and export transactions -- were denied to foreign firms. These restrictions constituted a deterrent to foreign investment and slowed the development of electronics and IT sectors dependent upon imported semiconductors.

- ***Weakness of the infrastructure***. China lacked the infrastructure needed to support advanced semiconductor manufacturing. As recently as 2000 an official from Taiwan's ERSO commented that it would not be possible to build a 12-inch wafer fab in China in the next five years because there was "no technology, no managers, no infrastructure, no management to control the work process."[81]

Through the mid-1990s Chinese government officials extolled the success of their country's efforts in microelectronics, but by the end of the 1990s the cumulative effect of the differing developmental paths taken by Taiwan and China were inescapable. Taiwan -- with a fraction of the resources and people available to China -- had succeeded in creating a globally competitive semiconductor industry with a growing share of the world market and excellent

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79 "We have policies we are adopting in semiconductors… You give us technology, we will give you a part of the market into which to sell your product." Interview with Ministry of the Electronics Industry (MEI) (Beijing, June 1994).

80 In 1994 the tariff on integrated circuits was 30 percent, with a 20 percent rate applicable to transactions entitled to a preferential rate. Complex ICs that could not be made domestically were dutiable at a lower rate (11 percent regular, 6 percent preferential). Actual duties paid varied considerably as a practical matter reflecting the flexibility enjoyed by local customs officials. Tariffs were widely circumvented by smuggling, generally through Hong Kong. Electronic products subject to quotas in China in the mid-1990s included color televisions, central processing components for computers, hard disk drive, VCRs, CD players, electronic calculators, word processors, and home satellite receivers. Semiconductors were not subject to quotas. MOFTEC and SETC, *Quota List for Import of Machinery and Electronics* (January 1, 1994); *Rules and Regulations for the Import and Export of Tariff of the Peoples Republic of China* (1994); Office of the U.S. Trade Representative, *1994 National Trade Estimate Report on Foreign Trade Barriers*, p. 46; Semiconductor Industry Association, *Semiconductors in China* (1995), pp. 106-11.

81 Interview with ERSO, Hsinchu (July 2000).

future prospects.[82] By contrast the Chinese industry still lagged several technological generations behind the global state of the art, supplied only about 15 percent of China's domestic demand, and was not a significant presence in any major market outside of China.[83] To some degree, China's shortcomings reflected what it characterized as the Western "blockade" of the export of advanced semiconductor technology, which required China to rely for decades on indigenous technology, equipment and personnel.[84] But by the end of the 1990s, with Western export controls loosening, it was evident that China's weak performance could not be attributed solely to technology restrictions. The developmental system employed by Taiwan had proven superior to that of China.

At the end of the 1990s, in drawing up China's Tenth Five-Year Plan, the Chinese planners confronted not only the bleak results of their past promotional efforts, but the prospect that entry into the WTO would deprive them of many of the traditional industrial policy tools they had employed in this and other priority sectors.[85] In a major departure, the government devised a new plan for the semiconductors industry that would be based, to an unprecedented

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82 Taiwanese firms had not only pioneered the foundry business model, but could boast of the best foundry operations in the business -- TSMC and UMC, which between them held roughly two-thirds of global foundry production. Taiwanese firms were world leaders in semiconductor manufacturing efficiency, and by 2000, UMC was actually transferring semiconductor manufacturing technology to the Japanese semiconductor industry, a startling reversal of roles between Japan and a firm based in its former colony. Y. Nagahiro, "Hitachi-UMC Tie-Up to Generate Test Cases that will Forecast the Future of LSI Technology and Business," *Nikkei Microdevices* (February 2000).

83 By the end of 2000 China had approximately 30 operational front-end semiconductor fabrication facilities, of which two thirds employed very obsolete 3- to 4-inch wafer technology. Only two enterprises were producing DRAMS in China (Shougang-NEC and NEC-Huahong) and no MPUs were being manufactured anywhere in the country. Even with respect to discrete devices Chinese firms held only about 30 percent of the domestic market. "China's Semiconductor Industry: Foreign, Firms Hold Key to Meeting Great Demand," *Tokyo Semiconductor FDP World* (July 2002). As the Chinese government itself acknowledged in 2000, the most recent national promotional effort, which had been implemented under the Ninth Five-Year Plan, had left China's semiconductor industry as a "bottleneck that curbed the development of the [Chinese] IT manufacturing industries…. The scale of the IC industry was small; the development of new components was more backward than the development of machinery. Key instruments and equipment basically relied on import[s]." http://www.trp.hku.hk/infofile/china/2002/10-5-yr-plan.pdf.

84 With respect to the evolution of technology controls, see Appendix 4. Between 1973 and 1978 China developed a complete set of manufacturing tools for a production line for fabricating 2-inch wafers, with processing coordinated at the Beijing #878 factory. Between 1980 and 1986 China developed indigenous equipment for fabrication of 3-inch wafers, with processing at the Shaoxing #871 factory, subsequently the Huayue Microelectronics Corporation. These two generations of home-grown equipment -- development of which "helped China to maintain a self-reliant spirit" -- were the mainstays of the Chinese IC industry for many years. Ma Xinru, "Status of Semiconductor Equipment Industry," *Zhongguo Dianzi Bao* (November 10, 1998).

85 See the essay by Wang Yungui, State Planning Commission Foreign Economic Institute, "A Study of China's Strategy for Using Foreign Investment After WTO Entry," *Chunqing Gaige* (July 25, 2001).

degree, on incentive policies and measures commonly found in capitalist countries, with a particular eye towards Taiwan and other neighbors in East Asia:[86]

> *China, which has carefully observed how Taiwan succeeded in the LSI industry, hopes to 'as far as possible put into practice measures that were successful in Taiwan,' said as LSI industry leader.*[87]

These policies are being implemented at present pursuant to the Tenth Five Year Plan and define the current public policy environment for the semiconductor industry in China. At present

> *China is following the Taiwan model to build its chip industry, enlisting overseas Chinese from Europe, the U.S., Singapore and Taiwan to invest, build, and cash in on its own market.*[88]

B. The Taiwan paradigm (1972-2000).

Taiwan's creation of an internationally competitive semiconductor industry offers perspectives on the likely further evolution of the Chinese industry. Instead of seeking to hold "foreign capital" at arms length, as Japan and Korea had done, Taiwan embraced it, providing certain key inducements -- most notably efficient semiconductor manufacturing services. Taiwan became an environment that was extraordinarily attractive to leading edge foreign semiconductor manufacturers, and in so doing, drew in investment, technology and talent. With government assistance and incentives, Taiwanese nationals with accumulated experience at foreign semiconductor firms left to establish new, indigenous Taiwanese enterprises.

It is hardly surprising that Chinese planners looked with growing interest at the example being set in microelectronics by their "compatriots" across the Taiwan Straits. As recently as the mid-1970s Taiwan, like China itself, was a poor agrarian society -- as a TSMC executive expressed it, the island's economy consisted of "nothing but paddy fields, sugar cane, and pineapples."[89] A single generation later, large Taiwanese semiconductor producers dominated the world market for foundry manufacturing and were regarded as among the most efficient semiconductor manufacturers in the world -- a TSMC official could boast in 1999 that "our

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86 In May 2000 Qu Weichi, the Vice Minister of Information Industry, said with respect to the next phase of the industry's development that "Learning and studying successful experiences of developed countries and neighboring regions in developing an integrated circuits industry and summing up our country's experiences and lessons in developing an integrated circuits industry has become undoubtedly and extremely vital to our country's development for the future." "How to Develop Integrated Circuits Industry," *Renmin Ribao* (May 15, 2000).

87 Mikimju, "Special Projects -- Part One -- Industry, Government and Universities United in Enthusiasm and Talent for LSIs and Even LCDs," *Nikkei Microdevices* (March 2002).

88 "Chips and the China Syndrome," *Taipei Times* (January 1, 2002).

89 Taiwan's semiconductor industry in the mid-1970s was limited to offshore assembly operations of foreign manufacturers and one small indigenous maker of bipolar devices.

company and Intel are both at the 0.18 micron level so there is no technological gap."[90] Taiwan was mapping out an aggressive capital investment program for the semiconductor industry for the 2000-2010 decade which, if implemented, would have accounted for over half the world's total planned investment in 300mm wafer capacity.

Taiwan's stunning success is often attributed to its private sector, but the Taiwanese industry – like that of China -- was created by the government and has flourished subsequently as a direct result of long range planning and specific supportive government policies. In 1972 Y.S. Sun, then Taiwan's Minister of Economic Affairs, organized the Industrial Technology Research Institute (ITRI) as an arm of his ministry providing applied industrial research to Taiwanese industry. Within ITRI, an organization was established to develop a semiconductor industry, the Electronic Research and Service Organization ("ERSO"), which established pilot manufacturing facilities on its premises for demonstration purposes. Programs sponsoring integrated circuit research were established in Taiwanese universities. Technology was acquired from many foreign sources, including foreign investors in Taiwanese companies.[91] Financial and tax benefits were channeled to the semiconductor industry under the *Statute for the Encouragement of Investment* (1960-91) and its successor, the *Statute of the Upgrading of Industries* (SUI, 1991-2009).[92] Foreign involvement in Taiwan's developmental effort, primarily American, was welcomed from the outset and has remained pervasive down to the present day.[93]

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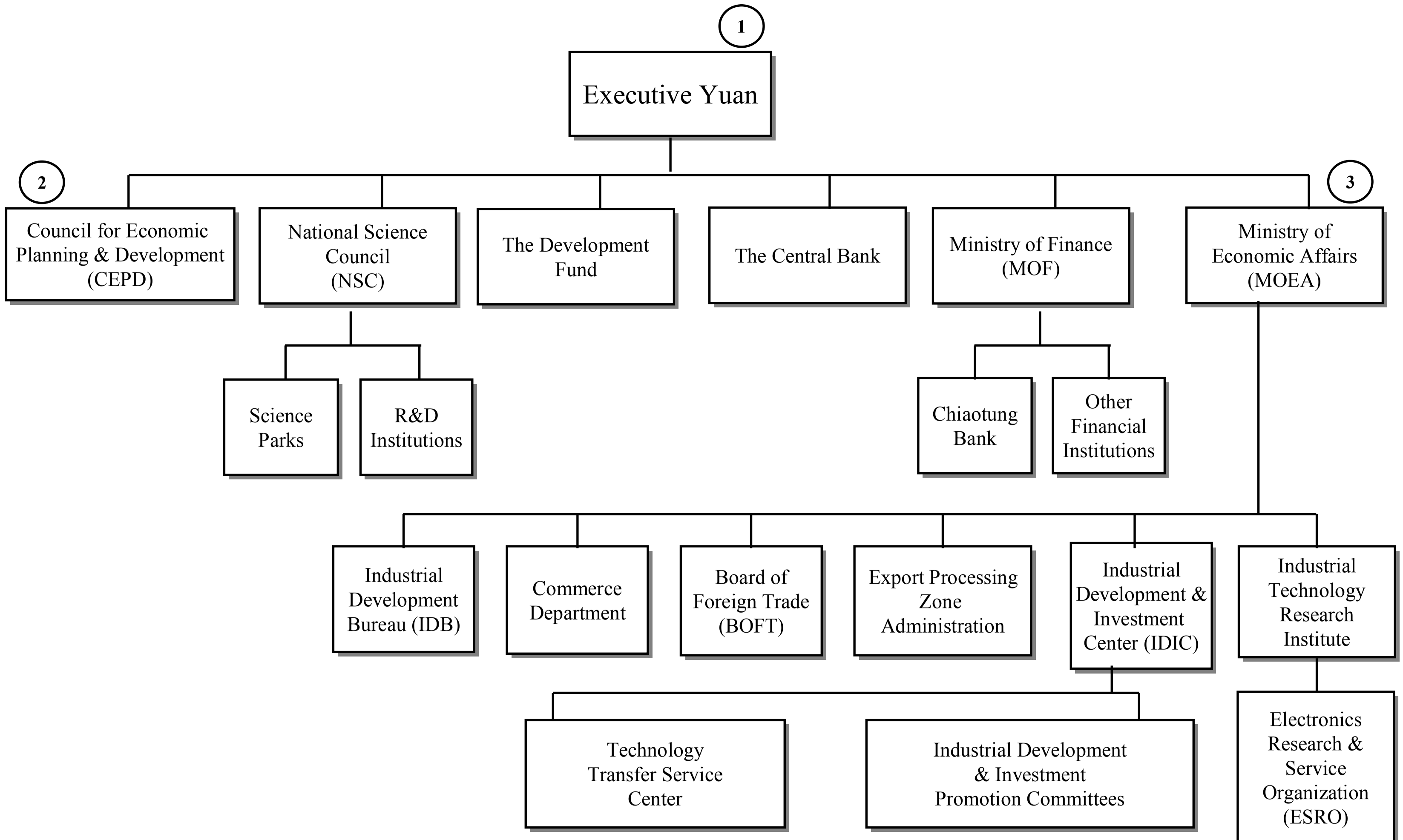
90 "Interview with TSMC's Tseng Fan Ch'eng Regarding Taiwan's Semiconductor Foundry Strategy," *Nikkei Sangyo Shimbun*, August 24, 1999.

91 Taiwan received CMOS fabrication technology from RCA in 1976; TSMC acquired VLSI technology from Philips in 1986; and in the 1990s, DRAM fab upgrades were acquired from Texas Instruments and Oki (Nan Ya and Mosel-Vitelic); Mitsubishi (Powerchip); and Toshiba (Winbond). Despite the deep involvement of foreign firms in the Taiwanese industry, the government ensured that total foreign equity participation was kept below a controlling interest. Matthews and Cho, *Tiger Technology*, op.cit. (2000) at 188-89.

92 The SUI authorizes the government to provide an array of financial and tax benefits on designated priority industries. The Executive Yuan (Cabinet) picks the industries and products to be so favored; the semiconductor industry has been designated as eligible since the inception of the SUI in 1991. Responsibility for directing specific benefits to designated industrial sectors rests with the Industrial Development Bureau (IDB) of the Ministry of Economic Affairs (MOEA). Within the IDB, semiconductor-related policies are formulated by the Semiconductor Industrial Promotion Office (SIPO).

93 Taiwan established an advisory group in the United States consisting of engineers from various U.S. universities and companies, and entered into a relationship with RCA to learn the fundamentals of semiconductor technology. An initial group of 40 Taiwanese went to RCA in 1976 to learn the essentials of semiconductor technology, and a number of this group went on to become leading figures in Taiwan's semiconductor industry. In 1979 Sun established the Science and Technology Advisory Group (STAG) to advise the government on technology issues; the core of STAG was a group of U.S. semiconductor executives including Pat Haggerty, former CEO of Texas Instruments, and B.O. Evans, former VP for Development at IBM.[93] Taiwanese semiconductor companies typically had both U.S. and Taiwanese operations, American and Taiwanese executives, and capital and technological relationships with U.S., Japanese and European firms.[93] Vitelec Corp., for example, was a U.S.-based Silicon Valley firm established by a former Fairchild executive. Vitelec (Taiwan) established a wafer fab in Taiwan in 1989, licensing technology from Oki of Japan, which took a capital stake in the company and a seat on Vitelec's Board. The first director of Taiwan's Hsinchu Science-Based Industrial Park was an American, Cho Li, a

Figure 12
Taiwan's Institutions of Industrial Promotion



Notes:

1. The Executive Yuan revises the statute for upgrading Industries (SUI) and passes it to the Legislative Yuan for deliberation. The Executive Yuan reviews the Industries eligible for preferential treatment under the SUI every two years.

2/3 The CEPD formulates short- and medium-term economic development plans but implementation resides with the MOEA's IDB. The CEPD is currently focused on the APROC plan turning Taiwan into an Asia-Pacific Regional Operations Center in the 21st Century.

Chinese planners built their industry on a foundation of state-owned enterprises, laboratories and research institutes, with pervasive control over decisionmaking by government ministries. By contrast, the government of Taiwan utilized incentive policies intended to create and strengthen a vibrant private sector and did not attempt to exert influence over individual enterprise management. China sought to control inward foreign investment to such a degree that most foreign semiconductor producers were deterred altogether from major investments in China; Taiwan welcomed inward foreign investment with relatively few restrictions.

Science-based industrial parks. In 1980 the government of Taiwan established the Hsinchu Science-Base Industrial Park to attract high technology investment, an initiative based on the example of U.S. regional technology clusters in Silicon Valley and Boston's Route 128. The park has subsequently evolved into one of the most dense concentrations of high technology manufacturing activity in the world. The park offers numerous infrastructural advantages for semiconductor manufacturing and design, including transportation and utilities infrastructure, nearby universities' national laboratories and superb research institutes (including ITRI, arguably the best applied industrial research organization in the world).[94] Two of Taiwan's best universities, National Tsing Hua and National Chiao Tung Universities, with a combined total of 15,300 students and 1,300 professors, are located near the Park, providing not only a source of talent but sites for training and sources of new enterprises.[95] Tax and financial incentives are offered to firms locating in the park.[96] Hsinchu has succeeded in attracting a complete microelectronics industry chain, including wafer fabs; equipment, materials and service suppliers; and assembly, test, and packaging facilities.[97]

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former Honeywell executive. Dr. Morris Chang, the founder of TSMC, served for 25 years at Texas Instruments during the era in which TI emerged as one of the leading semiconductor producers in the world. In a distinguished tenure, Dr. Chang rose to a position of Group Vice President in charge of semiconductors, managing 25,000 employees at 16 plants in 11 countries. Constance Squires Meany, *State Policy and the Development of Taiwan's Semiconductor Industry* (Draft mimeo, December 4-5, 1989).

94 At least 31 of the companies doing business in Hsinchu Park were originally spin-offs from ITRI, including UMC. Nearby national laboratories include the Chip Implementation Center and the National Nano-Device Laboratory. Hsinchu Science-Based Industrial Park website, http://www.sipa.gov.tw/en/sewnde/indus-e/indus-e.html.

95 At least 15 companies located in Hsinchu Park were supported in starting up by academic groups at these two universities. Hsinchu Science-Based Industrial Park website, http://www.sipa.gov.tw/en/sewnde/indus-e/indus-e.html.

96 Financial benefits include equity investments of up to 49 percent from several government institutions, including the Chiao Tung Bank, the National Science Council Science and Technology Fund, and the Executive Yuan Development Fund; low interest loans for up to 65 percent of the total amount of an investment, including a 1-3 year grace period; and grants for R&D. MOEA website, http://it.moeaidb.gov.tw/committee/english/b-4.html.

97 By July 2000 of the 299 companies approved to operate in the park, 118 were integrated circuit enterprises. Hsinchu has been so successful that it no longer has room for additional companies, and Taiwan has established new science-based industrial parks at Tainan and Nankang. Statistics from Science-Based Industrial Park Administration, http://www.sipa.gov.tw/en/seconde/hsip/his00001_07_01.html.

The semiconductor industry is expected to be the largest investor in the newly-created 640-hectare Tainan Science-Based Industrial Park, with investments through the year 2010 projected at $1.12 trillion.[98] Because Hsinchu no longer has sites available, most of Taiwan's new 12-inch wafer fabs are being built in Tainan:

> *The [Tainan Park] is an overspill for Hsinchu, but as 12-inch fabs are being concentrated there, [Tainan] will become much more important in the next 10 years.*[99]

Tai Chein, Directorate General of the Tainan Park administration, has promoted the integration of manufacturing leisure, and environmental protection in the new park, and commented in May 2003 that "If you can make this place look and feel like Silicon Valley, then of course overseas Taiwan scientists and engineers will return. This is their home."[100]

Tax-free environment for enterprises. Taiwanese government officials and local semiconductor executives universally cite the government's tax policy as the single most important form of government financial support for the semiconductor industry. Pursuant to the Statute for Upgrading Industries (SUI), a five year tax holiday is available to firms who use the retained earnings to invest in strategic industries, and numerous additional special tax preferences are provided.[101] The cumulative effect of various tax credits, holidays and special deductions is that major companies like TSMC and UMC can be highly profitable but pay virtually no tax to the government year after year.[102] The impact of these policies on semiconductor enterprise financial results is dramatic -- TSMC, for example, not only enjoys enough tax credits to avoid taxation, but records accumulated excess credits as assets to be used in future years. Thus TSMC has higher net profitability *after* than *before* taxes (Figures 13 and 14).

Open environment for foreign investment and trade. Taiwanese developmental strategy in microelectronics has long emphasized the need to attract inward foreign investment. While

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98 *Taiwan Central News Service* (January 2002). ITRI has opened a "Tainan campus" in the new park, which will have 2000 employees by the year 2008. The National Science Council is also opening a facility at Tainan, the Center for Industrial-Academic Research and Development. Two universities are adjacent to the new park, Cheng Kong University and Sun Yat-Sen University. Http://www.IDIC.gov.tw; www.nsc.gov.tw/english/misisons/tn_schipark.html.

99 "Southern Taiwan Science Park Gets Boost from Flat Panel Makers," *Taipei Times* (July 3, 2003).

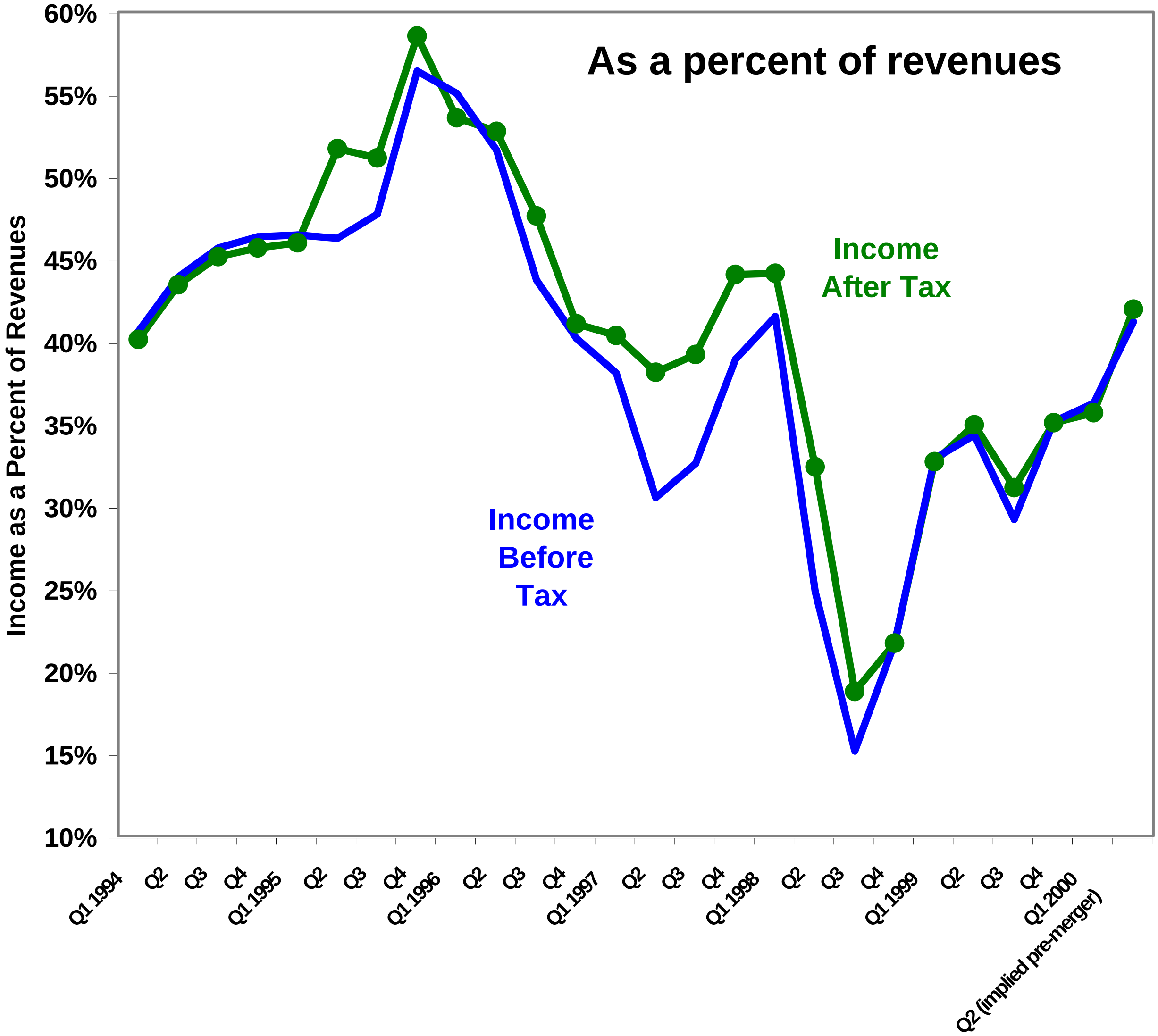
100 William C. Pao, "Southern Taiwan Technology Report Illustrates Success," *China Post* (May 12, 2003).

101 Under the SUI, R&D-related equipment can be fully depreciated in two years; tax exemptions and deferrals are available with respect to mergers; 80 percent of the returns on venture capital enterprises are tax exempt; and special deductions are available for R&D and training. "Cabinet Passes Draft Revision of Statute for Upgrading Industries," *Newsletter*, http://www.web.tranda.com.tw.

102 In addition, in the Science-Based Industrial Parks, a four-year corporate tax exemption is available for expansion of production, with three year carryforward; new enterprises established in the Parks qualify for a five year tax holiday. (MOEA website, http://it.moeaidb.gov.tw/committee/english/b-4.html). There are numerous additional benefits.

Figure 13

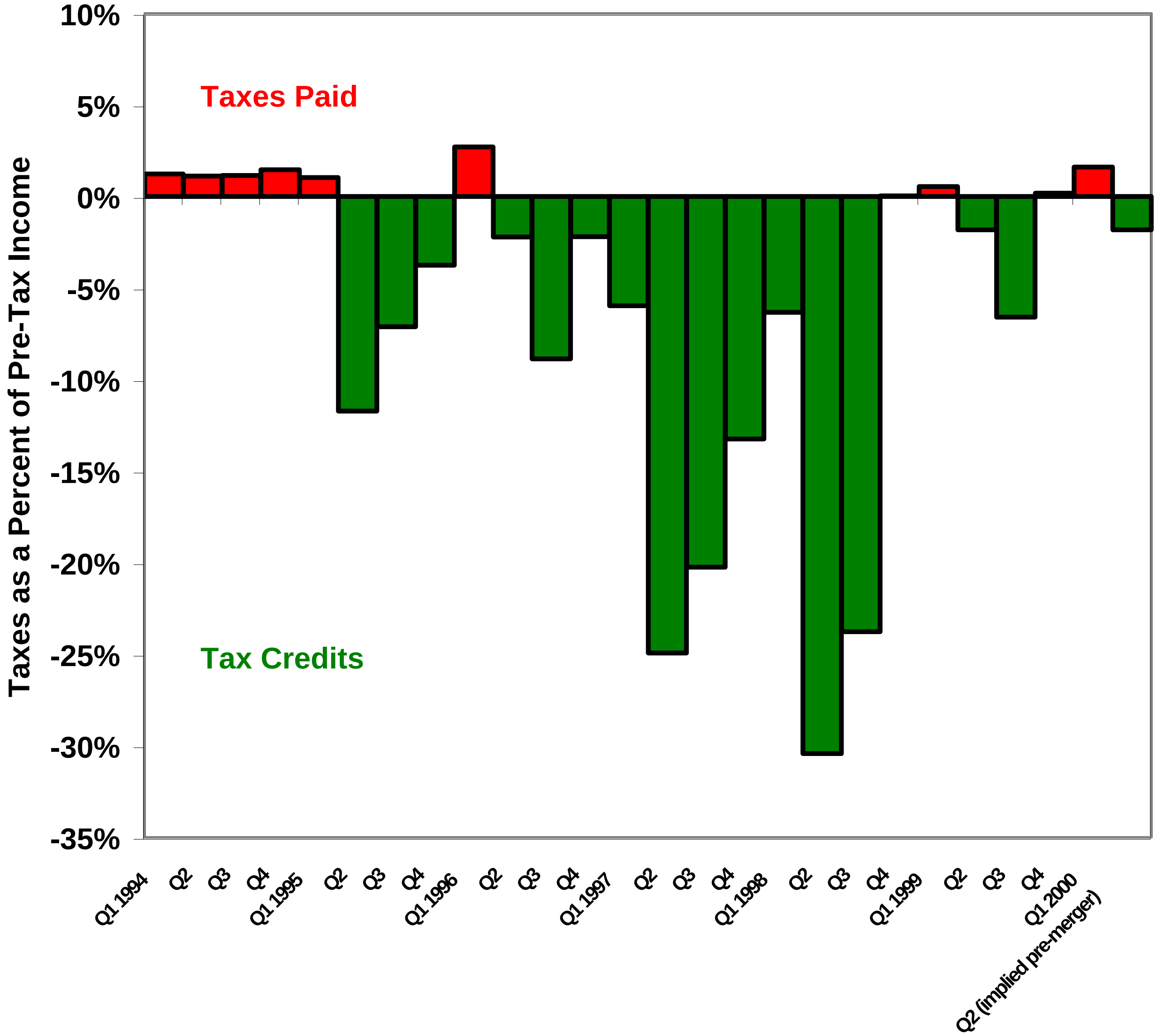
TSMC's Tax Credits Have Boosted Reported Profits



Source: TSMC financials.

Figure 14

TSMC Enjoys Significant Tax Credits and Rarely Pays Taxes



Source: TSMC financials.

foreign investments were subject to screening and approval on a case-by-case basis, foreign semiconductor producers were able to make substantial investments in Taiwan, including equity investments in Taiwanese enterprises. A survey of Taiwanese subsidiaries of U.S. semiconductor producers in Taiwan in mid-2000 revealed no significant trade or investment barriers, a common observation being that "this place is wide open."[103] Taiwan's semiconductor tariffs were reduced to zero on January 1, 1999.[104]

Creation of a venture capital industry. In the 1970s Dr. K.T. Li, a former Taiwan Minister of Economic Affairs, observed how the dynamic venture capital industry in Silicon Valley contributed to the rapid development and commercialization of new technologies.[105] In 1983 Taiwan's government enacted measures supporting the promotion of an indigenous venture capital industry, and "seed funds" were supplied by the Executive Yuan Development Fund to start-up venture capital firms.[106] The government arranged collaborations with U.S. banks to accelerate transfer of know-how, sent individuals to the U.S. for training in managing venture capital companies, assisted Acer in establishing Taiwan's first venture capital fund, and encouraged overseas Chinese to establish venture capital businesses in Taiwan.[107] Such efforts enabled Taiwan to develop one of the most dynamic venture capital industries in the world (Figure 15).[108] The government continues to provide support measures for the venture capital industry, and, in some cases, to play the role of venture capitalist itself.[109]

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103 Interviews in Taiwan (July 2000).

104 "Cabinet Okays Lowering of Duty on Imported Semiconductors," *Taiwan Central News Agency* (April 8, 1999).

105 Li conferred extensively with U.S.-educated Taiwanese engineers based in Silicon Valley, and these individuals helped develop policies that were later adopted by the Taiwanese government. Taiwan's Ministry of Finance contracted with some of individuals to draw up a plan for a venture capital industry in Taiwan. The model developed was patterned on the U.S. venture capital system. U.S.-based ethnic Chinese managers also successfully lobbied for legislation establishing promotional measure for venture capital industry. Anna Lee Saxenian and Chuen-Yueh-Li, *Buy-to-By Strategic Alliances: The Network Linkages Between Taiwan and the U.S. Venture Capital Industries* (2001).

106 On November 10, 1983, the Executive Yuan released Regulations Governing Venture Capital Investment Enterprises, and the Project for Project for Promoting Venture Capital Enterprises. Among other things venture capital investors received a 20 percent tax deduction with respect to investments in strategic industries. The tax preference was repealed in 1999. Saxenian and Li, op.cit. (2001).

107 Saxenian and Li, op.cit. (2001). H&Q Asia Pacific Ltd., Taiwan's first U.S.-style venture capital firm, was founded by Ja-lin Hsu, a founding member of the Executive Yuan Technology Review Board, which advised the Executive Yuan (cabinet) on all technology issues. http://www.hgap.com

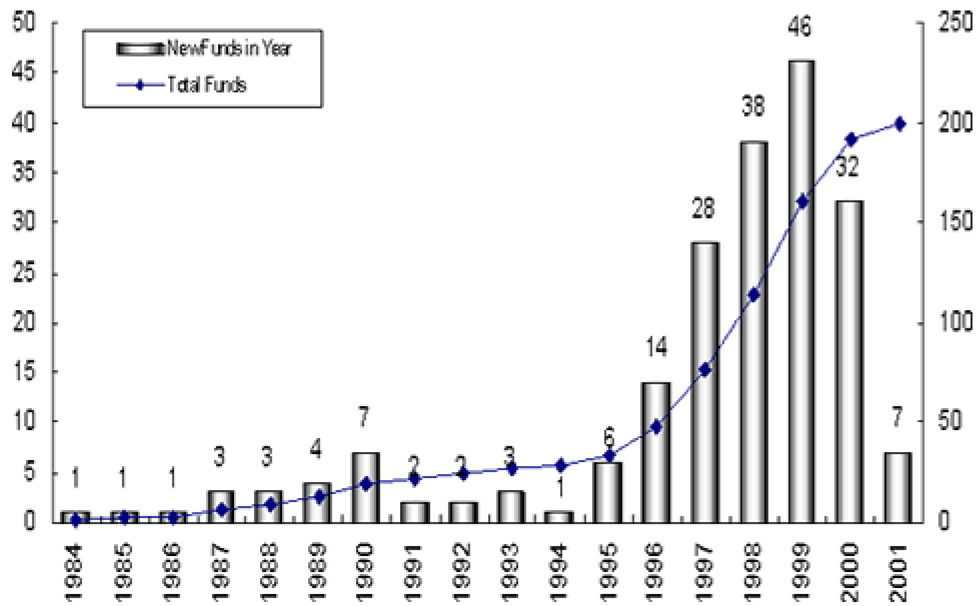
108 At the end of 2001 Taiwan had 190 venture capital firms with total investment of about $4.3 billion. During the past two decades these enterprises have enabled over 300 Taiwanese and foreign high technology companies to be listed on the stock market. "Taiwan Should Offer Favorable Treatment to Venture Capital Companies," *Taipei Central News Agency* (14:50 GMT, February 7, 2003).

109 In early 2003 the Cabinet-level Council for Economic Planning and Development (CEPD) indicated that the government would set up a new seed fund which will "play the role of venture capitalists and support entrepreneurial start-ups, even if their business plans fail to convince banks to give them loans." "Taiwan

Figure 15

Growth of Venture Capital Investments in Taiwan

New Venture Funds Established Per Year (1984-2001)



New and Accumulated Capital Levels (1984-2001)

Source: Taiwan Venture Capital Association, www.tvca.org.tw/eindustry.

Direct government financial support. While the preponderance of the capital investment undertaken by the Taiwanese semiconductor industry has been provided by the industry itself, the government has provided a variety of forms of direct financial support:

- ***Preferential lending.*** Taiwan's government-controlled banks provided low-interest debt financing to the semiconductor industry, and a number of banks also made equity investments in the industry.[110]

- ***Passive equity investments***. The Taiwanese government made equity investments in a significant number of start-up microelectronics firms. It undertook such investments to mobilize private capital for risky ventures, and did not use its minority interest to attempt to direct management decisions of individual enterprises.[111] In general the government has sold off these shares -- frequently at a profit -- when the firms have reached commercial maturity.

- ***Grants.*** Several government entities, such as the Industrial Development Bureau of Taiwan's Ministry of Economic Affairs and the administration of Hsinchu Science-Based Industrial Park, have made R&D grants to Taiwanese companies, which, although relatively small, have played an important role in helping them commercialize new products which they have developed.[112]

- ***Special government funds.*** Taiwan's government has several special funds at its disposal which it utilizes to make loans and equity investments with respect to strategic industries. The most important of these, the Executive Yuan Development Fund (EYDF) is a special fund used by the Executive Yuan (cabinet) to fund

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High-Tech Entrepreneurs Urge Government to Help Grab Regional Market Share," *Taipei Times* (February 15, 2003).

110 The Chiao Tung Bank (CTB), a national development bank, includes a venture capital arm which has provided "concessional loans… venture capital investment[s]" and "strategically nurtured the growth of the island's high tech industry and taken stakes in many semiconductor companies, including Winbond Semiconductor and United Microelectronics." "Message from the Chairman and the President," *Chiao Tung Annual Report*, 1998, pp. 8-10; "Taiwan's Chiao Tung Bank is Privatized," *Financial Times* (September 13, 1999).

111 The government of Taiwan held a 44 percent share of UMC when that firm was created in 1980; a 40 percent share in TSMC when that company was founded; a 29.9 percent share of Vanguard, and a 5.23 percent share of Powerchip. With respect to Vanguard, the government invested roughly $100 million in R&D to develop Taiwanese capability with respect to DRAMs, which was subsequently converted to equity in Vanguard. The Chiao Tung Bank held an equity stake in the Taiwan Masking Corp. (TMC), a maker of semiconductor masks, when that company was founded. Mead Ventures, *Taiwan Semiconductor Report 1990*. Vanguard International Semiconductor Corporation, *VIS Annual Report*, http://www.vis.com.tw/1998rp/rp98604.html; Powership Semiconductor Corporation, *Offering Circular* (October 21, 1999).

112 MOEA, "Investment Attractions," http://www.it.moeaidb.gov.tw.

industrial projects which the private sector would not undertake on its own.[113] This fund provide 44 percent of the original capitalization of TSMC. Taiwan's Council for Economic Planning and Development (CEPD) operates a "Middle and Long Term Fund" which put together a syndicated loan to Winbond in 1999 of over NT $10 billion, one of the largest loans in Taiwan's history.[114] The Ministry of Economic Affairs has established a High-Tech Fund of NT $5 billion for subsidies to encourage investments in ten strategic industries, one of which is semiconductors.[115]

Creation of a private sector. Because private Taiwanese investors were reluctant to undertake expenditures of the scale necessary to create competitive semiconductor enterprises, ERSO began spinning off pieces of itself, effectively creating new private companies in which the government did not seek to exercise managerial functions.[116] Some of these spin-offs were subsequently acquired by TSMC, enabling that company to expand its asset base quickly (Figure 16). The most dramatic Taiwanese initiative was the pioneering of the foundry model of semiconductor manufacturing, pursuant to which a semiconductor manufacturer produces another company's designs for a service fee.[117] The foundry concept was originally deemed so risky that the formation of TSMC -- the world's first dedicated foundry -- was capitalized in part by Taiwan's Development Fund of the Executive Yuan, which supports projects that the private sector would not otherwise undertake by itself.[118] The foundry business model succeeded in spectacular fashion for TSMC and UMC (unlike TSMC, the latter firm produces its own line of semiconductors as well as providing foundry services). The advent of foundries enabled companies utilizing their services to commercialize their designs without making massive capital

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113 EYDF funds have been used for equity investments in Taiwanese semiconductor firms and for low interest loans to support repairs to wafer fabs damaged in the September 1999 earthquake. Interviews with Taiwanese government officials in Taiwan (July 2000); "Executive Yuan Mills Loan to Large Enterprises," *Taipei Ching-Chi Jih-Pao* (November 24, 1999); "Development Fund to Launch ADRs for TSMC," *Taiwan Economic News* (March 20, 2000).

114 "Winbond Secures NT 10B Loan," *China News* (May 4, 1999).

115 "NT $5 billion set for High-Tech Industries in Taiwan," *Central News Agency* (January 26, 2000).

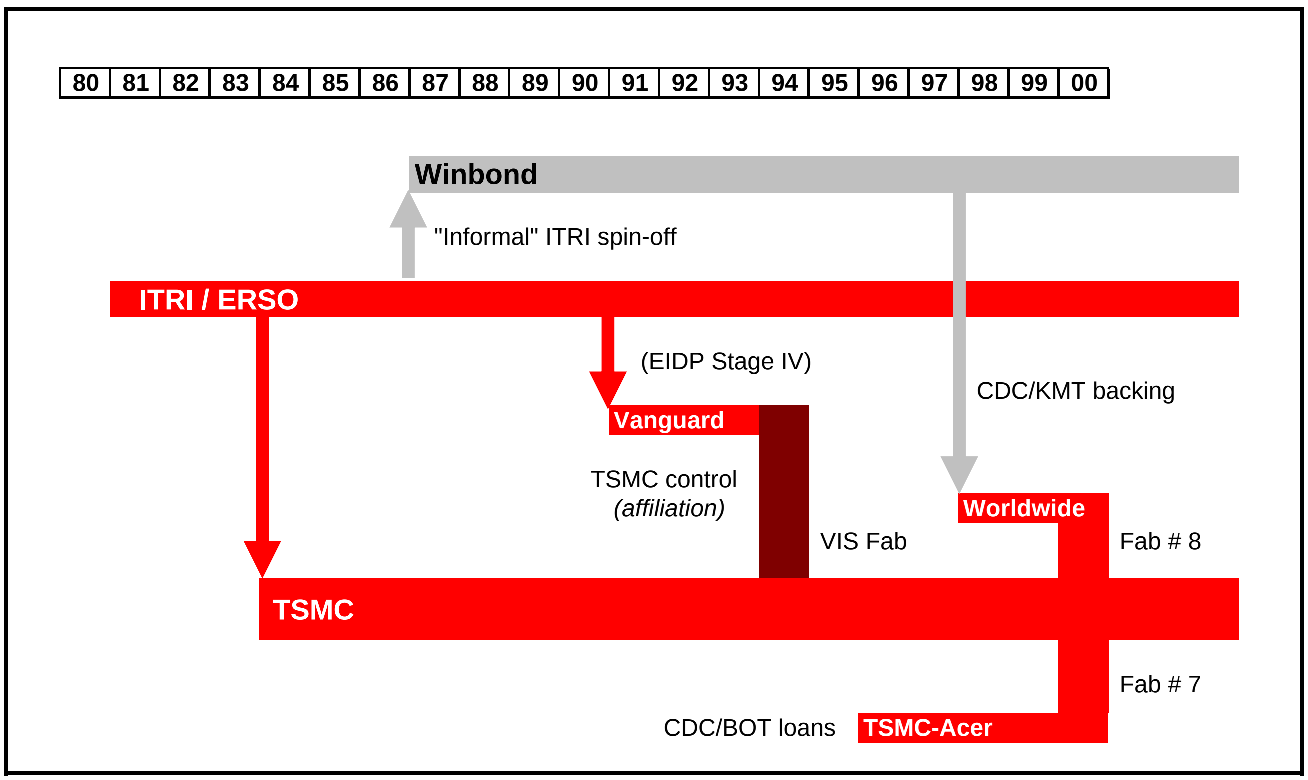
116 The United Microelectronics Corporation (UMC) was established in this manner in 1982, with the government retaining a minority equity share. The government created the Taiwan Semiconductor Manufacturing Corporation (TSMC) in the mid-1980s as the world's first dedicated foundry operation, retaining a minority equity stake. In 1994, Vanguard International Semiconductor (VIS), a DRAM producer, was formed as a joint venture between Taiwan's Ministry of Economic Affairs, TSMC, and other Taiwanese firms, with the government receiving an equity share in return for R&D expenditures utilized in developing DRAM technology. The government also established semiconductor infrastructure enterprises, such as Innova Inc., a maskmaking firm consisting largely of former ERSO maskmaking staff, and Taiwan Masking Corp. (TMC) with the government Chiao Tung Bank a major equity stakeholder.

117 The foundry concept was originated by Robert Tsao, founder of UMC, but was developed most successfully by TSMC.

118 Both UMC and TSMC owed much of their subsequent success "to a development loan provided by the Executive Yuan" (Taiwan's cabinet). Shuve Chi, Vice Chairman, Taiwan Council for Economic Planning and Development, in "Increase in Access to Government Loans Expected," *Taiwan Central News Agency*, March 18, 1999.

Figure 16

Some of TSMC's Acquired Assets Have Their Origins in Government



investments in wafer fabrication facilities, and is revolutionizing the global semiconductor industry.[119]

Financial incentives to individuals. A commonly-cited source of competitive advantage of Taiwanese firms like UMC and TSMC is the fact that they "can attract and keep the best people" with compensation arrangements that foreign firms cannot match. During the 1990s the market value of UMC and TSMC stock rose dramatically after the date of original issuance, but employees given stock as compensation were taxed on the face value of the shares, not the market value--which was often many times higher than the face value. Moreover, when the shares were sold, whether acquired directly or through the exercise of stock options, no capital gains tax is levied, because Taiwan eliminated its capital gains tax in 1990.[120] In addition, returning Taiwanese who bring with them capital gains from stock options or venture capital from another jurisdiction (such as the United States) are not taxed on those capital gains.[121] Such tax rules "[become] a big reason why Taiwan can attract the best talent in the high tech industry from at home and abroad."[122]

Support for research and development. The government of Taiwan has provided support for R&D in leading edge microelectronics technology, although in general it has not mounted large industry-government joint R&D projects on the scale of those in Japan and the European Union. Taiwan's most recent large-scale industry-government microelectronics R&D project, ASTRO, fell apart in 2001 and, according to government officials, similar projects will not be attempted in the foreseeable future.[123] Rather, government efforts have focused on the

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119 About 15 percent of the U.S. semiconductor industry is "fabless" and relies on foundries to manufacture their chips. Taiwanese foundries have a 63 percent market share of the global foundry business. Source: iSuppli.

120 *Income Tax Law* (Article 4-1); Interviews in Taiwan, July 2000. A Securities Transaction Tax must be paid on the proceeds of the stock sales but this amounts to only 0.3 percent of the transaction amount. *Regulations on Securities Transaction Tax* (Art. 2). In addition to these benefits, individual shareholders who own shares of companies in strategic industries (including semiconductors) for at least three years are eligible for a 10 percent tax credit every two years. "Cabinet Passes Draft Revision of Statute for Upgrading Industries," *Newsletter*, http://www.wegb.tranda.com.tw. An "unnamed official" reportedly stated in August 2003 that Taiwan's Finance of Ministry planned to revise this policy to tax income derived from exercise of optionsat the exercise (market) value rather than par value. *AFX Asia* (August 4, 2003).

121 Interview with EYDF official (Taipei, September 2002).

122 "Investment in 300mm Plants Heating Up; 32 New Lines to be Built," *Nikkei Microdevices* (June 2000).

123 The Advanced Semiconductor Technology Research Organization (ASTRO) was undertaken by the government and six Taiwanese device makers, Nanya, Powerchip, Winbond, Mosel Vitelec, Macronix and ProMOS. The government's role in ASTRO was to subsidize 50 percent of program costs and provide R&D results from the Sub-micron Project carried out by the ERSO between 1990 and 1996. Despite the government's role, ASTRO encountered a succession of difficulties. Participants were reluctant to share technology and were conflicted by their growing foreign R&D alliances; the technology ERSO was to contribute was considered outmoded; participants reportedly had divergent perspectives on how to develop technology; TSMC and UMC were reluctant to participate, which government officials attributed to the companies' concern about participating in a project that would enhance their competitors; and many engineers assigned to the ASTRO project simply quit. In 2001, ASTRO was dissolved. "Taiwan Chipmakers Join Forces to Develop Advance Tech," *Nikkei* (February 3, 2000); ITRI News Release,

acquisition and commercialization of advanced technologies from abroad, wide diffusion of that technology within Taiwan, and the provision of support (usually on a small or medium scale) for new technology development by individual enterprises, research institutes, and university-based research teams. The government has established a large number of consortia and research institutes and organizations, which emphasize collaborative research, training, and technology diffusion.[124] The National Science Council (NSC) provides government financial support for microelectronics-related R&D in Taiwanese universities, and some NSC-sponsored projects are yielding major technological advances with industrial and commercial applications in microelectronics.[125] Current government-sponsored microelectronics R&D projects are summarized in Part IV.B.3.

C. Influence of Singapore.

Chinese government leaders view Singapore, like Taiwan as an ethnic Chinese society which has achieved a high level of development which may provide useful developmental lessons for China.[126] Singapore's leaders have displayed a considerable interest in demonstrating their developmental model in China, and have invested in a broad array of projects in China. Perhaps because Singapore has not achieved the same degree of success in microelectronics as Taiwan, the influence of its example on China's policy formation in this sector has been less than that of Taiwan. On the other hand the absence of political tension between Singapore and China has made it much easier for the government of Singapore -- which played a pervasive role in the development of Singapore's semiconductor industry -- to participate directly in semiconductor-related initiatives in China. The most significant manifestation of Singapore's involvement is the

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February 2, 2000, http://www.itri.org.tw/eng/news_events/news/printable/n-20000202-erso-print.html; "The Portal of Taiwan Semiconductor Industry," *Computex Online*, http://www.computex.com.tw/tsia.asp. Interviews with Taiwanese government officials in Taiwan (Taipei and Hsinchu, July 2000, September 2002).

124 Current institutions and initiatives are described in Part IV.B. The net effect of the numerous consortia and research associations and organizations is a highly integrated domestic industry chain that is sometimes analogized to a single large integrated enterprise. "In Taiwan [in 2000 there were] 130 design companies, 5 mask companies, 20 wafer manufacturing companies, and 100 assembly and test companies. Those companies work together and as a whole form what is like one vertically integrated company. We can say that Taiwan is the world's largest semiconductor production base that resembles Silicon Valley of the U.S." A. Minamikawa, "Investment in 300mm Plants Heating Up; 32 New Lines to be Built," *Nikkei Microdevices* (June 2000).

125 Beginning in 2000, the NSC provided funding of NT$40 million for a project to develop a diffractive laser encoder system based at National Taiwan University. A research team consisting of 9 professors, nearly 100 researchers, and AHEAD Optoelectronics, Inc., the project's "collaborating industrial partner," developed a laser encoder system which integrates optical-mechanical elements and signal processing circuits to achieve sub-nanometer positioning accuracy -- a system which can "serve as a key subsystem for… semiconductor steppers." C.K. Lee, a projected leader, said that the new system "performs much better than major rival systems produced by the Japanese firm Canon. 'It has 10 times greater precision and its signal strength will be increased by a factor of 10.'" Chiu Yu-tzu, "Taiwan Using Nanotechnology to Reduce Costs in High-Tech Industries," *Taipei Times* (April 11, 2003); "Diffractive Laser Encoder System Leads Way Towards Precision Positioning," *Taipei Science Bulletin* (May 2003).

126 Zeng Hu, "Learn from Singapore's Experience," *Xinhua* (13:02 GMT, December 19, 1995).

Sino-Singapore Suzhou Industrial Park (SIP), " new town designed to replicate Singapore" in Suzhou, Jiangsu province, which former Singapore Prime Minister Lee Kwan Yew saw as "the precursor of more "New Singapores" in China.[127] Lee was reportedly "instrumental" in persuading the Chinese government to "allow foreign investors the freedom to handle every aspect of creating [new towns like Suzhou Industrial Park]."[128] In addition, the Singapore government has invested in an array of semiconductor projects in China, including equity participation in SMIC.[129]

D. China modifies its developmental model in microelectronics (1999-2000).

The failure of China's policies in high technology prior to 2000 have been acknowledged by Chinese planners, who concede that it was a mistake to "have relied on monopolistic state-owned enterprises to develop key high technology industries."[130] The government was seen as lacking the "market adaptability and competitiveness of private-sector enterprises in direct production and commercial activities."[131] Qu Weizhi, Vice Minister of Information Industry, observed in May 2000 that China's semiconductor industry "has remained rather weak and small in terms of its overall scale and has lagged relatively far behind in terms of its production technology development capability, product design and development capability and standard, and so on…"[132] Going forward, she said, the government should "withdraw from market activities" and, in particular, refrain from "operation of enterprises or interfer[ence] in policy decisions that will effect their manpower, material and financial resources as their production, supply, and market activities." The appropriate developmental model should be neither wholly state-driven nor entirely relegated to the private sector, but one that strikes a careful balance between the two.[133] The only suitable area for government intervention was

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127 "Lee Kwan Yew Views Japanese Project in Suzhou," *Kyodo* (06:14 GMT, September 11, 1995).

128 *Kyodo* (06:14 GMT, September 1, 1995).

129 In 1997 the Shanghai Zongxin Technology Corporation was formed as a joint venture between the Shanghai State Science and Technology Commission and the Singapore National Technology Bureau. The new entity was to invest, among other things, in projects developing new semiconductor materials. *Xinhua* (08:17 GMT, January 28, 1997).

130 Wu Jinglian, "Developing Hi-Tech Industries: System More Important than Technology," *Ta Kung Pao* (October 11, 1999). A senior economist in the State Council's Development Research Center observed in 1999 that under prior Chinese promotional efforts in the technology intensive sectors, "all high-risk investment projects were financed by state-owned risk investment funds (or companies). Experience proved that most of these practices were unsuccessful." Ibid.

131 Wu Jinglian, Research Officer, State Council Development Research Center, "Developing Hi-Tech Industries: System More Important than Technology," *Ta Kung Pao* (October 11, 1999)

132 Qu Weizhi, "How to Develop Integrated Circuits Industry," *Renmin Ribao* (May 15, 2000).

133 The appropriate role of government is to create a "general environment which is suitable for the development of semiconductor industry, providing preferential policies which are as good as those in the peripheral countries, simplifying examination and approval procedures, and encouraging foreign investment introduction and multi-channel financing as well as the development of people-to-people software design industry." Hu Qili, "Seize Opportunities to Develop China's Semiconductor Industry," *Renmin Ribao* (April 19, 2000). Other analysts made similar observations: "[W]e should promote

Where the market is malfunctioning. The government should play its role in making up for the malfunctioned market by establishing the market order, providing public property, and so on.[134]

For a time Chinese planners noted with interest the developmental effort by Japan's Ministry of International Trade and Industry in semiconductors, which enabled Japan to catch up with and surpass the U.S. in the DRAM market in the 1980s. However, by the end of the 1990s Chinese planners had concluded that the MITI approach did not work in high technology sectors once competitive parity with the global leader (the United States) was achieved:

"[D]uring the period of "catching up with and surpassing" the advanced, the government could clearly see the road traversed by the advanced countries and had a relatively full grasp of information. Under such circumstances, the government had the ability to mobilize resources in a way that the private sector could not have done. Hence there was a better chance of success. However, when confronted with the task of making innovation and exploring the unknown future, the government no longer had the information advantage. Its ability to respond and its efficiency in getting things done definitely could not compare with the private sector. Moreover, personal creativity was invariably suppressed when the government directly organized and managed hi-tech development and production. This led to its defeat in the contention with the United States for domination in the information industry."[135]

1. *Abandoning "command" policies.* Since the beginning of Deng Xiaopeng's economic reforms in 1978, China has been phasing out centralized command type economic policies and increasing its emphasis on autonomous decisionmaking by local governments and individual enterprises. This trend accelerated at the end of the 1990s, particularly with respect to the high technology industries. Chinese economic reformers used the prospect of imminent WTO entry and the demonstrated failure of past, centralized promotional efforts to secure the rapid adoption of industrial policies which much more closely resemble Western models. This new approach is embodied in the Tenth Five Year Plan (2001-05) and in sectoral policies implemented pursuant to the Plan, including the promotional effort in the semiconductor industry.

The Tenth Five-Year Plan sets forth an ambitious goal of ensuring that by 2005,

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integrated circuits development by integrating the state will with the market mechanism.... [T]he state should map out preferential policies to support its development, including preferential revenue, investment capital coordination and qualified personnel policies as well as other incentive policies, in order to speed up its development." Qu Weizhi, "How to Develop Integrated Circuits Industry," *Renmin Ribao* (May 15, 2000).

134 Ibid.

135 Wu Jinglian, Research Officer, State Council Development Research Center, "Developing Hi-Tech Industries: System More Important than Technology" (Part 3 of 3)," *Ta Kung Pao* (October 9, 1999).

"60 percent of IT products should be home-grown," and China shall "gradually design and develop its own IC products (including CPU)."

In addition to promoting the IC design and device manufacturing sectors, the government states that it will "support the development and production of materials used in the manufacturing of ICs and electronic components."[136]

Despite its frankly nationalist objectives, which are characteristic of prior Five Year Plans, the Tenth Five Year Plan represents a substantial departure with respect to high technology. Traditional policy tools have been discarded, such as prohibitions on 100 percent foreign ownership of enterprises in strategic sectors and reliance on state-owned enterprises to spearhead key developmental efforts. As in many Western countries, the government increasingly seeks to achieve its developmental objectives by providing broad policy incentives, leaving specific R&D, investment, and commercial decisions to individual enterprises.

2. *Effects of WTO entry.* China's WTO entry has influenced the methods by which it promotes key industries, including semiconductors. Prior to WTO entry, in this and other priority industries, the Chinese government pursued a development strategy of "trading markets for technology." Foreign firms were permitted to invest in China (although often only in Chinese-controlled joint ventures) and were permitted to sell into China's market, but based on a reciprocal transfer of technology and other benefits to the Chinese side. WTO entry imposes severe constraints on China's ability to utilize such methods in the future.[137] As a result China is turning to industrial policy tools commonly found in WTO member countries --subsidies, tax incentives, promotion of new businesses, and science, educational and training programs. China has taken care to negotiate WTO accession terms which allow it considerable leeway with respect to such "Western" style promotional tools:

- ***Subsidies.*** In acceding to the WTO China has agreed to phase out export subsidies,[138] and subsidies to certain lossmaking state-owned enterprises.[139] However, China has notified a large number of existing subsidy programs to the WTO without giving any commitments with respect to their eventual phaseout. Subsidies are being utilized as

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136 Tenth Five Year Plan, Sections 3.4.2.1, 3.4.2.2

137 China has acceded to the WTO Agreement on Trade-Related Investment Measures (TRIMs), and with respect to foreign-invested firms, and has agreed not to enforce local content requirements, foreign exchange balancing, performance requirements of any kind (including technology transfer). WTO, *Accession of the People's Republic of China* WT/L/432 (November 23, 2001), Part I.7.3 (*"China Accession"*). The net effect of these commitments is the "total abolition of the domestic market restrictions on FIEs [foreign invested enterprises]." Wang Yungui, State Planning Commission Foreign Economic Institute, "A Study of China's Strategy for Using Foreign Investment After the WTO," *Chongqing Gaige* (July 20, 2001).

138 WTO, *China Accession*, op. cit. Part I.10.1.

139 WTO, *China Accession*, op. cit. Annex 5B and Annex 5A. These measures may be subject to countervailing duties or action pursuant the WTO Agreement on Subsidies if they cause injury, but they are not prohibited per se.

promotional tools under the Tenth Five Year Plan. Such measures are the norm, rather than exception, in western countries with major semiconductor industries.[140]

- ***Special economic areas.*** China has given no commitment to phase out its special preferential economic areas and zones, although some of the benefits and incentives available in such zones (such as lower rates of taxation) have been notified to the WTO.[141] At present new special zones are being created and existing zones are expanding. However, while China's preferential economic areas have a distinctive history, they are coming to resemble industrial development zones commonly found in western countries, including the United States, which also offer preferential tax and utility rates, infrastructural support and financial assistance.[142]

- ***Government procurement.*** Preferential procurement has been an industrial promotion tool frequently employed in high technology sectors in western countries. Upon accession to the WTO China gave a commitment to the effect that "all state-owned and stated-invested enterprises would make purchases and sales based solely on commercial considerations, e.g. price, quality, marketability and availability, and that the enterprises of other WTO members would have an opportunity to compete for sales and purchases from these enterprises on non-discriminatory terms and conditions."[143] However, China did not join the WTO Agreement on Government Procurement and thus has no binding obligations with respect to preferential or discriminatory procurement by governmental organizations, as distinguished from state-owned enterprises. The Tenth Year Plan states that the government will "devise a national purchasing policy [in which] IT products sold to the government should be primarily produced locally."[144] Current promotional measures in the semiconductor

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140 For a synopsis of recent and current government financial support for R&D in microelectronics see Thomas R. Howell, "Competing Programs: Government Support for Microelectronics," in Charles W. Wessner (ed.), *Securing the Future: Regional and National Programs to Support the Semiconductor Industry* (Washington, D.C.: National Academy Press, 2003).

141 Ibid. China stated to the WTO Working Party that no new special zones are planned, and that there would be no discrimination in the zones with respect to imported vs. domestic goods or foreign vs. domestic enterprises. However, China has not undertaken binding commitments to forego the creation of additional zones. WTO, *Report of the Working Party on the Accession of China*, WT/MIN(01)/31 (November 10, 2001), paras. 218-228, 337-39.

142 For examples see http://www.semi-ny.com/sites/dutchedss-hurp.com (New York State, Hudson Valley Research Park); www.krat-techolpolis.or.jp (Japan, Kumamoto Technopolis); www.sedb.com/edbcorp/an)1998)02.jp (Singapore high tech sites at Woodlands, Tampines and Pasis Ris).

143 WTO, *Report of the Working Party on the Accession of China*, WT/MIN (01) 31 (November 10, 2001) para. 46. The government of China also made a commitment that it would not "influence, directly or indirectly, commercial decisions on the part of state-owned or state-invested enterprises, including on the quantity, value or country of origin of any goods purchased or sold, except in a manner consistent with the WTO Agreement." Ibid.

144 Tenth Five Year Plan Section 3.6.4.

design and software sectors provide for procurement preferences for domestic products.[145]

The Chinese government is making full use of industrial policy measures which it regards as permitted under the WTO, and it apparently does not plan to phase out the broad panoply of subsidies, tax breaks, special zones and other incentives that it notified to the WTO in 2001. These will probably be modified, if at all, only to ensure that there is no discrimination between domestic and foreign invested enterprises. Special or differentiated promotional measures will be "pushed down to the local level," where, it is felt, they will pose less of a potential problem under the WTO.[146]

3. ***Significant departures from past practice.*** China's promotional effort in microelectronics is characterized by extensive, significant departures from past policies and practices. All of these new policy dimensions serve to move China closer to western economic models and to facilitate the integration of domestic enterprises with the global semiconductor industry. Key changes include:

- ***Greater receptivity to inward foreign investment.*** Until 2000 Chinese semiconductor enterprises were either state-owned or joint ventures in which the Chinese partner was a government entity or a state-owned enterprise. Under the new policy regime, however, the government is welcoming inward investment by 100-percent foreign-owned semiconductor manufacturing and design enterprises.[147]

- ***New forms of enterprise organization.*** The Tenth Five Year Plan makes numerous references to "modern enterprise" techniques, an emphasis that has been manifested in the promotion of the shareholder/corporate form of ownership since 1999.[148] Existing state-owned Chinese semiconductor design enterprises are being privatized. The government is promoting a new "corporate" model of autonomous

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145 Circular 18, Several Policies for Encouraging the Development of Software Industry and Integrated Circuit Industry (June 24, 2000), Articles 25, 50, 51.

146 Interview with official of China Center of Information Industry Development (CCID) (Beijing, September, 2002).

147 Hu Qili, Minister of Information Industry, noted that Korea's three major semiconductor enterprises "all built up their fortunes on their cooperation with the United States and Japan.... If we just engage in development behind closed doors, totally rely on ourselves in the aspects of talented people, funds, and technologies, and produce products only to serve and support ourselves, it is absolutely impossible to establish ourselves in the intense international competitions." Hu Qili, "Seize Opportunities to Develop China's Semiconductor Industry," *Renmin Ribao* (April 19, 2000).

148 Li Lanqing, Vice Premier and head of the State Steering Group of Science, Technology and Education, stated that the organizational transformation in high-tech sectors is "not just to 'change the signs,' even less to have more state-owned enterprises in the traditional sense; instead, the transformation means hard work to establish a modern enterprise system and to change into having a corporate system based on diversified shareholding and centered on a legal-person governing structure." Li Lanqing, "Implement the Strategy of Achieving National Rejuvenation Through Science and Education in an In-Depth Manner and Accelerate the Reform and Development Cause of Science and Technology," *Beijing Qiushi*, July 16, 2002.

Chinese/foreign enterprises in which the state's role -- if any -- is that of a passive minority investor. The new semiconductor foundries being established in the Shanghai area are all majority foreign-owned and bear closer resemblance to Western multinational corporations than to prior generations of Chinese semiconductor enterprises.

- ***New emphasis on startups and small businesses.*** The advent of the Internet, driven by small start-up companies, helped influence Chinese planners to place a greater emphasis on fostering innovative new small start-up enterprises. "Incubators" were set up in Shanghai, Beijing and elsewhere to provide office space, financial support, training, and software design tools to individuals and small enterprises seeking to commercialize new ideas.[149]

- ***Adoption of modern financing techniques.*** Consistent with recent developments, the Tenth Five Year Plan declared the government would "expand the number of financing channels," and "change from relying on bank loans to obtaining capital investment directly from overseas or local financial markets."[150] Venture capital and initial public offerings are cited as a favored technique.[151] To "increase capital flow to the industry, [the government shall] provide a favorable interest rate, special depreciation policy, and reduce the profit tax of technological products… ."[152] The Plan calls for the government to "set up venture capital to encourage companies to increase investment in R&D."[153]

- ***Enhanced incentives to individuals.*** In a major departure from communist egalitarian values, Chinese planners now seek to establish programs which enable successful high technology entrepreneurs to reap major financial rewards. Enterprises are directed to "encourage the inclusion of capital and technologies in the

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149 See Part V infra.

150 Tenth Five Year Plan, Section 3.5.2.3.

151 Tenth Five Year Plan, Section 3.6.5.

152 Tenth Five Year Plan, Section 3.6.11. For smaller start-up firms (such as IC design firms) Vice Premier Li Lanqing said, "the government would work diligently to study and establish a venture capital market system suited for the small and medium enterprises…a system of small enterprise credits and guarantees characterized by sound risk sharing on the basis of enhancing the construction of innovation funds for small and medium-sized science and technology enterprises. Li Lanqing, "Implement the Strategy of Achieving National Rejuvenation Through Science and Education in an In-Depth Manner and Accelerate the Reform and Development Cause of Science and Technology," *Beijing Qiushi*, July 16, 2002.

153 Tenth Five Year Plan, Sections 3.6.2. and 3.6.11. For smaller start-up firms (such as IC design firms) Vice Premier Li Lanqing said, "the government would work diligently to study and establish a venture capital market system suited for the small and medium enterprises… a system of small enterprise credits and guarantees characterized by sound risk sharing on the basis of enhancing the construction of innovation funds for small and medium sized science and technology enterprises." Li Lanqing, "Implement the Strategy of Achieving National Rejuvenation Through Science and Education in an In-depth Manner and Accelerate the Reform and Development Cause of Science and Technology," *Beijing Qiushi*, July 16, 2002.

rationing of revenue [and] introduce bonus and share [stock] options to the remuneration of company directors."[154]

- ***Strengthened intellectual property protection.*** China has an extremely mixed record with respect to the protection of intellectual property rights (IPR), and while IPR problems have not been experienced on a widespread scale in semiconductors, that fact partially reflects the lack of technical capability within China to replicate advanced foreign designs. As Chinese technical levels have improved, instances of infringement of U.S. microelectronics IPR have begun to occur.[155] However, upon entering the WTO, China has undertaken new commitments to protect intellectual property rights pursuant to the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs). China issued a Regulation in 2001 extending protection to layout designs of integrated circuits.[156] While China's ability to enforce the new protections is an open question, statements by Chinese leaders indicate a recognition that if China aspires to be a country which originates microelectronics technology, it is in its own interest to ensure that intellectual property is protected.[157]

- ***Greater outreach to foreign personnel.*** Chinese planners view the source of the United States' success in high technology, in part, as "its superior mechanisms and conditions of absorbing assemblages of foreign S&T talent for enterprise creation," and the U.S. is seen to enjoy an "unparalleled competitive advantage in the foreign S&T talent resource pool."[158] Accordingly the Tenth Five Year Plan calls for increased efforts to "bring into the country technical and managerial professionals" in the IT sector in general, and in semiconductors in particular.[159] This policy is being implemented by establishing a panoply of rewards and incentives for foreign personnel and returning Chinese scientists and engineers who relocate to China.[160] The impact is already evident. An executive from Applied Materials observed in September 2002 that "just a year or two ago the typical manager in the Chinese semiconductor industry was a bureaucrat assigned by the government, and the entire sector employed perhaps 125 overseas managers and technical experts in total. Now there are 700 managers and engineers from Taiwan, the U.S. and Europe working at

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154 Tenth Five Year Plan, Section 3.6.4.

155 "Watching for Chinese Knock-offs," *Electronic Business* (January 2003); "Can China's Fabs be Trusted to Play Fair?" *Electronic News* (July 9, 2001).

156 The *Regulation on the Protection of Layout Designs of Integrated Circuits* implements China's commitments under the TRIPs Agreement, Section 6.

157 Department of New and High Technologies, Ministry of Science and Technology, "Impact of WTO Accession on China's Information Technology Industry and Countermeasures," *Jingji Ribao* (February 4, 2002). See also Part. V.E. infra.

158 Chen Zhaofeng "A Study of the Disposition of Foreign S&T Talent Resources Under the New Economic Conditions," *Keji Guanli Yanjiu* (December 2, 2001).

159 Tenth Five Year Plan Section 3.6.4.

160 See Part V infra.

SMIC, 200 at Grace, 10 at ASMC, and whole teams to come from UMC and TSMC."[161]

- ***Adoption of the foundry business model.*** "China is relying heavily on the foundry model."[162] Most of the new fabs being built in China will operate as pure-play foundries -- in effect, they will constitute mainland-based versions of Taiwan's TSMC.[163] From the perspective of the Chinese, who have long sought to attract Western microelectronics technology, the emergence of the foundry business model in Taiwan offers obvious advantages. The Taiwanese foundries have developed a complex system of multinational alliances with many of the world's leading semiconductor makers.[164] In the process of manufacturing some of the world's most advanced designs, the Taiwanese foundries developed process skills and cell libraries which have increasingly enabled them to generate their own process technologies and designs.[165] Designers and engineers -- whether Taiwanese or foreign -- have been attracted to jobs at the foundries or at related companies in Taiwan, reflecting Taiwan's growing status as a center for leading edge manufacturing. The existence of a large number of high-volume foundries in China will inevitably serve to foster an indigenous workforce which absorbs leading edge process and design skills.[166]

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161 Rong Ling Chen, Depute General Manager of Applied Materials China, in "Searching for Hope: Special Semicon West Show Report," *Solid State Technology* (September 2002).

162 Lisa Tafoya, "Issues to Consider When Putting China in Your Business Plans, Strategy," *Solid State Technology* (February 2003).

163 "[I]ronically, China appeared to be borrowing blueprints from Morris Chang, who is considered the father and chief architect of Taiwan's highly-successful semiconductor industry. Chang is also widely credited for pioneering the pure-play silicon foundry model." Mark LePerdue, "China's Latest Chip Plan Adds Help from Taiwan, " *Semiconductor Business News* (March 30, 2001).

164 For example TSMC has collaborative arrangements with Philips, ST Microelectronics and Motorola with respect to CMOS process technologies from 90nm down to 32nm. This enables TSMC to draw on the resources of all of these companies as well as their associated research laboratories, which include IMEC (Belgium), CEA/LETI (France), France Telecom R&D, and Philips Research. Motorola's contributions to this alliance include its leading-edge-silicon-on-insulator (SOI), advanced copper interconnect, and embedded MRAM technologies, "Collaborations Underscore Taiwan's Cutting Edge Foundries," *Solid State Technology* (August 2002).

165 "By the late 1990s Taiwan's leading semiconductor companies believed that they could either develop all the technology they needed internally, through licensing agreements, or through alliances." … "The Big Taiwan foundries are already capable of producing central processing units (not yet highest end) and are constantly improving first class design libraries and library tools. The foundries are gearing up for the next generation 'system on a chip' era by producing to world standard for most of the component parts; they are also building in the production capability necessary to 'put all the pieces' together quickly." William W. Keller and Louis W. Pauly, "Crisis and Adaptation in Taiwan and South Korea," in William W. Keller and Richard J. Samuels (eds.) *Crisis and Innovation in Asian Technology* (Cambridge: Cambridge University Press, 2003).

166 The adoption of the foundry model will serve to address another Chinese weakness, the virtually complete absence of Chinese semiconductor products from external markets. Many of the semiconductors fabbed in the mainland foundries will be exported globally under the brand names of well-known multinationals.

4. ***Implementation: State Council Circular 18.*** While the Five Year Plan establishes the government's objectives and identifies the broad means to be used to achieve them, it must be implemented by more specific measures. At present the seminal Chinese government policy document defining government policy toward the semiconductor industry is State Council Circular 18, published in June 2000, *Some Policies for Encouraging the Development of the Software Industry and the Integrated Circuit Industry.* With the exception of the automobile industry -- another government priority -- no comparable sector specific measure has been issued by the government, a fact duly noted by national, regional, and local government officials. **Circular 18's stated objective is to make China a leading design and manufacturing base for integrated circuits by 2010, and to ensure that within 10 years China will "meet the majority of domestic market demand" for integrated circuits and to export "a certain amount."**[167] Circular 18 specifies a number of promotional measure to be made available to the integrated circuit industry, which are available on an equal basis to qualifying firms whether foreign or domestically owned.[168] The key provisions of the Circular are as follows:

- ***Value-Added Tax.*** Qualifying IC manufacturing enterprises are eligible for refunds of that portion of the 17 percent value-added tax (VAT) on their sales which exceeds 6 percent, e.g. a refund of 11 percent and an effective VAT, after refund, of 6 percent. Qualifying IC design firms are eligible for a refund of the VAT in excess of 3 percent, or an effective post-refund VAT rate of 3 percent.[169] Both tariffs and import-related VAT are exempted for raw and semifinished materials and consumable goods imported by IC firms for their own use.[170] IC manufacturing equipment imported for use by IC manufacturing enterprises is exempt from tariffs and the import-linked VAT.[171] The VAT rebate scheme is addressed in detail in Section III of this study.

- ***Taxation holidays/reductions.*** Qualifying IC manufacturers are to receive a 5-year tax holiday with respect to the enterprise tax (the basic corporate income tax), which begins running in the first year an enterprise is profitable, and another 5 years of

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While foundry production model limits China's ability to build its own strong brands in the international market, it ensures that Chinese enterprises will participate in that market, a tradeoff that has proven acceptable to the Taiwanese foundries.

167 Circular 18, Article 2.

168 Circular 18 (June 24, 2000), Article 52.

169 Circular 18, Article 5 makes the 3 percent VAT available to software enterprises. Circular 18, Article 51 provides that the IC design industry "is regarded as a software industry on which relevant policy on software industry is available."

170 Circular 18, Article 44.

171 Circular 18, Article 47.

taxation at half the other applicable rate.[172] IC manufacturing equipment can be fully depreciated in 3 years.[173]

- ***Capital.*** The government will set up venture capital investment funds, and "arrange for part of the seed funds and raise funds through such measures as floating shares that are oriented toward society, and absorbing domestic and foreign risk funds" (e.g. venture capital).[174] In general the government will "change from relying on [government] bank loans to obtaining capital investment directly from overseas of local financial markets."[175]

- ***Foreign currency retention.*** Qualifying IC manufacturing enterprises are authorized to retain profits earned in foreign currencies in special accounts. These funds may be used for reinvestment in China.[176]

- ***Infrastructure.*** The government will provide "capital construction funds for infrastructure construction and industrialization projects" in the IC industry.[177] Whatever the hortatory value of this provision, as a practical matter virtually all infrastructural support measures are being provided by local governments at the local level.

- ***Procurement.*** A preference is established for domestically-made software in procurement by government enterprises. Where a domestic and foreign product are equal with respect to performance and price, the domestic product shall be selected.[178] This benefit has apparently been extended to the IC design industry as well by Article 51 of the Circular.[179]

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172 This benefit is extended by Article 42 of the Circular, which provides that the IC industry is eligible for he same tax preferences as the energy and communication sectors, which receive the 5/5 holiday/reduction. The Circular by its terms limits this benefit to IC firms with investments in excess of 8 billion yuan and design rules of under 0.25 microns. In practice, however, the benefits are being made available to firms with smaller invested amounts and design rules as large as 0.6 microns.

173 Circular 18, Article 46.

174 Circular 18, Article 3(1). This Article by its terms applies to software enterprises only, but through the operation of Article 51 is made applicable to the IC industry. The China Semiconductor Industry Association made a presentation in June 2002 in which it stated that one of the key policies for the semiconductor industry set forth in Circular 18 was the establishment of a venture capital fund for the industry CSIA, "China's IC Industry and Market" (June 2002)

175 Tenth Five Year Plan Section 3.5.2.3.

176 Circular 18, Article 45.

177 Circular 18, Article 3(2).

178 Circular 18, Article 25.

179 Circular 18, Article 51.

- ***Cutting red tape.*** Enterprises which establish IC manufacturing enterprises in China are to "receive stepped up" examination and approval from relevant government authorities.[180] Customs houses are directed to "provide customs-clearance convenience" to qualifying IC manufacturing enterprises.

Implementation of Circular 18 has proceeded in an uneven manner in different regions of China, with varying interpretations of ambiguities in its provisions prevailing from place to place. One MII official involved in the drafting of the Circular indicated that its implementation has been "chaotic," but that it has nevertheless achieved its main purpose, which was to induce provincial and local governments to begin establishing comprehensive promotional programs for the semiconductor industry at the local level. He indicates that with China's WTO entry, the country will find it necessary to devolve the provision of most incentives -- particularly those that vary in degree and kind from case to case -- from the national to the local level, where they will be less vulnerable to WTO challenge.[181] The Preamble to Circular 18 is a directive to local governments:

> *Local People's Governments and competent authorities of the State Council should make efforts to study how to formulate the implementation of detailed rules and supporting policies for the earlier implementation in line with the requirement of Regulations.*

While Circular 18 is universally cited by national, regional and local officials as definitive with respect to China's semiconductor policies, most of its provisions are not self-implementing. Parts of Circular 18 have been put into effect, often at the initiative of individual officials and local authorities applying what they believe to be the intended policies of the central government. But full implementation will require the issuance of regulations at the provincial and local level as well as clarifications at the national level. In the interim, some Circular 18 benefits intended for the industry have been forthcoming, while others are -- thus far -- prospective only. As SMIC spokesman Joseph Xie expressed it to a Chinese industry journal in late 2001:

> *Xie: The number 18 paper has helped us a lot. The number 18 paper's regulation clearly provides for reduction in taxes on some imported equipment and materials. SMIC is one of the first companies to receive this benefit. When we imported equipment, customs personnel gave us a lot of help. But because related details of the regulations have not yet been formulated, some policies are still difficult to implement. We hope that the number 18 paper can be fully*

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180 Circular 18, Article 40.

181 Interview with MII official, Beijing , September 2002. MIT's assessment of the effect of the circular finds support in the interviews undertaken for this study. Virtually every provincial and municipal official interviewed, representing numerous localities, cit Circular 18 as the paramount set of rules governing policies toward the semiconductor industry, and most officials are quite familiar with all of the Circular's main provisions.

implemented at the earliest date. To summarize, we have benefited greatly from the number 18 paper. We are very thankful for it. [182]

5. *Initial follow-on measures by the central government.* To date the central government has drawn up one significant follow-on document to Circular 18 which is reportedly being utilized as a guideline for policy, but which has not been formally adopted or made public. Circular 51, *More Favorable Policies for the IC Industry* (October 29, 2001) is, technically speaking, still a draft proposal prepared by MII. But it has been circulated to and endorsed by key members of the State Council, and is said to embody current national policies to the semiconductor industry.[183] By its terms Circular 51 sets forth the following main policy measures:

- ***Reinvestment incentive.*** IC manufacturing enterprises (including packaging enterprises) that reinvest their after-tax profits are entitled to a 40 percent refund on the income tax already paid on the reinvested amount. Reinvestments in western China are entitled to an 80 percent refund.[184]

- ***Conditional VAT rate of 3%.*** IC manufacturers that sell their own devices shall receive refunds of VAT payments in excess of 3 percent "for R&D and capacity expansion."[185] This provision may be the source of numerous reports to the effect that the effective VAT rate will soon be lowered to 3 percent for IC manufacturing enterprises (which MII denied as of September 2002).

- ***Extension of benefits to non-leading edge firms.*** IC enterprises utilizing design rule line widths up to 0.8 microns are eligible for exemption from the enterprise income tax for 2 years (beginning in the first year of profitability) and taxation at half the normal rate for the following 3 years. These firms are also exempt from paying tariffs and VAT on raw materials and supplies that cannot be obtained domestically.[186]

- ***Express customs clearance.*** IC enterprises that export over $50 million/year will enjoy express customs clearance and preferential treatment and express clearance with respect to commodity inspection and quarantine.[187]

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182 *Semiconductor Technology* magazine, November 2001 (translation from Chinese).

183 Circular 51 has not been formally issued and published because the government did not wish to issue another sector-specific Circular so soon after the release of Circular 18.

184 Circular 51, Article 1. It is not clear that this provision will have much practical effect over the near term since few IC manufacturers are likely to pay any income tax at all for many years.

185 Circular 51, Article 3.

186 Circular 51, Article 5.

187 Circular 51, Article 4. "Express customs clearance" includes treatment such as advance online clearance, express transfer, factory-site inspecting and clearance by guaranty.

- ***Venture capital funds.*** Venture capital funds may be established to encourage the development of the IC industry, and the government will establish one or two R&D centers that integrate production with academic research.[188]

- ***Upstream and downstream firm eligibility.*** Circular 51 is also said to have extended the benefits of Circular 18 to assembly, test, and packaging enterprises, and to manufacturers of semiconductor materials and equipment.[189]

6. *Regional and local implementation.* Circular 18 directed regional and local authorities to augment national-level promotional measures with their own complementary measures:

> *Local People's Governments and competent authorities of the State Council should make efforts to study how to formulate the implementation of detailed roles and supporting policies for the earlier implementation in line with the requirement of Regulations.*

Regional and local governments are responding to the central government's call and have adopted their own measures to promote the semiconductor industry within their jurisdictions.[190] As a result, a three-tier structure of government benefits has emerged (Figure 17). The central government has attempted both to stimulate local initiative with respect to promotional incentives and to prevent an overheated competition between regions -- in the form of incentives -- to attract semiconductor investment. Three areas are emerging from this process the main sites for new semiconductor investment, Shanghai, Suzhou and Beijing. In all three areas, significant promotional measures have been developed and put in place, although officials indicate that implementation of their responsibilities under Circular 18 is a work in progress and not complete. IC-specific promotion policies have also been developed by Dalian, Zhejiang, Tianjin, Jilin and Shandong Provinces.

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188 Circular 51, Articles 2 and 6.

189 Interview with MII official, Beijing, (September 2002). Perhaps because it is not a public document, some changes in national policy toward the semiconductor industry which have reportedly been adopted are being attributed to Circular 51, which do not in fact appear within the four corners of the document.

190 In theory, the means available to local governments to attract and promote their regional semiconductor industries are limited. Under Chinese law, provincial and local authorities have no authority over the dominant taxes foreign-invested enterprises face -- the value-added tax and the enterprise income tax -- nor any authority over the lending decision of the central-government's banks, which control a large majority of all bank funds in China. Therefore, these governments must rely on the development of attractive economic zones and infrastructure. The reality, however, is that nearly every aspect of central-government authority is implemented in some part at the local level by officials who either are themselves eager to provide benefits to local enterprises or are under severe pressure from other, more powerful local officials who want such benefits granted. Both taxation and lending by national, centrally-controlled banks are often shaped by local officials. Even import regulations -- the ultimate central-government purview[190] -- are implemented on a discretionary basis by local governments.

Figure 17
Layering of Chinese Promotional Policies in Microelectronics

	Central government	Regional government	Local government
VAT	• Provides 3-6% VAT preference	• Delegates authority to associations to determine enterprise eligibility	• May rebate locate portion of VAT to enterprise • May apply preferences more broadly
Enterprise tax	• Provides tax holiday	• Provides exemption from local taxes/fees	• May rebate local portion of tax
Individual tax	--	--	• Special tax rates in Parks • Rebates to individuals for housing/cars
Equity investment	• Ownership of SOEs, laboratories	• Equity participation in semiconductor enterprises	• Equity participation in semiconductor enterprises
Interest rate subsidy	• One point	• One-two points	--
Land use fees	--	--	• Provides preferential terms (including free land)
Utilities	--	--	• Provides preferential terms
Infrastructure construction	• Encourages infrastructure projects • Approves, sets guidelines for new Hi-Tech parks	• Provides funding, land, guidance for infrastructure projects, including new Hi-Tech parks	• Constructs sites providing infrastructure for semiconductor industry
Attracting overseas talent	• Sets broad policies	• Grant residency • Provide venture capital, incubators for returnees	• Provide incubators • Offer individual incentives (cash, facilities, housing, car)

- ***Beijing's Circular 2001-4***, entitled, "Measures for Implementing 'Policies for Encouraging the Development of Software and Integrated Circuit Industries'" provides many of the same benefits as Shanghai's Circular 54, but appears to "up the ante" in many respects. For example, where Shanghai establishes a 1-percent loan subsidy to qualified IC enterprises, Beijing allows for a 1.5-percent subsidy, which can be increased to 2 percent under certain conditions.

- ***Shanghai Circular 54***, Some Policy Guidelines of this Municipality for Encouraging the Development of the Software Industry and the Integrated Circuit Industry. Much of Circular 54 simply parallels Circular 18 but in a number of areas it provides more specific detail regarding responsible agencies, funding amounts, and eligibility requirements.[191]

While China has not imitated every facet of Taiwan's promotional polices in microelectronics, all of Taiwan's principal policies in this sector are now being closely paralleled on the mainland -- tax holidays, the establishment of science-based industrial parks, spinoff of government research institutes, preferential lending, promotion of semiconductor foundries, lucrative financial incentives for key personnel, and passive government minority investments in semiconductor enterprises. Several aspects of Taiwan's microelectronics industry cannot be replicated simply by adopting new policies -- most notably the superiority of Taiwan's semiconductor enterprises in manufacturing process technology, and Taiwan's R&D, design, and university-based research capabilities. However, China is addressing its weakness in process technology by encouraging the physical relocation of Taiwanese semiconductor manufacturing operations to the mainland, a trend which will facilitate China's absorption of manufacturing technology. Taiwan's adjustment to this trend -- an attempt to transform itself into an R&D and design-intensive "headquarters" for mainland semiconductor manufacturing operations -- is likely to enable China to capture benefit from Taiwan's superior research and design institutions and enterprises even if it cannot fully replicate them on the mainland in the near term. The principal policy utilized by Chinese policymakers to encourage the relocation of Taiwanese production to the mainland is the differential Value-Added Tax (VAT).

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[191] For example, the construction of IC manufacturing facilities by even nominally private companies is granted the status of a "government project" and is to be provided explicit loan subsidies, and the IC industry is given its own 24-hour "window" at customs for "10-hour-or-less" service on all imports and exports; new integrated circuit chips manufacturing projects will, within the three years after the date of accreditation, be exempted from the payment of handling charges and property right registration fees in purchasing housing for production and management use, and will be exempted from the payment of project-related water supply capacity-increase charges, gas supply capacity-increase charges and power supply and distribution service charges. Shanghai Circular 51, January 2001, Article 22.

III. THE PREFERENTIAL VAT: LEVERAGING CHINA'S MARKET

By far the single most important promotional measure applied by the Chinese government in semiconductors under the Tenth Five Year Plan has been the establishment of a different and more favorable rate of payment of China's value-added tax (VAT) by any enterprise, by domestic or foreign, which designs or manufactures integrated circuits in China. When this policy is fully implemented domestically designed and/or manufactured ICs will pay an effective value-added tax of 3 percent, while imported ICs will pay China's normal VAT of 17 percent.

- The preferential VAT, standing alone, gives China-based integrated circuit firms as much as a 14-percent cost advantage over comparable devices designed and/or manufactured in Taiwan, Malaysia or any other country with respect to ICs sold in the Chinese domestic market.

- This VAT differential is being cited by Taiwanese investors, in particular, as the principal factor underlying their decision to invest in manufacturing in China.

In addition to the effective 3 percent rate on domestic output, domestic manufacturers of integrated circuits can import semiconductor manufacturing equipment and materials without paying any VAT. Such imports are exempt from the 17 percent VAT that normally applied to imported goods.

The VAT differential, when fully implemented, will have largely the same effect as a 14 percent tariff on imports of integrated circuits. In effect, it establishes a protected sanctuary for local investors insides the world's fastest-growing major market for semiconductors.[192] On the other side of the Taiwan Straits, potential competition exists for any new mainland foundry from the most efficient foundry operations in the world, TSMC and UMC, both of which have substantial underutilized capacity. TSMC and UMC can operate 12-inch fabs that can produce over twice as many devices per wafer than the 8-inch fabs being set up by SMIC, Grace and the others on the mainland. In an open, competitive free-for all with Taiwan, the new mainland enterprise would face an uphill struggle getting started. The VAT differential, therefore, provides the *sine qua non* underpinning the current wave of new Taiwanese investment in mainland foundries.

> *The high-end Chinese foundries will have no reason to operate fabs in China if their VAT break is rescinded... These companies are now importing expensive new equipment that is not depreciated. It would not be economical for these*

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192 Richard Chang, the CEO of SMIC, estimates that while world demand for semiconductors will remain flat through 2005, Chinese demand growth will average over 30 percent per year during the same period. SMIC cites estimates that China's semiconductor market will nearly double in the next three years, from $19.4 billion in 2002 to $36 billion by 2005. "Chinese LSI Manufacturers Launching Ambitious But Realistic Programs," *Nikkei Microdevices* (January 2002).

companies to purchase and maintain such equipment if they did not have the tax break.[193]

A recent analysis by a Chinese semiconductor industry spokesman drew a similar conclusion with respect to semiconductor design firms:

> *Shanghai Integrated Circuit Industry Association (SICA) General Secretary Zhao Jianzhong said, "If imported chips are also granted VAT rebates, then high-end products will flow in one by another, attacking the Chinese market, and creating the disaster of all disasters for the design industry."*
>
> *The reasoning is simple: Moore's Law states that for a single chip, every 18 months its number of transistors doubles and its price falls by half (generally, connoting a 2X jump in the level of technical sophistication). In terms of technological level, China's chips are 2-3 generations behind the rest of the chip-producing world. If, in fact, imported chips are given VAT rebates, then it will create a situation such that every time China comes out with a new chip, a foreign-invested company will top it one with the importation of a newer generation of chip. As for the assembly and manufacturing industries, there's not much to say. Everyone will use the best, and before you know it, the China design industry will be out of luck.*
>
> *In Zhao Jianzhong's opinion, chip design is the nerve center of the chip industry; without it, the whole system crumbles.*[194]

Conversely, *with* the VAT advantage SMIC's Richard Chang reportedly believes that the mainland foundries will enjoy "an unbeatable edge" over their rivals in Taiwan and that "Taiwanese foundries have to come to China. They have no other choice."[195] In a 2001 interview with London's *Financial Times*, Chang conceded his operation had only a slight operating cost edge over Taiwanese foundries, could not import the most advanced production equipment, and was compelled to "import pricey talent from Taiwan."

> *But Mr. Chang points at one pressing reason for being based in China if you want to sell to the Chinese market: tax benefits… Most importantly, the new foundries expect to pay less than 5 percent of China's 17 percent value-added tax.*[196]

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193 Tim Wang, Director, iSuppli Asia, in "Why China is Unlikely to Abandon Tax Breaks," *Semiconductor Business News* (December 19, 2002).

194 *Southern Weekend* (July 3, 2003).

195 Mure Dickie, "Pioneering SMIC Leads Chip Exodus to China," *Financial Times* (November 13, 2001).

196 Ibid.

A. Economic impact of the differential VAT.

China's differential value-added tax on domestically-produced semiconductors has not yet been fully implemented and its parameters have not been completely clarified. Nevertheless, it is already having a powerful effect on investment patterns, reflecting the fact that private investment decisions are made based on the *expected* return on investment and its associated risks. Recent comments by executives at the new Taiwan-invested mainland foundries indicate that they regard the VAT policy as a powerful consideration underlying their investments,[197] "The greatest incentive for SMIC [to establish mainland operations] is the value-added rate of 3 percent charged on sales in China versus the 17 percent levied on imported semiconductors."[198]

The "main customers so far for the foundries in China are the multinational systems and chipmakers, starting now to design in China for the local market, and looking for some local manufacturing to bypass the 17% value added tax on imports and meet the fuzzy Chinese requirements for local content."[199] Cirrus Logic, for example, cited "substantial savings" with respect to the value-added tax as a factor underlying its decision to enter into a 5-year contract for foundry services with Central Semiconductor Manufacturing Company (CSMC), a Taiwanese-based mainland foundry.[200] As China's market grows, the pressure on foundries like TSMC and UMC to locate more of their fabs in China to avoid the 17 percent VAT will increase.

> *Because China will be the second-largest market for semiconductors in the world by 2010 or sooner, many IDMs and design houses are, as expected, selling to China. TSMC can only benefit from establishing its own fabs there. The most urgent reason: value added tax (VAT). China slaps a 17 percent VAT on imported semiconductors, as opposed to 3 percent of locally manufactured ones. For now, the local fabs can only supply 25 percent of total demand, so vendors have little choice but to import from TSMC and UMC. But the two companies have been warned. "Our US. customers, who have either joint ventures or wholly owned subsidiaries in China, have indicated to us that sooner or later, we have to*

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197 "China offers tax advantages. Chips made outside of China are subject to value-added tax of 17%. When sold in the local market, while those produced within China are only taxed at 3%. Right there, using SMIC brings a 14% tax savings." Interview with Tsuyoshi Kawanishi, Outside Director of SMIC, *Nikkei Sangyo Shimbun* (March 28, 2002). Part of TSMC's rationale for establishing an 8-inch fab near Shanghai is that by its doing so "TSMC's customers will be able to avoid a Chinese tax levy against imported goods if the company can make its wafers locally." "Taiwan to China," *CFO Asia* (July 2002).

198 Duncan Clark, "Incentives Give Push to Global Chip Ambition," *BDA China Limited* (June 18, 2002).

199 "Downturn Pushes China Foundries Toward Smaller Geometries, More Emphasis on Service," *Solid State Technology* (April 2002). "Taiwan's high-tech companies must be able to manufacture in China to help their customers, who have all of their operations there, to cut costs. For example, TSMC's customers will be able to avoid a Chinese tax levy against imported goods [the 17% VAT on imported devices] if the company can make its wafers locally." Abe de Ramus, "Taiwan to China," *CFO Asia* (July 2002).

200 Initially CSMC was to produce CMOS-based mixed signal consumer ICs for Cirrus but was expected to produce a broad range of products under the contract. "Cirrus Logic Signs Five-Year Foundry Manufacturing Agreement with CSMC in China," *Semiconductor Fabtech* (August 8, 2001).

be there, because it costs them a lot in taxes to import our goods," says [TSMC's] Chang.[201]

The differential VAT is cited as "the most urgent reason" why TSMC abandoned its longstanding reluctance to establish fabs on the mainland and began to establish manufacturing operations in Songjiang.[202] In a recent interview TSMC's Chairman, Morris Chang, commented as follows:

Q: *Why can't you produce from a foundry in Taiwan for [mainland design houses]?*

A: *To try to serve the Chinese market from Taiwan does not make sense. There are things like VAT [value-added taxes] local content [and other tariff related] barriers that will make it rather ineffective for a foundry to try to serve the Chinese market from outside.*[203]

To potential investors, the VAT differential is more than just a shield against external competition. It offers a formula for achieving high levels of profitability, reflecting the fact that the VAT preference has a multiplier effect on enterprise profitability much greater than an incremental cost advantage of as much as 14 percent might suggest at first impression.

- ***Price umbrella.*** The VAT differential creates a price umbrella for domestically produced semiconductors in China. The higher prices that can be charged by Chinese-based manufacturers will enable them to more than double their net profits, based on a model utilizing SMIC's forecast income (see Appendix 2).

- ***Improved utilization.*** Domestically-based manufacturers may also elect to take advantage of the price umbrella created by the differential VAT to underprice imports and gain additional volume in the Chinese market. This will increase capacity utilization rates and reduce unit costs. An increase in utilization from 71 to 90 percent would increase net profits by over 400 percent (see Appendix 2).

The VAT differential, standing alone, can multiply investor's expected rate of return in China by 2 to 4 times. One industry analyst noted recently that the reduction of the VAT on indigenous semiconductors to 3 percent, coupled with growing Chinese demand

[H]as done wonders for the country's domestic chip industry. Multiple companies have jumped feet first into the high-volume, high-end foundry business... The major motivation for locating manufacturing operations in China is rock-bottom labor costs. However, this is less meaningful in the semiconductor business, in which the primary expenses are equipment and facilities. This leaves

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201 "Taiwan to China," *CFO Asia* (July 2002).

202 "Taiwan to China," *CFO Asia* (July 2002).

203 "China's Fabless Appeal," *Business Week Online* (September 23, 2002).

> *only one competitive advantage for the domestic Chinese foundries: the VAT break. Without the VAT break, much of the justification for the existence of the high-end Chinese foundries would go away, something that would conflict with the goals of the government.*[204] (emphasis added)

The VAT preference only affects semiconductors which are sold in China, giving domestically-made devices an edge over imports. All of the new Taiwanese-invested foundries plan to export a portion of their output as well as selling into the domestic Chinese market, and such exports are not affected on a transaction-by-transaction basis. However, the fact that each foundry enjoys what is in effect a stable, protected home market with respect to its internal sales will enhance their ability to compete in international markets.[205]

B. VAT rebate implementation to date.

The implementation of the differential VAT for integrated circuits has only begun, and its principal impact to date has been on investors' expectations rather than the market itself. Basic parameters of the new regime have not been established or are in a state of flux if not confusion. But a survey of the implementation process as it currently stands indicates that over time the policy will be clarified and made uniform in a manner that provides protection for domestic manufacturers and designers roughly equivalent to a tariff of up to 14 percent.

China's VAT is levied on goods produced in or imported into China. It is normally collected by the seller of a product and included in the purchase price charged to the buyer. It is paid at regular intervals by enterprises at the local bureaus of the State Administration of Taxation. It is determined by applying the VAT rate (normally 17 percent) to the price of the product being sold ("output VAT") minus the VAT previously paid on direct inputs, such as components and raw materials, provided these can be properly documented ("input VAT").[206] The cost of fixed assets and any other costs not directly associated with the production of the product in question is not includable in the input VAT.[207] Siginificantly, imported materials used in semiconductor manufacturing are exempt from VAT and are thus not included in the input VAT. The rebate on semiconductor design and production is applied for at the relevant local tax bureaus at the same time the VAT is paid, and requires a showing that the enterprise is eligible

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204 Jonathan Cassell, "Why China is Unlikely to Abandon Tax Breaks," *Semiconductor Business News* (December 19, 2002).

205 "With a home market, companies can advance when possible, and pull back when necessary. They can build up their resources using the home market, and then expand step by step into the international market, without any need to rush." Steve Chou, general manager, Shanghai Microtek, speaking of China as a home market in explaining motivations for Taiwanese IT makers to relocate in China. Laura Li, "Shanghai or Bust! Taiwanese Hi-Tech Descends on Eastern China," *Sinorama* (June 2001).

206 VAT Regulations, Articles 4 and 5.

207 VAT Regulations, Article 10(1).

for the rebate, that the product in question is eligible, and that all invoices and other documentation are in order.[208]

The basic relevant provisions in Circular 18 with respect to the VAT rebate itself are not a model of clarity. Article 41 of Circular 18 provides that with respect to IC manufacturers, "the portion of the actual burden [17 percent] that exceeds relevant amount by 6 percent shall be immediately returned when the tax is collected, and it is to be used by the enterprises for the research and development of new IC and for expanding production." Article 51 of Circular 18 states that the IC industry is to be treated "as the software industry" and enjoy the preferential policies available to the software industry -- which include VAT payment at an effective 3 percent rate.[209] Several ambiguities have become evident.

1. ***6 vs. 3 percent.*** As of the end of 2002 Chinese semiconductor manufacturers were reportedly paying an effective VAT rate, after rebate, of 6 percent.[210] Reports were widespread, however, that the effective rate for IC manufacturing will be reduced to 3 percent, and several sources indicate they have received official confirmation of that fact.[211] One source of these reports is the central government's unpublished Circular 51, Article 3 which provides that ordinary VAT taxpayers "that sell self-made IC products (including singly-crystal silicon wafers) shall receive refunds of actual VAT payments in excess of 3% for R&D and capacity expansion."[212] Circular 51 has not been officially adopted but is reportedly being given normative effect by the central government. Another basis for the 3 percent figure is an undated Circular 70, jointly issued by the Ministry of Finance and the State Administration of Taxation in 2002, announcing that "From January 1, 2002 until the end of 2010, IC companies that sell self-produced ICs will be subject to a 17 percent VAT; however, upon collection, such the amount that exceeded what the cost of the VAT would have been had it been 3 percent will be rebated to those same companies to be used to expand production and further R&D."[213] *China Daily*, the country's official English-language newspaper, reported in October 2001 that

> *China will give a huge financial boost to the country's chip manufacturers to attract investment to the heart of information technology products, according to*

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[208] The rebatable amount is the net VAT paid (after input VAT is subtracted from output VAT) in excess of 3 or 6 percent, as the case may be.

[209] Circular 18 Article 5

[210] Interviews with industry executives (Shanghai, September 2002); official of Shanghai Integrated Circuit Association (Shanghai, September 2002).

[211] Interview with official of Shanghai Caohejing Hi-Tech Park Development Corp. (Shanghai, September 2002).

[212] However a footnote to this provision limits the availability of the benefit to small companies (enterprises whose gross revenues do not exceed RMB 1 million).

[213] Ministry of Finance and State Administration of Taxation *Regarding Policies Toward Developing the Software and IC Industries within China: An Announcement* (2002). The notion that the VAT would soon fall to 3 percent for IC manufacturing was reportedly being leaked by MOFTEC and other ministries in late 2002, and has been touted by some of the new mainland foundries as a further reason to use their services in the future. Interviews with Shanghai-area foundry executives, September 2002.

government officials. Value-added tax for chips -- also called integrated circuit (IC), will be reduced from 6 per cent to 3 per cent, one of the lowest rates among all kinds of products, in an effort to help the industry, said Zhang Qi, Director of Electronic Products Management Department of the Ministry of Information Industry (MII)… "We're going to give chip makers the best policies in the world," she said.[214]

Executives at the mainland foundries universally use the 3 percent figure in touting their competitive edge. In sum the preponderance of available information indicates that the preference will be clarified at the 3 percent level.

2. ***"Shall be immediately returned."*** Article 41 of Circular 18 states that with respect to eligible IC manufacturers, that portion of the 17 percent VAT which exceeds 6 percent "shall be immediately returned when the tax is collected." To the extent this language suggest that the rebate is given back to the enterprise at the time the tax is paid, it is misleading. In practice, the enterprise pays the full 17 percent VAT to the local office of the Tax Bureau and applies for a rebate, which may or may not be forthcoming over a time frame which may vary from case to case. The local tax bureau office may dispute the eligibility of the enterprise or of the product in question for the rebate, and reportedly unless the enterprise devotes some time and expertise to establishing eligibility, a rebate is unlikely to be paid.[215] Chinese firms in various sectors eligible for VAT rebates typically receive them six months to one year after applying for them, although IC manufacturers in the Shanghai area reportedly receive their rebates within 30 to 45 days, reflecting the IC industry's status as a priority industry.[216] Beijing IC design houses were not receiving the rebate at all as of late 2002, reflecting the resistance by the local tax bureaus. The most likely outcome over the longer term is a clarification of the policy that enables all qualifying firms to receive the rebate.

3. ***VAT exemptions for imported raw materials and equipment.*** Article 44 of Circular 18 provides that tariffs and imported-related VAT "shall be exempted for manufacturing-related raw and semifinished materials and consumable goods that are imported for their own use" by qualifying IC manufacturing enterprises. Article 47 exempts imported "IC equipment and instruments" from tariffs and import-related VAT. The exemption from tariffs/VAT on imported semiconductor manufacturing equipment is characterized by Chinese

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[214] Hou Mingjuan, "PRC Government to Issue Tax Incentives for IT Sector," *China Daily* (October 15, 2001). Reports of the reduction in effective VAT rates for domestically-made ICs were widespread. See "China to Provide More Tax Breaks for Domestic Chipmakers," *AFX-Asia* (October 15, 2001); "Tax Favour For Heart of IT," *Asiainfo Daily China News* (October 15, 2001); "Last summer the central government moved to lower the value-added tax on ICs from 17 percent to 6 percent, then to 3 percent." "China's Silicon Road," *Electronic Engineering Times* (October 15, 2001); "[New] incentives would enable domestic chip plants to benefit from a VAT rate of 3 percent, compared with the previous 6 percent, *Shanghai Daily* quoted senior government official Zhang Qi as saying," "Range of Incentives Announced Following Claims Chip Sector Being Ignored," *South China Morning Post* (September 20, 2001); "Chip Plants Secure Tax Cut," *Asiainfo China Daily News* (September 18, 2001).

[215] Interview with official of Shanghai Integrated Circuit Industry Association (Shanghai, September 2002).

[216] Interview with official of Caohejing Hi-Tech Park Development Corp. (Shanghai, September 2002).

officials as an important incentive, and domestic semiconductor manufacturing and design enterprises are reportedly urgently seeking to qualify for exempt status with respect to equipment imports. The tariff/VAT exemption for raw and semifinished materials and consumable goods raised many questions, such as whether imports of semifinished semiconductor wafers would qualify for the exemption. MII, in consultation with other Ministries, was reportedly preparing a catalog specific of semiconductor materials and equipment that can be imported duty and VAT free in late 2002, but it has not yet been released. In its absence, customs offices in different localities appear to have applied the exemptions in a differential manner.[217]

4. ***VAT treatment of domestically-designed devices manufactured abroad.*** Given the fact that Chinese semiconductor manufacturing technology lags several years behind the global state of the art, the prospect exists that Chinese IC design firms will produce designs for which no suitable manufacturing capability exists inside the country. Such designs would of necessity be fabricated outside of China and reimported, to the extent they were destined for domestic consumption. In October 2002 the Ministry of Finance and the State Administration of Taxation issued a circular providing that with respect to integrated circuits designed in China, manufactured abroad, and reimported into China, a VAT refund would be provided for any amount collected in excess of 6 percent of the value added upon import. Thus domestically-designed, foreign made ICs pay an effective VAT of 6 percent upon import, compared with 17 percent VAT for other imports.[218] This measure was issued with a retroactive effective date of July 1, 2000.

5. ***Identifying eligible IC enterprises and products.*** One of the most significant initial challenges in implementing Circular 18 has been finding a mechanism for determining which enterprises and which products are eligible for its benefits, particularly with respect to VAT rebates. The local offices of the State Administration of Taxation are charged with issuing the rebates upon presentation of appropriate documentation, but do not have any expertise with respect to the semiconductor industry or what does or does not constitute an "IC manufacturer" or an "IC design house." No implementing regulations had been issued as of late 2002. The natural impulse of the tax authorities when presented with a request for a VAT rebate in a particular instance is often simply to deny the request. The problem has been particularly acute with respect to small IC design firms that cannot readily demonstrate their eligibility for a rebate.

- ***Certification of manufacturers.*** Certification of large semiconductor manufacturing enterprises for eligibility under Circular 18 is undertaken at the national level. MII and the State Tax Bureau must jointly approve the eligibility of each company for

217 For example, officials in Shanghai Pudong's Waigaoqiao Free Trade Zone point out that in their zone a broader spectrum of imported manufacturing equipment qualifies for exempt status (such as air conditioning equipment, elevators, and other machinery not necessarily associated with the manufacturing process) than is the case at other points of entry in the Shanghai Area. Interview with official of Economic & Trade Department, Shanghai Waigaoqiao Free Trade Zone Administration (Shanghai, September 2002).

218 Circular 140 of October 25, 2002, Notice Regarding Tax Policy for Importation of Overseas Manufactured Integrated Circuit Products which are Domestically Designed.

VAT rebates, tax exemptions, and other benefits.[219] The major enterprises currently producing semiconductors appear to have qualified as eligible (their eligibility in most case being "self-evident") but are reportedly "encountering difficulties" in collecting VAT rebates.[220]

- ***Certification of IC design firms -- Shanghai.*** In Shanghai, certification has been addressed by delegating authority to the local industry association, the Shanghai Integrated Circuit Association (SICA) to examine design houses and issue certifications on an annual basis that these organizations are eligible for the preferences specified in the circular. Certification for Shanghai area IC firms also qualifies them for benefits at the Municipal level pursuant to Shanghai circular 54. In order to qualify for certification, an entity must 1) have a design team, defined as 5 or more engineers; 2) demonstrate a qualifying design environment, meaning legal (non-pirated) workstations and design software; 3) have home-grown IPR and have a certificate for it (patents from overseas don't count); 4) show that its designs are being fabbed in China, or, alternatively, present evidence that the design cannot be fabbed in China and is therefore being fabbed overseas. In 2001 over 80 IC design firms were certified as eligible for Circular 18 benefits, but in late 2002, as a result of "infighting between the Tax Bureau and MII" no new certifications were being issued, and the 80 existing certifications were due to expire soon (the process must be repeated annually).

- ***Certification of IC design firms -- Beijing.*** In the Beijing area MII initially certified individual IC enterprises as eligible for Circular 18 benefits.[221] This function was later delegated to two industry associations, the China Semiconductor Industry Association (CSIA) and the Beijing Semiconductor Association (BSIA). However, following a jurisdictional struggle between MII and the Tax Bureau in which the latter prevailed, the ultimate authority to determine eligibility rests with the individual local Tax Bureau offices. According to CSIA and BJICA, the tax offices know little about integrated circuit technology, so they consult with and are guided by the

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219 Circular Concerning the Printing and Distribution of Regulations on Approval of Integrated Circuit Design Enterprise and Products (Xi Bu Lian Chun (2002) No. 86). The manufacturer submits a form supplied by the State Administration of Taxation, Certificate Application Form of Integrated Circuits, which requires provision of general corporate information, taxpayer ID, and a business description. The applicant must also provide specifics about the types of IC products manufactured (MEMS, ASIC, DSP, memory, analogue IC, etc.), the fields in which the devices are applied (automotive, computer, telecom, etc.), forms of design support (EDA, probes, design testing training, etc.), and the intellectual property involved. The enterprise must supply the name and model number of the integrated circuit products concerned.

220 Interview with Shanghai Integrated Circuit Industry Association (Shanghai, September 2002).

221 MII, Provisional Administrative Measures for Approving Integrated Circuit Design Companies and Products (October 8, 2000, No. 1067)

> Associations on a case-by-case basis to determine whether or not to certify a particular enterprise.[222]

Over the longer term it is virtually inevitable that a coherent system for certifying enterprise eligibility will emerge and that of necessity the certification process will be substantially influenced, if not controlled, by domestic semiconductor manufacturers and design firms because of their technical knowledge.

C. The VAT differential and China's WTO obligations.

When China acceded to the WTO, it made a binding commitment to the effect that "internal taxes, including value-added taxes, applied or administered by national or sub-national authorities shall be in conformity with GATT 1994."[223] This included a commitment under GATT Article III (1) not to apply internal taxes and charges in a manner in which "afford[s] protection to domestic enterprises." GATT Article III(2) provides that

> *The products of the territory of any contracting party shall not be subject, directly or indirectly, to internal taxes or other internal charges of any kind in excess of those applied, directly or indirectly, to like domestic products.*

Granting a whole or partial exemption from an internal tax or domestic like products (but not imports) is a violation of Article III.[224] China's differential VAT, which provides a partial VAT exemption for domestically designed and manufactured integrated circuits, but not imported like products, appears to be a clear violation of GATT Article III(2). Because the effect of the differential VAT is to protect "domestic enterprises," the measure is also inconsistent with GATT Article III(1).

The WTO Working Party on China's accession stated that "Non-discriminatory application of the VAT and other internal taxes was deemed essential."[225] Yet it is clear that investors in China's new semiconductor foundries believe that the differential VAT *will* provide them with a competitive advantage over comparable imported devices, and that that fact is a principal consideration underlying their decision to establish production facilities in China. The operators of the new foundries are using the cost differential created by the VAT preference to drum up business for their operations.[226]

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222 Interview with Beijing Semiconductor Industry Association, (Beijing, September 2002).

223 WTO, China's Accession, op. cit., Part I.11.1.

224 John H. Jackson, *World Trade and the Law of GATT* (Charlottesville, Va.: The Michie Company, 1969), p. 284, citing a 1950 complaint by the Netherlands against Great Britain.

225 WTO, *Report of the Working Party on China's Accession*, WT/MIN(01)/31 (November 10, 2001) para. 169.

226 "Pioneering SMIC Leads Chip Exodus to China," *Financial Times* (November 13, 2001); *Nikkei Sangyo Shimbun* (March 28, 2002).

Chinese responses. Although Chinese officials generally defend the WTO-legality of the VAT, the legal basis offered in support of the policy tends to vary. Some Chinese authorities who have addressed the relationship of the differential VAT to the country's WTO obligations have simply stated that the issue will need to be examined more closely in the future.[227] Others have argued that the measure is not a denial of national treatment because domestic and foreign-invested firms located in China qualify for the benefit on a nondiscriminatory basis.[228] But Article III is a commitment to national treatment with respect to imported and domestically produced *goods*, not enterprises. If -- as here -- imported goods must pay an internal tax at a differential and higher rate than comparable domestically made goods, then China is not meeting its WTO obligations under Article III:

> *The evil that the draftsmen [of Article III] sought to proscribe by the first sentence was an internal tax applied discriminatorily to imported products, thus operating as effectively as a tariff to protect local products against foreign competition.*[229]

This "evil" -- essentially a tariff-like barrier to access to China's market -- is exactly what the differential VAT is designed to achieve. SMIC President Richard Chang explained it frankly in these terms in a February 2002 interview with a Japanese industry journal:

> "Strengths Vis-à-vis Taiwan Foundries
>
> ***Question:*** *There is a powerful competition in the world of Si foundries. Where do SMIC's strengths lie?*
>
> ***Answer:*** *There are three areas, the provision of customized service for customer, ready access to the Chinese market, and the provision of higher-performance processes than other firms.*
>
> ***Question:*** *What do you mean by ease to the Chinese market?*
>
> ***Answer:*** *When you import a chip from outside China, it results in a value-added tariff of upwards of 17%. If this is produced in China, this tariff is only 3%. For example, when*

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227 The *Financial Times* reported in late 2001 that "E]ven as they talk about cutting the VAT levied on chipmakers further, Chinese officials appear more than a little doubtful about the long term prospects for such favoritism -- doubts which are likely to grow now that China has won entry into the World Trade Organization." "We need to research later how these policies will be affected by entry to the WTO," says Shen Weiguo, deputy general manager of the Zhangjiang High-Tech Park, where SMIC and Grace are located. "Pioneering SMIC Leads the Chip Exodus to China," *Financial Times* (November 13, 2001).

228 Interviews in China, September 2002.

229 John H. Jackson, *World Trade and the Law of GATT* (Charlottesville, VA: The Michie Company, 1969), pp. 279-80.

Japanese firms sell LSIs in China, if SMIC produces them, a cost reduction of 14% can be achieved."[230]

Some Chinese authorities have also reportedly contended that the differential VAT established by Circular 18 is designed to reduce the "overall burden" of the VAT to an effective rate of 3 (or 6) percent on semiconductor enterprise, not to establish differential rates with respect to imported versus domestic products.[231] Chinese officials argue that this is necessary to "equalize" the VAT burden between Chinese and domestic enterprises because foreign semiconductor manufacturers received a rebate of the VAT in their home countries paid on their capital equipment, whereas Chinese enterprises must pay a VAT on domestically-produced semiconductor manufacturing equipment, with no eligibility for a rebate. This argument suffers from a number of factual defects:

- Leading Chinese semiconductor manufacturers do not utilize domestically-made semiconductor manufacturing equipment, which is not internationally competitive. They import virtually all of their equipment -- completely VAT free.

- U.S. semiconductor produces do not pay VAT in the United States, but they often pay sales and other taxes on equipment purchases which is not rebated when U.S.-made semiconductors are exported.

- Chinese IC design firms also qualify for the VAT rebate. These firms frequently make little or no expenditure on capital equipment, and the equipment they do purchase (such as CAD design tools) is imported -- again, VAT free.

- If China's intention is to "equalize" the VAT burden on domestic and foreign semiconductor firms, the policy is a self-evident failure -- the executives of SMIC, China's leading foundry, are proclaiming around the world that the VAT preference gives chips fabbed in China an "unbeatable competitive advantage" over comparable imported devices.

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230 Interview with Richard Chang, *Nikkei Microdevices* (February 2002). Chang has characterized the VAT as an effective replacement for China's disappearing tariff on semiconductors in other contexts: "Richard Chang, CEO of Semiconductor Manufacturing Corp, says China's entry into the World Trade Organization will bring down import tariffs on semiconductors but China's value-added tax policy will continue to give China's chip producers the edge over foreign competitors; says sales of imported chips will continue to be saddled with 17% VAT, while rates for domestically produced chips will be lowered to 3% from 6%." *New York Times Company Abstracts* (December 10, 2001).

231 This was ostensibly done to reduce the VAT burden on capital-intensive industries like semiconductors relative to other domestic industries, which may pay a lower effective VAT after netting out the input costs. Capital-intensive industries which cannot use capital depreciation to reduce VAT payments supposedly bear a higher burden. While that may well, be, the issue is not the relative VAT burden borne by two classes of domestic industry, but the VAT levied on imported versus domestic products. The notion of the VAT differential as an equalizing of burdens between capital-intensive and other industries is undercut by the fact that key beneficiaries of the 3 percent VAT -- the software and IC design sectors -- are not capital-intensive.

- Rebates are applied for and paid out on a monthly basis, prior to the availability of data with respect to an enterprise's annual revenues, a procedure appears inconsistent with the assertion that the rebate amount is based on a ratio of VAT paid to total annual enterprise revenue. The Ministry of Finance and the State Administration of Taxation characterize the scheme as a "refund-as-you-pay policy."[232]

- The application form for the rebate requires the applicant to state the specific products with respect to which the rebate is sought, which suggests the rebate is product-specific and not enterprise-specific. The application also requires the enterprise to segregate its revenues from integrated circuits sales from its revenues from all taxable goods and services, which suggests that the rebate is linked to revenues from monthly IC sales only, not to total enterprise revenue. If the latter were the case there would be no need to break out the two categories of revenue.[233]

The policy is being applied in a manner which establishes a preference in favor of domestic products over comparable imported products. The effective VAT on imported devices is higher than on comparable domestic devices. That is all that is required to establish a violation of Article III(2).

A recent WTO panel report ruled that *any* differential in the VAT burden between domestic and like imported products is a violation of GATT Article III(2). At issue were regulations by Argentina which imposed different rules on domestic and imported products with respect to the method for collecting the VAT, effectively requiring higher pre-payments on imported products and thus increasing their VAT burden relative to domestic products (through the time value of money). The panel found the regulations to be in violation of GATT Article III(2). The panel stated:

> *If the tax burden on imported products is in excess of the tax burden on like domestic products, there is an infringement… [The determination of the existence of an infringement] must be made on the basis of an overall assessment of the actual tax burdens imposed on imported products, on the one hand, and domestic products, on the other hand.*[234]

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232 "From 1 January 2002 through the end of 2010, a refund-as-you-pay policy shall be carried out for the value-added taxpayers selling IC products (including single-crystal silicon wafers) made by themselves after paying tax at the 17 percent tax rate. The refund covers the part of the actual value-added tax they have paid in excess of 3 percent." Ministry of Finance and State Administration of Taxation, Circular No. Caishui-2002-70, *Tax Policies to Further Encourage Development of Software and IC Industries*, reproduced in *Beijing Zhongua Renmin Gongheguo Duiwai Maoyi Jingji Hezuo Bu Wengao* (January 16, 2003).

233 State Administration of Taxation, Software and Integrated Circuit VAT Rebate Application Calculation Form.

234 Argentina -- Measures on the Export of Bovine Hides and the Import of Finished Leather (WT/DS155, December 19, 2000).

Chinese officials also argue that the United States and other WTO members were aware of the differential VAT on semiconductors when China entered the WTO and cannot now complain about it. However, the fact that a WTO member may have been aware of this WTO-inconsistent policy when China undertook WTO commitments does not excuse China from adherence to those commitments. China gave assurances upon accession that its policies, including internal taxes, would *not* discriminate against imported goods.[235] It was specifically asked to give assurances that the VAT would be applied to imported products in a nondiscriminatory manner. The Working Party on China's accession noted that

> *"…some members of the Working Party expressed concern that some internal taxes applied to imports, including a value-added tax, were not administered in conformity with the requirements of the GATT 1994, particularly article III. Those members of the Working Party noted that China appeared to permit the application of discriminatory internal taxes and charges to imported goods and services, including taxes and charges applied by sub-national authorities. Those members requested that China reaffirm all such internal taxes and charges would be in conformity with the requirements of GATT 1994."*[236]

China gave the specific assurances requested by the Working Party:

> *"the representative of China confirmed that from the date of accession, China would ensure that its laws, regulations, and other measures relating to internal taxes and charges levied on such imports would be in full conformity with its WTO obligations and that it would implement such laws, regulations, and other measures in full conformity with those obligations. The Working Party took note of this obligation."*[237]

China was admonished by the WTO Working Party that nondiscriminatory application of the VAT was "essential."[238] To argue now that the WTO members were aware of nonconforming VAT policies at the time of accession is tantamount to suggesting that they should have known that assurances of nondiscrimination given by China should not have been regarded as credible.

World Semiconductor Council Joint Statement. In May 2003 the World Semiconductor Council (WSC) released a Joint Statement urging China to reduce its VAT rate to 3 percent for

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235 "The representative of China confirmed that the full respect of all laws, regulations, and administrative requirements with the principle of no-discrimination between domestically produced and imported products would be ensured and enforced by the date of China's accession unless otherwise provided in the draft Protocol or Report," WTO, *Report of The Working Party on the Accession of China*. WT/MIN (01)/3 (November 10, 2001), para. 22.

236 WTO, *Report to the Working Party on the Accession of China*, WT/MIN(01)/31 (November 10, 2001) para. 104.

237 Ibid. Para. 107.

238 WTO, *Report to the Working Party on the Accession of China*, WT/MIN(01)/31 (November 10, 2001) para. 69.

all semiconductors, whether imported or domestically designed or produced. The WSC is comprised of national semiconductor industry associations representing the industries of the United States, the European Union, Japan, Korea and Taiwan. The WSC stated that the discriminatory VAT "has the effect of limiting market access, distorting patterns of trade and investment, and negates the benefits China promised to provide when it joined the WTO." The WSC indicated that it would submit its recommendations as formal requests to the respective governments of its members at the Governments/Authorities Meeting on Semiconductors (GAMS) scheduled for November 2003.[239]

D. Government procurement

When China joined the WTO, it did not become a party to the WTO Agreement on Government Procurement (GPA) although it has accepted observer status and has indicated that it intends to join the GPA in the future. As a result China is under no WTO obligations with respect to procurement of semiconductors by government entities. China has stated that all government entities at the national and sub-national level will conduct their procurement in a transparent manner, and provide all foreign suppliers with an equal opportunity to participate on an MFN basis, e.g., no foreign supplier will be treated more favorably than another foreign supplier.[240] But, China is under no legal obligation to afford procurement opportunities on an equal basis between domestic and foreign enterprises, or between domestically-made versus imported goods.

With respect to software, Circular 18 states that in procurement by government entities, domestically made products will be favored if price and quality are equal between domestic and foreign products.[241] This policy is apparently extended to domestically-designed integrated circuits by provisions of the Circular which make IC design firms eligible for the same benefits extended to the software industy.[242] These provisions are consistent with a view expressed by China's senior economic planners that after WTO entry, "preferential government procurement contracts" should be offered for foreign investment projects that provide "new products and new technologies."[243]

The Chinese government's role in the economy, while reduced in recent years, remains very substantial, and procurement of semiconductors by governmental organizations and state-owned enterprises will constitute a significant part of the total market. Some procurement

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239 *Joint Statement on the Seventh Meeting of World Semiconductor Council (WSC)*, (Nice, France, May 15, 2003).

240 WTO, *Report to the Working Party on the Accession of China*, WT/MIN(01)/31 (November 10, 2001) paras. 337-339.

241 Circular 18, Several Policies for Encouraging the Development of Software Industry and Integrated Circuit Industry, (June 24, 2000), Article 25.

242 Circular 18, op.cit., Articles 50 and 51.

243 Wang Yungui, State Morning Commission Foreign Economic Institute, "A Study of China's Strategy for Using Foreign Investment After WTO Country," *Chongqing Gaige* (July 20, 2001).

projects will be undertaken with the express purpose of providing demand for local semiconductor manufacturers.[244] Procurement for planned government-issued IC-type identity cards will generate a large demand for semiconductors for those cards.[245] In Beijing, where the municipal government is drawing up plans to issue IC-embedded ID cards to residents, a professor at Tsinghua University, where some of the technology for the cards is being designed commented that

> *It will be a big contract. Many foundries want this order. [Whether SMIC's Beijing subsidiary gets the order] depends on whether SMIC has capacity left over after doing commercial ones.*[246]
>
> *Chinese officials disavow any plan to favor domestic over foreign-made semiconductors with respect to public procurement, while others say that such preferences are "inevitable."*[247]

However, the same government entities that are undertaking substantial equity investments in local semiconductor manufacturing -- such as municipal governments in Shanghai and Beijing -- may in some cases themselves be procuring entities. It would be naïve to expect that some degree of domestic preference will not occur.

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[244] A municipal official of Beijing, for example, commented in July 2003 that "the focus of the development of the semiconductor industry for us this year is to foster market demand." For this purpose the municipal government will "concentrate capital and energy on six major products… IC cards; shared point of sale (POS) systems for banks and taxation bureaus; digital cameras; high definition TV (HDTV); network computers (NCs); and mobile communication devices." "In High Technology, Beijing Focuses on Six of the Best," *China Daily* (Hong Kong Edition) (July 9, 2003).

[245] A recent order by the government of China for IC cards from Shanghai-Huahong NEC Electronics Co. of Shanghai is indicative of the likelihood that domestically-manufactured ICs are likely to be utilized in such procurements. The ICs in this case are to be designed for use in personal and social insurance ID cards, containing family register, race, and insurance information. The government solicited four domestic semiconductor manufacturers to submit encryption circuit designs, but by June 2002 Shanghai-Huahong was "cooperating with Chinese authorities on the technical aspects of encrypting the information to be stored in the ICs," and "to prevent leaks concerning the encryption technique, the GOC [government of China] will apparently give Shanghai-Huanhong NEC exclusive manufacturing rights." "NEC Joint Venture in Shanghai Making Chips for PRC Identification Cards," *Nikkei Sangyo Shimbun* (June 17, 2002).

[246] Interview with professor of microelectronics, Tsinghua University (Beijing, September 2002).

[247] An MII official comments that with respect to most forms of government procurement, the "buy domestic" provision of Circular 18 will be applied only to purchases of software, not semiconductors. However, with respect to government issue ID-type IC cards, national security considerations will probably result in the designation of a domestic manufacturer for the ICs to be embedded in the cards. Interview with CCID official (Beijing, September 2002).

IV. TAIWAN IN CHINA

The current burst of investment in China's semiconductor industry is being driven largely by capital and management from Taiwan. But the proliferation of Taiwanese-owned semiconductor foundries in China does not reflect any policy design of the Taiwanese government or any concerted strategic plan by the Taiwanese semiconductor industry or group of Taiwanese investors. The influx of Taiwanese capital, managers and engineers into China is a bonanza-style rush by individuals, enterprises, and large and small investors attracted by China's growing market and new incentives (particularly the VAT preference), no longer constrained by Taiwan's restrictions on the flow of investment, personnel, and technology to the mainland. The Taiwanese government's post-hoc policy responses to this rush to the mainland -- an effort to retain a role for the island as a "headquarters" for mainland-based semiconductor manufacturing operations -- will actually accelerate the fusion of the Taiwanese and Chinese industries and ensure that Taiwan's R&D and design resources are ultimately deployed in support of a "greater Chinese" semiconductor industry.

A. "Shanghai Fever": Taiwan's high-tech exodus to the mainland

China's developmental effort in microelectronics not only replicates that of Taiwan, but is capturing a growing segment of the Taiwanese semiconductor industry and infrastructure itself, bringing it physically within China's borders. People and technology, as well as capital, are flowing to China as tens of thousands of Taiwanese managers, engineers, designers, and former government officials relocate to the mainland.[248]

> *[T]he flow [of high-technology talent] has become a deluge. "It was amazingly abrupt -- a year ago [e.g. mid-2000], suddenly everybody wanted to work in China," says Manuel Lopez, who runs one of Taipei's top head-hunting firms.*[249]

The Taiwanese move to the mainland has been given various popular labels including "China fever," "Shanghai fever," "mainland investment fever" (*Dalu touzi re*), and "high-tech industry moving westward fever" (*gaokeji canye xijing re*).[250]

1. ***Erosion of controls on mainland investments.*** The wholesale migration of Taiwanese high technology investment and talent into China is attributable, in part, to Chinese promotional measures and incentives and the government's more liberal stance toward foreign investment and trade. It is also partially attributable to the perception in Taiwan that island's economy is stagnating while that of China offers growing opportunities. But the exodus also reflects the accelerating disintegration of Taiwan's traditional legal restraints on mainland

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248 "High-Tech Talent Flows to China," *Taipei Times* (March 25, 2002).

249 "Taipei's Talent Exodus," *Time Asia* (May 21, 2001).

250 Min Yau "Chaos and Resentment Everywhere in Taiwan," *Jiefangjunbao* (May 21, 2001); Suisheng Zhao, *Coping with the Chen Shui-ban Administration Beijing's Wait-and-See Policy and Two-Pronged Strategy* (paper delivered May 31, 2000, Conference "Assessing Chen-Shui-Ban's First Year: The Domestic and International Agenda, George Washington University).

investments in strategic industries, and the government's halting efforts to implement a new policy regime. A Hong Kong observer commented in 2000 that the Taiwanese government was

> *powerless to stop a new wave of hi-tech firms investing on the mainland… about 30,000 Taiwan firms have invested more than US $40 billion on the mainland in the past decade, the vast majority of them routed through Hong Kong [and third countries] to skirt a ban on foreign investment.*[251]

Taiwan's legal prohibitions on economic contacts with mainland China, imposed after Chiang Kai-shek's regime took refuge in Taiwan in 1949, have been eroding since Chiang's death in 1975. By the early 1980s the original "three nos" established by the KMT government-- "no contact, no negotiation, no compromise" -- were being widely circumvented by Taiwanese businesses, which developed a thriving indirect trade with China via Hong Kong and invested in mainland businesses through offshore shell companies. The Taiwan government's posture toward these trends was schizoid, penalizing certain commercial activities of which it disapproved, but actively encouraging indirect mainland investments in designated sectors.[252] In 1996, President Lee Teng-Hui introduced the so-called "no haste, be patient" policy, designed to rein in further large-scale Taiwanese investments in China.[253] But from its inception the "no haste, be patient" policy was massively circumvented by Taiwanese investors, who ignored the government's restrictions on mainland investment while the government "feigned ignorance" of their mainland activities.[254]

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251 "Taiwan Legislator Warns of High-Tech Exodus," *South China Morning Post* (July 5, 2000).

252 Far Eastern Economic Review (May 9, 1991).

253 Under the new policy mainland investments were divided into three categories -- prohibited, permitted, and case-by-case review -- according to sector and size of investment. Categories of indirect mainland investments worth more than US $50 million were required to secure prior approval from Taiwan's Ministry of Economic Affairs (MOEA). Direct and indirect investments in sensitive sectors, including semiconductors, were banned outright. Lee presented this policy as pragmatic. Recognizing that commercial links between Taiwan and China were inevitable and an integral aspect of China's eventual reunification, "it is necessary to remind Taiwan's business people that they must be moderate and cautious and not bank on the mainland. They must take root in Taiwan and coordinate with the government." Huang Kuo-chang, "Taiwan Absolutely Needs the No Haste, Be Patient Policy," *Chungyang Jihpao* (December 23, 1997).

254 A survey taken in 2001 indicated that between 300,000 and 500,000 Taiwanese citizens had invested in China, but MOEA's Investment Commission -- charged with tracking such investments -- only listed 23,754 of the registrations required for legal investment in China. A number of Taiwanese government officials themselves reportedly made direct investments in China. Su Yung-you, "Retired Government Officials Work for PRC While Enjoying Retirement Pensions Issued by Taiwan Government," *Tzu-Yu Shih-Pao* (March 15, 2002). Zhou Ling, "Investment Made on Mainland by Taiwan Businessmen Scales Another Summit This Year," *Zhongquo Tongxun She* (09:05 GMT, December 16, 1997). MOEA's claims that it had reduced mainland investment volume "failed to reflect the whole picture, as a large number of Taiwanese companies avoid government detection by routing their investments in China through a third country." Raye Kao, "Taiwan has Trouble Separating Politics from Cross-Strait Economics," *Taipei Review* (July 1, 2002). "New Rules for Mainland Investment May be Ignored," *Taipei Times* (November 9, 2001).

Much of Taiwan's information industry relocated to the mainland during the "No Haste, be Patient" era, often paying little attention to the government's notice and prior approval requirements. In November 2000 the Taiwanese Minister of Economic Affairs, Lin Hsin-yi, acknowledged that 50 to 60 percent of mainland China's total production of information technology hardware was controlled by Taiwanese firms that had located manufacturing and assembling facilities in China.[255] Taiwan's desktop computers were largely produced in Taiwanese-owned facilities on the mainland, as well as 56 percent of Taiwan's motherboards, 88 percent of its scanners, 74 percent of its CD drives and 58 percent of its monitors.[256] Much of this investment took place via offshore shell companies whose activities could not easily be tracked by Taiwanese authorities.

2. *The change in administration (2000).* During the Kuomintang Party's long monopoly on power in Taiwan, close ties were forged between the party and Taiwan's leading industrialists, including prominent executives in the semiconductor industry. Although Taiwan's trade and industrial policies were fashioned by an elite group of liberal technocrats with little interference from the Party, the nexus between the KMT and big business ensured that significant rifts between government and industry over economic policy were generally avoided.[257] The close relationship between the KMT and business became a heated electoral issue in 2000 and was one reason for the landmark defeat of the KMT by the Democratic Progressive Party (DPP) in that year.

The DPP government reached out to the Taiwanese business community in general and the semiconductor industry in particular, backtracking on some of its campaign pledges to curtail public benefits to strategic sectors. However, the DPP's tenure has seen a discordant public debate over whether to permit the establishment of Taiwanese semiconductor wafer fabrication facilities in mainland China.. Soon after the DPP took office, at the urging of a number of powerful Taiwanese business leaders, the new President, Ch'en Shui-ban, undertook a review of mainland investment policy.[258] In August 2001, a new policy was announced -- "proactive

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255 "Taiwan's High-Tech Advantage Over China Eroding," *Taipei Times* (November 30, 2000); "Taiwan Electronics Industry Migrates to China," *Central News Agency*, August 24, 2000.

256 "Taiwan's Electronics Industry Migrates to Mainland China," *Taiwan Central News Agency* (August 24, 2000). In September 2002, officials in China's Kunshan Hi-Tech Park, where a large number of Taiwanese IT firms are located, indicated that with the exception of chipsets, everything needed to make a finished PC could be manufactured with the boundaries of the Park, primarily by Taiwanese companies. Interview with officials of Kunshan Hi-Tech Industrial Park (Kunshan, Jiangsu Province, September 2002).

257 During KMT's decades in power, its Central Finance Committee channeled Party funds and personnel into key industries, including the semiconductor industry. See William W. Keller and Louis W. Pauly, "Semiconductors in Taiwan and Korea: The Political Economy of Semiconductors," in William W. Keller and Richard J. Samuels (eds.) *Crisis and Innovation in Asian Technology* (Cambridge: Cambridge University Press, 2003), p. 142.

258 These included Lin Pai-li, Chairman of Guangda Computers, who was unhappy with restrictions that prevented him from building a plant to manufacture notebook computers on the mainland; Wang Yong-ching, head of the Formosa Plastics Group, who was seeking to establish semiconductor manufacturing operations on the mainland; and Chang Chung-mou (Morris Chang) of TSMC. "How Much Longer Can the 'No Haste, be Patient' Policy Resist the Pressure?" *Chung-Kuo Shih-Pao* (November 23, 2000).

opening, effective management." While the new policy represented a substantial relaxation of the "no haste, be patient" policy, it proved controversial.[259] The liberalization of restrictions was sharply criticized by some Taiwanese political groups as fostering the hollowing-out of Taiwanese industry, the loss of jobs to the mainland, and the erosion of Taiwan's autonomy and security. The remaining restrictions, however, were attacked by the business community as allowing too much government discretionary control over private business decisions.[260]

Although Taiwan's leading edge semiconductor firms, TSMC and UMC, remained initially noncommittal about mainland investments, during 2000-2001 China successfully courted individual Taiwanese entrepreneurs who had limited future prospects on the island, promising them full support and freedom from interference should they undertake to establish new semiconductor enterprises in China.[261] A Taiwanese observer commented in 2001 that "Every Taiwanese businessman who comes here [China] feels like a prince -- complete with his own fiefdom."[262] Taiwanese semiconductor business leaders, such as SMIC's Richard Chang, in

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259 1,722 investment items requiring case-by-case review were liberalized, requiring no prior government approval. The list of 195 proscribed sectors was reduced to 150. The prohibition on all forms of direct investment was dropped, so that investors did not need to utilize intermediary companies for approved investments (although many continued to do so).[259] The $50 million ceiling on single-project investments was lifted. A new administrative screening mechanism was established for mainland-based investments, based on seven decisional factors -- operation of businesses, financial situation, technology transfer, labor affairs, sources of funds, and "security and tactical affairs." "Taiwan Set to 'Fully Open,' 1722 Items for China-Mainland Investment," *AFP* (05:04 GMT, November 9, 2001); Ch'en Hsin-lan, "Many Mysteries in the Indexes for Examination," *Ching-Chi Jih Pao* (November 20, 2001).

260 A coalition of labor, academic and civic groups has emerged in opposition to mainland investment in semiconductors, citing national security concerns and possible "hollowing out" of the economy. Former President Lee Teng-Hui has warned against lifting the ban on mainland semiconductor investments. Proposals to permit even restricted Taiwanese investment in mainland semiconductor production (such as 8" wafer fabs) have strongly opposed by the pro-independence Taiwan Solidarity Union (TSU), the governing DPP's "sister party" and ally. "NGO Coalition Organizing Protest of Chip-Makers Moving to China," *Taiwan News* (March 6, 2002). "Former Taiwan President Speaks Against Moving Fabs to Mainland," *Taipei Times* (March 8, 2002). The TSU threatened to mobilize 10,000 demonstrators against any move to liberalize mainland semiconductor investment. "Wafer Debate is Struggle Between Lee, Chen Forces," *Chung-Yang Jih-Pao* (March 13, 2002). "The new version of the mechanism for examining mainland investments is vague, obscure, and full of administrative tailoring power and makes enterprises feel uncertain about making investments in the mainland." "Many Mysteries in the Indexes for Examination," *Ching-Chi Jih Pao* (November 20, 2001).

261 "One of Taiwan's greatest strengths in the late 1980s and early 1990s was the great number of Chinese from both Taiwan and the mainland who had extensive industry experience outside of Taiwan, particularly in the US. These professionals were eager to come to Taiwan and use their experience and skills to found a new industry. Morris Chang, who had a 25 year career at Texas Instruments (TI), where he became group VP of semiconductors, is but one example of the Chinese who came to Taiwan to found a new chip industry. Something similar is happening in China today. The difference now, however, is that the flow is moving from Taiwan to China. For example, the founder and president of SMIC, Richard Chang, formerly with TI, was president of WSMC in Taiwan before he came to Shanghai. Winston Wong, Grace Semiconductor, Shanghai, set up Nan Ya Semiconductor in Taiwan before coming to Shanghai." "New Player in Global IC Market; China Pushes Chipmaking," *Solid State Technology* (February 2002); "Taipei's Tech Talent Exodus," *Time Asia* (May 21, 2001).

262 Laura Li, "Shanghai or Bust! Taiwanese High-tech Descends on Eastern China," *Sinorama* (June 2001).

turn called upon old colleagues in Taiwan and other countries to join their new mainland ventures, and many hundreds of semiconductor managers and engineers-- retired, unemployed, or stuck in middle-management positions in Taiwan -- answered the call.[263] The flow of Taiwanese semiconductor capital, personnel, and technology to the mainland increased rapidly in and after 2001, notwithstanding Taiwanese legal restrictions.[264]

> *China seems to be growing an entrepreneurial semiconductor foundry industry thanks to the success of an aggressive drive to recruit industry talent from Taiwan.*[265]

3. ***The unstoppable flow of investment.*** As the Taiwanese government debated a partial lifting of the mainland investment ban on semiconductors, a significant number of Taiwanese investors went ahead and "invested in such [facilities] before winning government approval." According to reports appearing in 2002, "virtually every electronics company" in Taiwan had undertaken mainland investment, but "Taiwan's electronics industry maintains a code of silence on the subject."[266] In March 2002, Ts'ai Ying-wen, Chairwoman of Taiwan's Mainland Affairs Council, indicated that according to information developed by her organization, "two Taiwanese-funded [semiconductor] firms have 'secretly moved' to the mainland."[267] One PRC-owned mainland newspaper reported in mid-2002 that:

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263 "If you are a process engineer in Taiwan, you can't get rich. You have to move to fabless startup in Taiwan or move to a new foundry in China to make a lot of money." Yukio Sakamoto, CEO of Elpida Memory Inc., in "Chinese Foundry Fits Elpida's DRAM World View," *Electronic Engineering Times* (February 3, 2003).

264 Taiwanese capital from sectors other than semiconductors has flowed to the mainland to support semiconductor production there. For example, Formosa Plastics was a main beneficiary of Taiwan's strong promotion of the petrochemical industry in 1990s -- on a par with semiconductors -- yet large amounts of the resulting wealth generated for Formosa Plastics major shareholders is being invested in China's Grace Semiconductor Manufacturing Corporation, rather than being recycled into Taiwan's economy. With respect to the personnel exodus, one estimate puts the number of Taiwanese semiconductor employees that moved to SMIC and Grace alone at 3,000, and one recent article reported that the average mid-level manager would make $30,000 more when moving to China, often with a free house and car. A survey of 14,664 Taiwanese showed that 82 percent would not necessarily reject the idea of working in China, and 18 percent were actively seeking such employment. Taiwanese government officials, many in the high-technology fields, have also moved to China after retirement to work for government programs there, a situation that has caused concern among Taiwanese national security officials. *Taipei Times*, "High-Tech Talent Flows to China," (March 25, 2002); "Retired Government Officials Work for PRC While Enjoying Retirement Pensions Issued by Taiwan Government," *Taipei Tzu-Yu Shih-Pao*, (March 21, 2002).

265 "Update From China: Taiwan Talent Builds Entrepreneurial Foundries," *Solid State Technology* (January 1, 2002).

266 "Few people can identify any specific [electronics] companies" with mainland investments; "Firms try hard to keep these investments under the table." "Taiwan's Tech Companies Flout China Investment Restrictions" *Electronics Buyer's News* (August 5, 2002). "Most [Taiwanese semiconductor producers] bypassed restrictions by channeling investments through a third country or party." "Taiwanese Firm Plans a Foundry in China," *Los Angeles Times* (August 31, 2002)

267 Hsu Yu-chun "Tsai Ying-wen Says Punishment Will Be Meted Out to Enterprises Which Have Moved to the Mainland," *Ching-Chi Jih-Pao* (March 2, 2002).

About 20 percent of semiconductor manufacturing companies in Taiwan have totally stopped production on the island, and have only left the marketing department in Taiwan. It is expected that their marketing departments will also be shifted to the mainland in the future, in order to have a better position to make overall arrangements and occupy the market on the mainland, so as to gain maximum market results.[268]

Widespread reports of such unauthorized investments led Taiwanese editorial writers to charge that the investment ban lacked credibility and that the government "must take action, especially since KMT bigshots and business heavyweights… are leading offenders. This had led smaller businesses to feel that the law only restricts them, not the big fish."[269] The clandestine flow of Taiwanese capital and expertise to semiconductor operations on the mainland created competitive pressure on the main line Taiwanese semiconductor producers that had respected the government's investment ban. Compliance-oriented Taiwanese firms began hemorrhaging talent and customers to the mainland operations. A leading Taipei economic newspaper reported that:

It is widely spread in business circles that Zhongxin International Integrated Circuit Co. and Hongli Semiconductors Co. Ltd. with Taiwanese funds have started production in Shanghai's Zhangjiang High-Tech Park. After Spring Festival, they even crossed the strait to lure away a large number of staff members from the TSMC and United Microelectronics Corp., resulting in the brain drain of high-tech semiconductor talent. Aside from the exodus of talent to Taiwanese-funded wafer plants in Shanghai, a large number of foreign customers have also undermined the foundation of Taiwan's wafer plans by turning orders to the two plants in shanghai. The tendency worries businesses which still listen to the government's words and stay in Taiwan.[270]

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268 Wang Peng, "The Third Wave of Taiwan Businessmen's Investment on the Mainland," *Ta Kung Pao* (August 1, 2002).

269 In fact, however, the degree to which Taiwan's mainland semiconductor investment restrictions were flouted is suggested by recent investigations and enforcement actions, which have involved very "big fish" -- not only some of the biggest players in the Taiwanese semiconductor industry, but Kuomintang Party members, government officials, and even the Development Fund of the Executive Yuan. In April 2002 Taiwan's Ministry of Economic Affairs announced an investigation had been opened based on the suspicion that UMC had invested in He Jian Technology Co., a mainland company constructing an 8" wafer fab in Suzhou, Jiangsu Province. "Cracking Down on the Big Fish," *Taipei Times* (July 35, 2002). In July 2002 MOEA compiled a list of venture capital companies that had made illegal investments in China. These included Prudence Capital Co., in which the Kuomintang Party was a major investor, and which had allegedly invested in the Shanghai-based Semiconductor Manufacturing International Corp. (SMIC).[269] Particularly awkwardly, the Development Fund of the Executive Yuan -- the Cabinet organization spearheading the drive against illegal investments -- was found to hold a 2.5 percent stake in Prudence, which was withdrawn "to comply with government policy." "Taiwan Cabinet Fund to Withdraw Investment in PRC-based Semiconductor Firm," *AFP* (12:00 GMT, April 18, 2002).

270 Hsu Yu-Chun, "Tsai Ying-Wen Says Punishment Will Be Meted Out to Enterprises Which Have Moved to the Mainland," *Ching-Chi Jih-Pao* (March 2, 2002).

4. *Conditional lifting of the semiconductor investment ban.* Following implementation of the "proactive opening, effective management" policy, the island's semiconductor companies lobbied intensively for further relaxation of the semiconductor investment prohibition.[271] In March 2002 the Taiwanese government announced that it would conditionally lift its prohibition on domestic investment in semiconductor manufacturing operations in mainland China. Under the new policy, effective in August 2002, a government interagency panel chaired by the Ministry of Economic Affairs will review applications by Taiwanese semiconductor makers to undertake investments in mainland manufacturing operations:

- The "proactive opening, effective management" rules permit Taiwanese investment in 6-inch and smaller wafer fabs on the mainland and unconditionally prohibit investment in 12-inch fabs.[272]
- Taiwanese semiconductor makers will be permitted to establish up to three mainland fabs utilizing 8-inch wafers. Any firm establishing a mainland fab must also have been engaged in mass production of 12-inch wafers in Taiwan for at least six months, must have received orders and begun shipments for semiconductors manufactured at 12-inch fabs.
- The mainland plants must utilize "manufacturing equipment phased out in Taiwan."
- Investors are prohibited from transferring technology to the mainland plants for feature sizes smaller than 0.25 microns.[273]

According to some reports only TSMC and UMC were in a position to satisfy all of the requirements for mainland investment, leading to the charge that the Taiwanese government had "gerrymandered" or tailor-made its rules to benefit these two firms. But to a considerable

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271 TSMC's Morris Chang commented with respect to the ban in January 2002 that "inappropriate [government] interference in industry decision will be harmful to the national economy." "TSMC Chairman Criticizes 'No Haste, be Patient' Policy," *Taipei Central News Agency* (10:28 GMT, January 9, 2002). Gordon Witli Chen, President of Taiwan's Semiconductor Industry Association (TSIA), argued that allowing 0.5, 0.35 and 0.25-micron processing lines to migrate to China would have a positive effect on Taiwan's competitive position: "The void they have behind will be filled by more advanced lines, such as 0.18 and 0.13 microns. These offer greater economic efficiency. The older lines are already outdated in Taiwan's market, but they can still serve China's needs. A new cluster of production lines will likely form in China because of our presence there. But that cluster will be a low level one, and it can't constitute a threat if its sole purpose is to support Taiwanese companies too while allowing production lines in the HSIP [Hsinchu Park] to upgrade." Ray Kao, "To Go or Not to Go?" (July 1, 2002) http://publish.gio.gov.tw.FCR/ current/Ro207P12.html.

272 "Executive Yuan Passes Easing of 'No Haste, Be Patient' Policy," *Taipei Central News Agency* (7:07 GMT, November 7, 2001).

273 "MOEA Announces Regulations on Wafer Fab Transfers to Mainland," *Taipei Central News Agency* (8:55 GMT, August 9, 2002); "Taiwan Allows Chipmakers to Operate in Mainland," *China Post*.(August 10, 2002).

degree, the government's decision with respect to 8-inch fabs appears to be a partial post-hoc legal ratification of investment moves already under way by many Taiwanese investors who clearly do not qualify for the limited approvals offered under the current policy.

5. ***The migration of skilled manpower.*** An equally complex challenge facing Taiwanese regulators has been posed by the flow of Taiwanese personnel with advanced technological knowledge and skills to the mainland. A spring 2002 survey of human resources managers at 278 Taiwanese high technology enterprises revealed widespread concern "about the flight of high technology professionals to China." In the second half of 2001, nearly 3000 Taiwanese were reportedly attracted to semiconductor operations in China, drawn by incentives such as higher salaries and perks, including housing and a car:[274]

> *Taiwan is not just supplying personnel for the top [semiconductor] posts on the mainland. From engineers on the factory floor all the way to top management, the Chinese in Taiwan, and to a lesser degree in Singapore too, see China, and especially Shanghai, as the next big thing in the chip industry. They are voting with their feet and moving to the mainland to staff the new chip companies.*[275]

In addition to private sector talent, a number of former Taiwanese government officials "have now chosen to start a new career in mainland China," including those formerly involved in fields like high technology and military intelligence.[276] A report published in 2001 by Taiwan's Control Yuan, an oversight organization, concluded that of a total of 414 recently retired Taiwanese military and intelligence professionals, as many as 200 had violated regulations restricting their travel to China.

In April 2002 Taiwan's National Science Council announced draft regulations which would prevent "mainland Chinese companies and those firms illegally funded by Taiwan people on the mainland from headhunting Taiwanese high tech experts."[277] The draft regulations would require Taiwanese enterprises to report to the government the names of their skilled employees and that such employees obtain a license from the government as a prerequisite to working on the mainland. The total number of employees authorized to work on the mainland would be limited, and under a "revolving door clause," high tech personnel would still be subject to controls for two years after leaving their positions.[278]

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274 "Taiwan Worried of High Tech Brain Drain to China," *Taipei Times* (March 25, 2002).

275 "New Global Player in IC Market; China Pushes Chipmaking," *Solid State Technology* (February 2002) Shanghai-based SMIC "has recruited dozens of engineers who used to work for one of two Taiwan semiconductor manufacturing giants -- the UMC and the Taiwan Semiconductor Manufacturing Corp. (TSMC)." "Severe Penalties for Irregular Investments on the Mainland," *Taipei Central New Agency* (April 2, 2002).

276 Su Yung-yao, "Retired Government Officials Work for the PRC While Enjoying Retirement Pensions Issued by Taiwan Government," *Tzu-Yu Shih-Pao* (March 15, 2002).

277 *Taipei Central News Agency* (10:30 GMT, April 17, 2002).

278 "High Tech Employees Must Get License Before Working in the Mainland," *Lien-Ho Pao* (April 6, 2002).

The storm of criticism these proposals provoked in Taiwan, coupled with the government's partial backtracking from its original proposal, suggest that legal proscriptions on the movement of people with technological expertise from Taiwan to China are unlikely to be effective. Taiwan's high technology community blasted the draft regulations as "high tech martial law" which would "turn back the clock of democracy in Taiwan." It was argued that the regulation, if adopted, would deter high technology workers from locating in Taiwan for fear of becoming "stuck" there by the restrictions.[279] But the proposal was more widely seen as futile rather than draconian, with observers noting that "it would be nearly impossible to stop people from heading across the Taiwan Strait… over $50 billion in Taiwanese investment capital has already circumvented government regulators and found its way into China."[280] Andrew Young, Secretary General of a Taiwan-based think tank, the Chinese Center for Advanced Policy Studies, commented in 2002 that

> *"you cannot control talent… if they want to go to China, they can go by different channels." The government's restrictions were seen as a way to symbolically send a warning signal. Whether it is effective or not is not a major issue.*[281]

In deference to the strong objections raised, the government ultimately settled for a more limited version of its original proposal. The original draft proposed to restrict movements of personnel involved in semiconductor wafer fabrication, wafer R&D, and semiconductor design. After receiving "vehement protests" from Taiwan's semiconductor industry, however, the draft regulations were "watered down," ultimately restricting only personnel involved in semiconductor wafer fabrication photolithography.[282]

6. ***Relaxation of technology controls.*** Although Taiwan is not a party to the Wassenaar Arrangement, the multilateral accord regulating export of dual use technologies, its practice with respect to export of semiconductor technology has been to "follow whatever rules the US lays down as far as technology exports to China is concerned, and may even maintain more stringent laws if it is deemed vital to Taiwan's interests."[283] The surge of semiconductor investment and personnel from Taiwan to the mainland raised the prospect that technology might be transferred notwithstanding government restrictions. Accordingly the DPP administration also attempted to restrict the flow of state-of-the-art semiconductor technology to the mainland through the adoption of new regulations.[284] However, recent reported technology leaks involving

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279 Ibid.

280 "Restrictions on Workers Seem Futile," *Taipei Times* (April 19, 2002).

281 Ibid.

282 "High Tech Personnel Control Narrowed Down to One Category: Official," *Taipei Central News Agency* (13:57 GMT, April 24, 2002).

283 "Chipmakers May Receive Big Fines," *Taipei Times* (January 22, 2002).

284 In April 2002 Taiwan's National Science Council proposed a "National Technology Protection Law." Under this proposal any person who exported designated advanced technologies developed by private companies or institutes sponsored by the government in Taiwan would face up to two years in prison and fines of up to US $286,000. This law is patterned on the U.S. Economic Espionage Law. "Technology Law to Guard Valued Assets," *Taipei Times* (April 17, 2002). In September 2002 the NSC announced

Taiwan's two leading semiconductor manufacturers are indicative of the difficulties inherent in administering such controls:

- In March 2002 the Hsinchu District Prosecutor's Office was reported to be investigating allegations that a former TSMC manager in charge of 12-inch wafer development had sold trade secrets via e-mail relating to 12-inch wafer technology to an unidentified Chinese firm which subsequently hired to TSMC manager. TSMC indicated it had installed firewalls to prevent further leaks.[285]

- In March 2002 Taiwanese legislators accused UMC of illegally selling semiconductor manufacturing equipment to Chinese companies based in Shanghai via Happy Wealth Holding, a "paper company in the Cayman Islands."[286]

B. Taiwan adjusts

Taiwan, which was one of the principle drivers of global semiconductor industry trends in the 1990s, is now reacting to forces seemingly beyond its control -- the exodus of its semiconductor industry capital, managers, engineers, and customers to mainland China. Taiwan's planners appear to be resigned to the prospect that much of the island's semiconductor industry manufacturing capacity will move to China, and they are implementing policies aimed at retaining a role for Taiwan in semiconductor R&D, design, finance, logistics, distribution, and high-end manufacturing. An ambitious new government program, the Si-Soft Project, is being implemented which will promote Taiwanese human resources in the microelectronics field, open a semiconductor "design park" comparable to the island's science-based industrial parks, and invest roughly $250 million in R&D funds in optoelectronics, embedded processor design, and wireless technology.[287] But while Taiwan may well succeed in retaining key high-end microelectronics functions on the island, these activities will support, and therefore be increasingly integrated with, semiconductor manufacturing operations physically located on the Chinese mainland. Taiwanese expertise, design capabilities, technology, and government industrial policies will rectify many of the critical deficiencies that have historically impeded the

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additional controls on "sensitive" technologies, which included "a number of semiconductor - related technologies," which require with respect to all government funded research projects that the project directors either receive prior government approval or make prior reports to designated government agencies before making their results public. "Sensitive Technologies to be Placed Under Security Control," *CNA* (05:33 GMT, September 2, 2002).

285 Jimmy Chuang, "Taipei Businesswoman Accused of Selling Tech-Secrets to Shanghai Firm," *Taipei Times* (March 2002).

286 Lin Mei-chun, "TSU Claims Illegal Chip Equipment Sales Made to China," *Taipei Times* (March 16, 2002).

287 Shojiro Mori, "Taiwan's Design Parks," *Nikkei Microdevices* (January 2003).

development of the Chinese semiconductor industry, a process which is already well under way.[288]

1. ***Multiple shocks.*** Since mid-2000, when Taiwan's semiconductor producers were committing to a bullish capital expansion plan, the industry has experienced a series of unanticipated shocks. Global demand for semiconductors plummeted in and after 2000, sharply reducing operating rates and revenues and forcing curtailment of planned capital expenditures.[289] Elections in mid-2000 brought the Democratic People's Party (DPP) to power, which had campaigned against the Kuomintang (KMT) Party's alleged favoritism to industry, particularly the tax holidays regarded as critically important by the semiconductor industry.[290] Finally the challenge from China caught both the Taiwanese semiconductor industry and the new government off balance. China's implementation of sweeping new promotion measures produced a seemingly unstoppable exodus of Taiwanese capital and talent to the mainland. The speed with which this development overturned longstanding Taiwanese assumptions is reflected in two public statements by TSMC's Morris Chang in over a 7-month interval in 2001:

- **February 2001.** Chang discounted the role of mainland China in the semiconductor industry for the foreseeable future, saying "there needs to be a stable political situation," as he announced plans to invest some $20 billion in six new fabs in southern Taiwan.[291]

- **September 2001.** Chang sent executives into China to look into market opportunities, saying "The focus of global IC manufacturing will be shifting to China

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288 China will absorb much of Taiwan's "high end" expertise, entrepreneurial skill and technology as employees of Taiwanese-owned mainland foundries. As they gain expertise, Chinese managers and engineers are likely to break away to start their own enterprises, following the same career paths as their Taiwanese colleagues. As one Taiwanese semiconductor executive expressed it in mid-2000, "the Chinese will do the same thing to us [Taiwan] that we did to the Americans," e.g. split off and start their own companies after absorbing the knowledge and skills necessary to do so. Interview in Taipei, (July 2002).

289 "Production Facilities of Taiwan's IC Foundries Lying Idle: CEPD," *Taipei Central News Agency* (09:47 GMT, August 31, 2000). By the third quarter of 2001 TSMC's capacity utilization had fallen to 41 percent. This recovered somewhat in 2002 (to 79 percent in the third quarter) but did not return to the 100 percent utilization rates experienced in prior years. TSMC's capital expenditures were $3.5 billion in 2000; these were scaled back to $2.2 billion in 2001, reflecting a decision to defer constriction of a planned 12-inch fab in Taiwan. UMC's capital expenditures were reduced from $2.8 billion in 2000 to $1.5 billion in 2001. TSMC 20-F filings; "TSMC Trims Expansion Plans," *Electronic Engineering Times* (September 28, 2001)..

290 Critics of the tax holidays charge that ordinary small businesses in Taiwan paid taxes at a level nine or ten times higher than the semiconductor industry, which was extremely profitable. Interviews with Taiwanese government officials (Taipei and Hsinchu, July 2000). During KMT's decades in power, its Central Finance Committee channeled Party funds and personnel into key; industries, including the semiconductor industry. See William W. Keller and Louis W. Pauly, "Semiconductors in Taiwan and Korea: The Political Economy of Semiconductors," in William W. Keller and Richard J. Samuels (eds.) *Crisis and Innovation in Asian Technology* (Cambridge: Cambridge University Press, 2003), p. 142.

291 "Bargaining Chips," *AsiaWeek* (February 2001)

over the next decade…The industry will be driven by China whether or not Taiwan participates."[292]

The shocks experienced by the Taiwanese semiconductor industry in 2000-01 compounded problems of longer standing. The island's physical resources have been stretched by the demands of the expanding semiconductor industry, although the government has to date succeeded in providing most of the necessary infrastructural support.[293] Taiwan is located in an earthquake zone, and while the government has taken numerous steps to reduce the earthquake risk, the large quake which occurred in September 1999 demonstrated that earthquakes can still significantly disrupt semiconductor production.[294] Finally, notwithstanding the large number of high-quality graduates being produced by Taiwan's excellent university system and the attraction of thousands of trained personnel from overseas, serious questions remain whether Taiwan can possibly train, attract and retain skilled manpower at the levels necessary to sustain its semiconductor industry.[295] At present, even as semiconductor industry employment levels decline, the industry finds itself short of skilled managers and engineers as the exodus to the mainland accelerates.[296] China is playing on these concerns as it urges investors to consider the mainland as an alternative to Taiwan for semiconductor operations.

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292 *SiliconStrategies*, September 3, 2001.

293 Hsinchu Science Industry Park has suffered from severe water shortages in 2002, which the Economic Daily News estimated to have cost TSMC and UMC $29 million, with perhaps further losses as the drought continued. In early 2002, trucks brought 50,000 metric tons of water to the Park per day. A Hsinchu Park official noted that IC companies used 80 percent of Hsinchu Park's water supply, and that a 30 percent cut in that water supply would halt operations. In December 2000, Taiwan's Toppoly Optoelectronics Corp. stated that, "…the scarce resources for production (water, electricity, and land) have been nearly depleted, and as a result, the [high-tech] industries concerned have raised doubts as to whether or not the government can fully support such production resources to industries who increase their capital for expansion of their plants." Toppoly Optoelectronics Corp., *Immediate Significance of Toppoly's Stationing at Chunan Science Park*, December 26, 2000. While stating that the water problem is drought-related, in 2002 the Ministry of Economic Affairs embarked on a $24 million program to dredge reservoirs and take other actions to forestall further disruptions. Officials acknowledge that they are encouraging semiconductor fabs to recycle more water. Taiwan's fabs currently have an 85-percent recycle rate. "Drought Costs NT$1 billion," *Taipei Times*, (May 5, 2002). Officials now claim that the crisis is over. *Central News Agency*, "No More Water Shortages for Hsinchu High Tech Park: Official," March 5, 2002.

294 The government has dispersed its new science-based industrial parks around the island, reducing the risk that an earthquake can disable all semiconductor production, and has improved the infrastructure for backup supply of electricity and water in the event of another quake. One of the new parks, Tainan, is located close to a new high speed train line, which has required expensive modifications both of the rail line and of new semiconductor fabs in the park to offset the vibration effects of passing trains.

295 ERSO officials acknowledge that "there will be a shortage of engineers, no question." Despite numerous programs underway to train more people, there were serious doubts that Taiwan could produce enough engineers and technicians on its own in the next decade. Interview with ERSO (Hsinchu, July 2000).

296 At Hsinchu Science Park, where the bulk of the industry resides, semiconductor employment declined by substantially in 2001. Despite the overall decline, Taiwanese semiconductor companies still found it difficult to fill key engineering slots: even in late 2001, TSMC and UMC could not fill several hundred engineering jobs although running at low capacity: "a prevailing shortage of technical people in Taiwan has made filling up such positions quite a challenge." In the IT industry as a whole, Taiwan officials report that

2. *"Roots in Taiwan."* Taiwan's present strategy is one of adapting to, rather than contesting, Chinese initiatives in the semiconductor industry. China's application of the differential VAT preference for mainland-based firms partially walls off the rapidly-growing Chinese market to semiconductor manufacturers based in Taiwan. The differential VAT is being cited by executives at the Taiwan-invested mainland foundries as one of the main reasons why it is not practical to serve the Chinese market from Taiwan, despite the island's physical proximity. While the discriminatory VAT raises issues under the General Agreement on Tariffs and Trade, the government of Taiwan has made no public move to invoke legal rights that may be available in the WTO. Its only readily apparent policy response to China's new promotional measures has been to promulgate new rules refining restrictions on Taiwanese investment in the mainland semiconductor industry, which have to date not proven particularly effective.[297]

With Taiwanese semiconductor manufacturing moving to the mainland and China making rapid technological strides in microelectronics, a fundamental question exists as to whether the semiconductor industry has a long run future in Taiwan.[298] In an ambitious effort to answer that question in the affirmative, Taiwanese planners are implementing a new strategy in microelectronics under the slogan "Roots in Taiwan."[299] This approach accepts that the industry's "trunk and branches," e.g. lower-end manufacturing and finishing operations, will gravitate elsewhere, particularly China. Roots in Taiwan adjusts to this trend by seeking to preserve a special leadership role for Taiwan in the semiconductor business. The strategy has two basic objectives:

- ***Retain superiority in manufacturing technology.*** Taiwan seeks to ensure that high-end semiconductor manufacturing capability (e.g., 12" wafers, smaller geometries) remains on the island as lower-end capability migrates elsewhere. Taiwanese

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the country is "short" 20,000 people each year. The twin problems of an inadequate domestic training program and "challenges from [employees] moving to more cost-effective areas like China" were routinely cited as the causes. "Government Aims Project at Boosting Taiwan's IC Design Capabilities," *Electronic Engineering Times*, (December 16, 2001).

297 "[T]he government declared it would approve only three 8-inch fabs on a case by case basis, by 2005. This policy is completely unrealistic. The result has been a kind of rush to establish new ventures in China, with only mild efforts to disguise the circumvention of ongoing restrictions." Barry Naughton, *The Information Technology Industry and Economic Interactions Among China, Taiwan and Hong Kong* (mimeo, 2003), p. 23.

298 Vice President Annette Lu warned in 2002 that the move to the mainland "will create technology downfall. All industry will close, talent will leave, and the science parks will return to their original undeveloped state." "Analysts Sanguine About Tech Investment in China," *Taipei Times* (March 2, 2002).

299 "Roots in Taiwan" is a catch phrase that has been used since the mid-1990s with reference to all Taiwanese sectors investing in the mainland. It is now being used by President Chen's administration with particular focus on the island's high technology industries. Government offices cite the concept in their planning documents. In an MOEA document called "Promotional Strategies and Measures," one itemized strategy is "increasing international competitiveness by establishing a division of labor with mainland China," stating MOEA is operating "under the premise of 'leaving roots in Taiwan.'" *Sinorama Magazine,* "There's No Place Like Home: Keeping Investors in Taiwan," November 1996; MOEA, *Promotional Strategies and Measures, 2002*.

government planners express confidence that the island's semiconductor manufacturers will be able to retain a technological edge over mainland enterprises for the foreseeable future.[300] They regard Taiwan's semiconductor industry as "mature" and capable of self-financing its own new 12-inch fabs.[301] The government continues to maintain legal prohibitions on investment in 12-inch fabs on the mainland, and, while sharply curtailing financial assistance for new semiconductor manufacturing facilities, has pledged to continue "support measures" for 12-inch fabs in Taiwan.[302]

- ***Maintain "headquarters" functions in Taiwan.*** Taiwan envisions a continuing role as a "headquarters" for semiconductor manufacturing operations based elsewhere. The functions which would be maintained in Taiwan include management or "operational headquarters," IC design, and logistics, marketing distribution and finance,[303] and Taiwan is currently implementing a broad array of policies to realize this vision.[304]

The two prongs of the Roots in Taiwan strategy are in tension with each other. On the one hand Taiwan is deploying policies designed to maintain Taiwan's manufacturing superiority in competition with new foundries on the mainland, but at the same time is implementing parallel policies to promote an R&D, design and a managerial role for Taiwan with respect to the same

300 Taiwanese officials express confidence that Taiwan will retain a large lead over China in the semiconductor industry because of Taiwan's strong technology and experience. One MOEA official said that Chinese fabs will quickly obtain 0.18 micron capability because "if you have 0.25 it's easy to 0.18," but said that "0.13 is a whole different ball game." Similarly, officials say that China will not have anywhere near the number of 12"-wafer fabs that Taiwan will anytime soon, and uniformly note that one 12-inch wafer has more than 2.5 times the devices as an 8-inch wafer, providing enormous advantages in terms of cost savings and world market share. Interviews in Taipei and Hsinchu (September 2002).

301 Interviews with Taiwanese government officials (Taipei and Hsinchu, September 2002).

302 [T]he government will adopt specific and effective measures to accelerate the development of 12-inch wafer foundries and assist the development semiconductor-related industries in Taiwan. We are confident that the open policy help to significantly upgrade the industries on Taiwan. We will actively work to develop Taiwan into a 12-inch wafer fabrication center, in IC design center, and a research and production center for the semiconductor and production center. *Government Information Office* release, "Liberalization of mainland-bound Investment in Silicon Wafer Plants," 2002.

303 This strategy is a modified version of a program initiated by the Kuomintang government in 1995 aimed at transforming Taiwan into an "Asia-Pacific Regional Operations Center," (the so-called APROC plan). This project foresaw the offshore relocation of much of Taiwan's manufacturing and sought to promote a new role for the island as a hub for distribution, logistics, headquarters functions, and R&D/design in the East Asian region. The DPP government changed the name of the initiative to "Green Silicon Island" -- envisioning Taiwan as a high tech headquarters for the whole world, not just Asia -- but the basic concept has been retained. "About APROC," http://www.aproc.gov.tw_links_el/1.html; interviews in Taipei (July 2000).

304 Measures include further deregulation of telecommunications, creation of more science-based industrial parks, liberalization of restrictions on trade with the mainland, and establishment of a "Legalization Coordination Center" to identify other legislative changes needed to transform Taiwan into a "silicon-based global operations center." http://it.moeaidb.gov.tw/committee/english/b-4.html

mainland foundries. Increasingly, Taiwanese "roots" will nurture a microelectronics "tree" whose trunk and branches are growing on the mainland.[305] Under such circumstances Taiwan's promotional policies in microelectronics -- increasingly aimed at high end, design-intensive functions -- must be regarded over the long run as supporting a "greater Chinese" semiconductor industry. Given the spectacular success of Taiwanese policy measures during the past generation, the impact of Taiwan's current developmental efforts on the Chinese industry could well be significant.

3. *Revised promotional policies.* Taiwan has modified its promotional measures in microelectronics in an effort to adjust to new competitive realities. Figure 18, prepared by government officials to illustrate this strategy, depicts the thrust of government initiatives moving away from "low value added high substitution" production and assembly toward innovation, design, marketing and service. Major new initiatives are being undertaken to strengthen Taiwan's capabilities with respect to IC design, R&D, and management functions. Government financial assistance is being redirected toward these areas and away from manufacturing. The tax holiday is being narrowed to benefit "high-end" microelectronics technologies more exclusively. Human resources are emerging as Taiwan's principal source of comparative advantage in microelectronics as other advantages fade with the emergence of new competitors, and the government's human resources initiatives, already very substantial, are being intensified. While the government is probably allocating a smaller volume of overall financial support to the semiconductor industry than was the case in the 1990s, its current efforts in the area of R&D and design are sufficiently impressive to prompt a Japanese observer to comment that

> *With things left as they are, we will be overtaken by Taiwan not in [semiconductor] manufacturing but also design... We can say it is a program in which the Taiwanese government is making an all-out effort.*[306]

a. *The Si-Soft initiative*. The centerpiece of Taiwan's new strategy in microelectronics is the National Si-Soft ("silicon software") Project, a broad effort to promote the creation of intellectual property by Taiwanese IC design houses, particularly System-on-Chip (SOC) technologies. This effort is intended to build on and upgrade Taiwan's IC manufacturing infrastructure, particularly the state-of-the-art 12-inch fabs, and is intended to cross-fertilize a broad range of Taiwanese IT and energy industries (Figure 19). The project will be financed 30 percent from public and 70 percent from private sources.[307] According to Tsai Ching-yen, a minister-without-portfolio in charge of science technology development, the project could more

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305 "[T]he evidence is accumulating that current Taiwan policies will not be effective in preventing the further development of the IT industry in China, and the ever-closer integration between Taiwan and China companies." Naughton, op.cit. (2003), p. 24.

306 Shojiro Mori, "Taiwan's Design Projects," *Nikkei Microdevices* (January 2003).

307 Chun-Yen Chang and Charles V. Trappey, *The National Si-Soft Project* (Undated mimeo, National Chiao Tung University).

Figure 18
"Roots in Taiwan" Policy: Government View

Government diagram provided September 2002

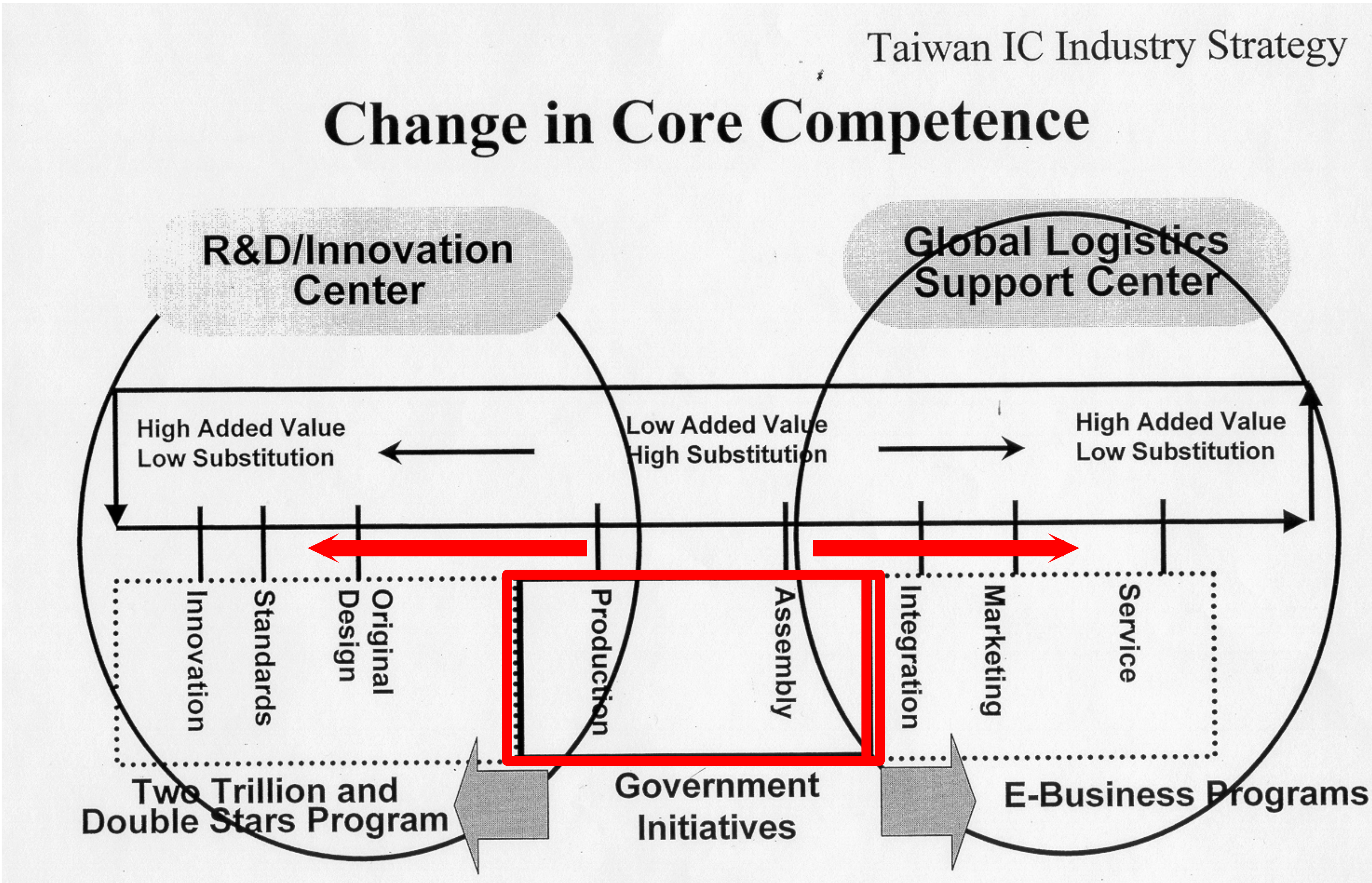
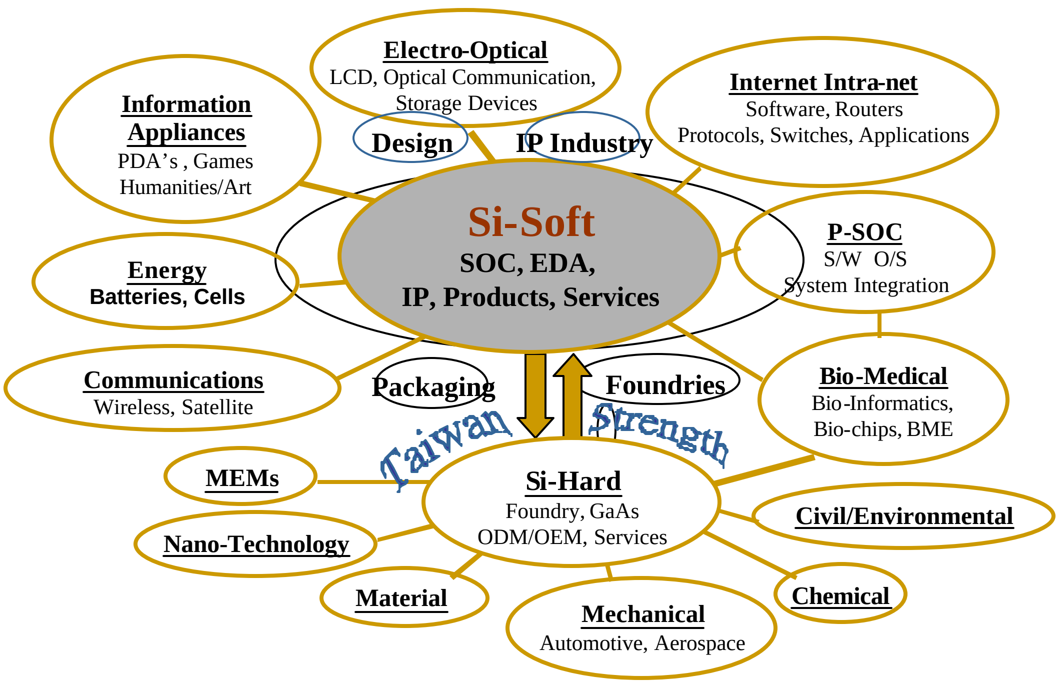


Figure 19

Graphic Depicting Industrial Linkages of Taiwan's Si-Soft Project

"Building out the Taiwan electronic industry supply chain with Si-Soft"



Source: Chun-Yen Chang and Charles V. Trappey, *The National Si-Soft Project*.

than double Taiwan's share of the world semiconductor market (from 16 to 33 percent) by 2010.[308] Si-Soft has several important elements:

- ***Expansion of university-based training.*** Taiwan plans to increase its university faculty staff by 85 positions annually for three years, for a total of 255 new university instructors by 2006 who specialize in VLSI education. Taiwan will create new undergrad and graduate level university courses in semiconductor design and "will cultivate thousands of design engineers every year" -- it is "hoped" that by 2004 the project will have cultivated more than 20,000 hi-tech professionals and technicians."[309] Some key aspects of this program include: (1) Compulsory system-on-a-chip design for all students in electronics and electrical engineering, allowing "even bachelor graduates [to] be able to engage in IC design;" (2) making semiconductor-related courses mandatory for all engineering students in Taiwan; and (3) the development of expertise in intellectual property rights and marketing.[310]

- ***Technology development.*** The government will invest $250 million in the development of new technologies in the fields of wireless communications, optoelectronics, and embedded processor design.

- ***IC Design Park.*** The Si-Soft project launched a new system-on-a-chip IC design park which will be networked with Hsinchu and Tainan Science-Based Industrial Parks and Nankang Software Park. The Nankang Integrated Chip Design Science Park opened in July 2003, with sites for IC design firms, an incubation center for start-ups, an open lab, and a service and management section. The main purpose of the new park is to "incubate" start-up design houses with up to 35 employees.[311] The Executive Yuan worked with the National Chiao Tung University to develop the design park, and "the Executive Yuan will support these IC design houses looking for business opportunities."[312]

b. ***Research and development organizations.*** In addition to the Si-Soft initiative, the government of Taiwan will maintain its support for existing microelectronics R&D organizations and university-based R&D, and a number of new organizations have been created with government backing. A number of these organizations are generating leading edge

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308 Deborah Huo, "Taiwan Developing Major Silicon-Oriented Industrial Plan," *Taipei Central News Agency* (10:14 GMT, September 30, 2001).

309 Deborah Huo, "Taiwan Developing Major Silicon-Oriented Industrial Plan," *Taipei Central News Agency* (10:14 GMT, September 30, 2001).

310 "Government Aims Project at Boosting Taiwan's IC Design Capabilities," *Electronic Engineering Times*, (December 16, 2001).

311 Shojiro Mori, "Taiwan's Design Projects," *Nikkei Microdevices* (January 2003).

312 "World's First System on Chip Design Center Will Open in Taiwan Industrial Park," *China Post* (April 23, 2003). The government is providing incentives "for the enlisting companies to lower the overhead cost." "Nankang Integrated Chip Design Park Opens," *China Post* (July 10, 2003).

technologies with microelectronics applications. All are encouraged to undertake cooperative arrangements with foreign companies and research organizations (Figure 20). Some of the key research institutions and recent initiatives:

- ***National Science Council (NSC) support for university-linked R&D.*** The NSC supports silicon-related research projects on microelectronics and optoelectronics at Taiwanese universities.[313] Most projects are joint ventures between universities and the National Nano Device Laboratories (NDL) which is located at Chiao Tung University near Hsinchu Science-Based Industrial Park (Figure 20).[314] In addition to the NDL, the NSC sponsors the Semiconductor Research Center ("SRC") adjacent to the NDL facility at Chiao Tung University. The SRC has a class of 10,000 clean rooms for student's education and research and generates more research papers than NDL.[315] Finally, the NSC has established the Chip Implementation Center to support

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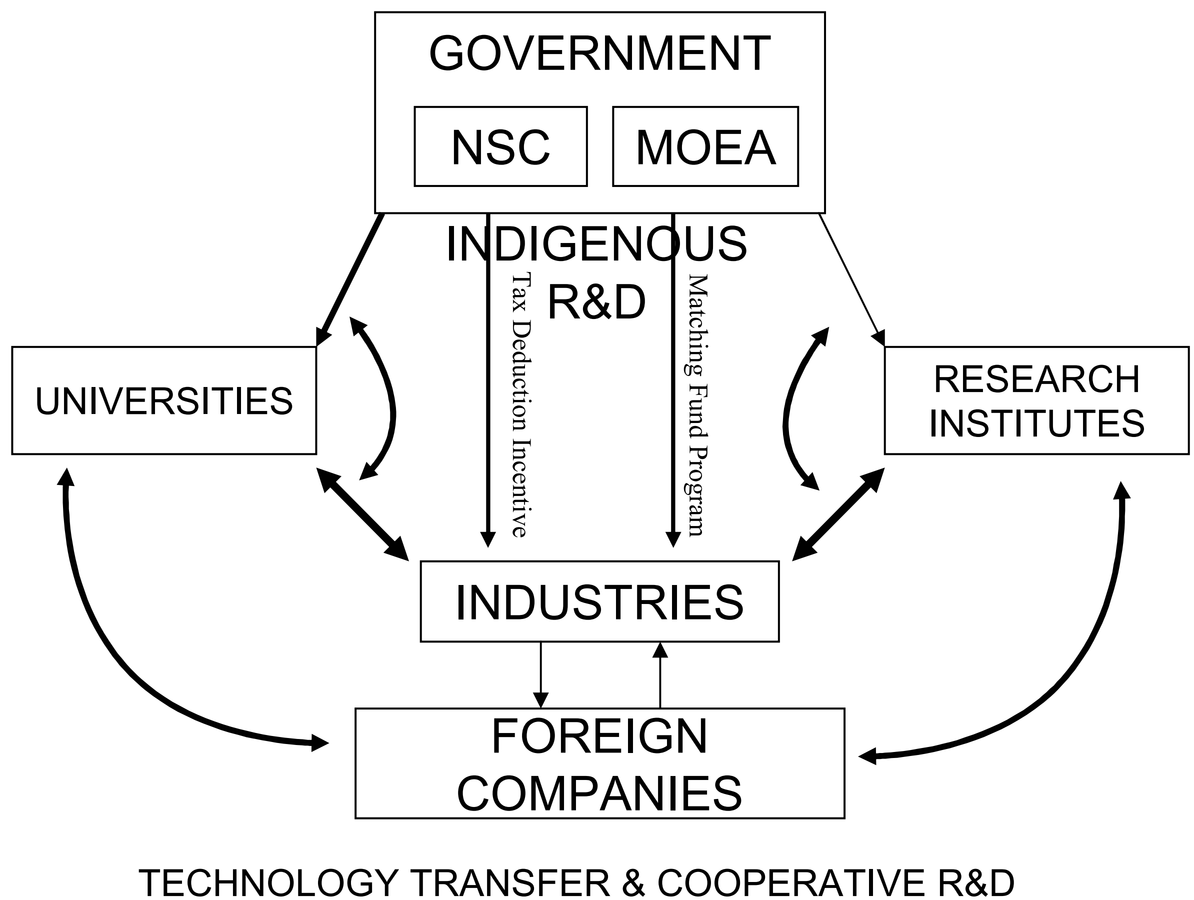
313 Taiwan has a number of outstanding universities: National Taiwan University (NTU), National Tsing-Hua University (NTHU); National Chiao-Tung University (NCTU); and National Cheng-Kung University (NCKU). In addition, National Central University, National Sun Yat-Sen University and National Chung-Cheng University are in the process of building up significant research capabilities. "Foreign Applied Semiconductor Research, Implications for the U.S. Industry, a Report to the Semiconductor Research Corporation," Monterey Institute of International Studies, August 1997, at 39.

314 NDL's objectives are to foster high-caliber talent for the semiconductor industry and academia; to collaborate with industry and academia for advanced R&D on new nano device technologies; to promote research standards in the electronics area; and to strengthen Taiwan's competitiveness in the world's IC market. About 500 students use NDL's facilities for university projects. Although NDL often works on topics that are needed by the industry in the near term, its orientation is toward basic research and its main product is a steady stream of skilled engineers and researchers as a resource for Industry. NDL's R&D efforts are mainly associated with silicon-based semiconductor devices and materials with a special focus on deep sub-micron MOS devices. The projects conducted by NDL vary from very basic research such as Single Electron Transistors, to more industry-related problems such as CMP of low-k and Cu materials, CoSi2 process development, and shallow junctions. NDL is also conducting R&D into radio-frequency ("RF") integrated circuits. NDL has built its capacity of RF device testing and modeling. According the plan by the National Science Council, such RF device testing capacity will be expanded to an RF testing center for academia in order to support the development of microwave communication technology in the future. National Nano Device Laboratories website, http://www.ndl.gov.tw/English/research.htm; "Parameter Extraction and Design Optimization Software -- A powerful New Nano-Scale Circuit Development Tool," *Taipei Science Bulletin* (December 1, 2002); "Taiwan Nanotechnology Center in the Offing," *Taipei Central News Agency* (12:38 GMT, July 17, 2001).

315 The SRC's lithography level is only one micron, but a great deal of fundamental work can nevertheless be done – indeed, more university research papers are written based on the research performed at SRC than that at NDL. National ChiaoTung University's Semiconductor Technology Department publishes an impressively large number of papers in IEEE *Transactions of Electron Devices* and IEEE *Electron Devices Letters* (possibly more than any other university or company in the world). The University is among the leading institutions in the world with respect to the number of papers accepted for the International Electron Devices Meeting and VLSI Symposium. ATIP99.085: Taiwan National Nano Device Laboratories, section 3.2. The NDL laboratory is reportedly more restrictive than SRC, reflecting the fact that NDL is more sensitive to contamination problems, and many new ideas can therefore not be implemented at NDL. ATIP99.085: Taiwan National Nano Device Laboratories, section 3.2.

Figure 20

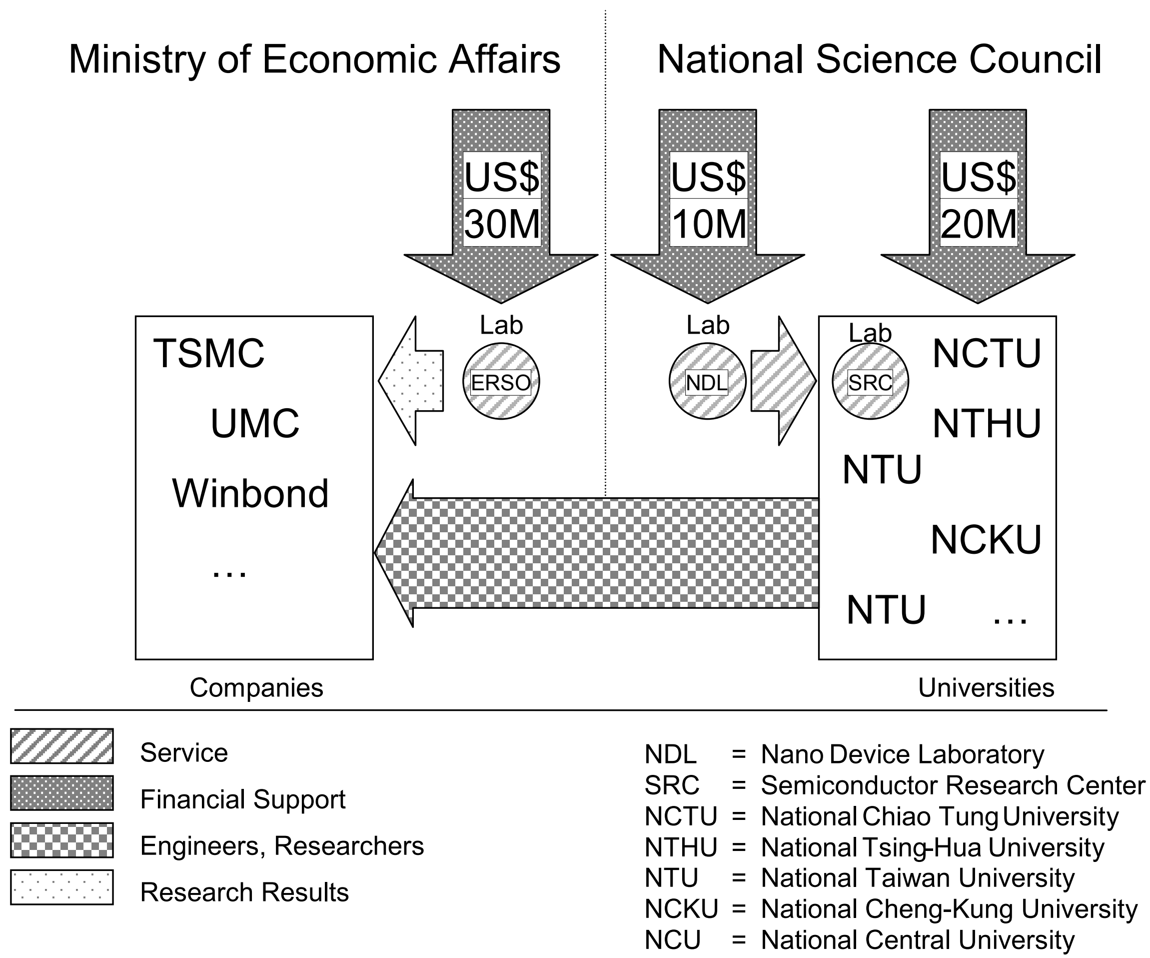
Relationship Between Government, Universities, Research Institutes and Industries in the Development of Taiwan's Science and Technology Infrastructure



Source: Taiwan Electronics Industry, Chung-Shing Lee and Michael Pecht (1997)

Figure 21

Connection Between NDL, Universities, and the Industry



Source: "Taiwan National Nano Device Laboratories," Asian Technology Information Program (ATIP) Report, Dec. 7, 1999 university-based R&D.[316]

- ***ERSO.*** ERSO, which is wholly dedicated to microelectronics R&D, channels its support to areas of perceived technological weakness in the Taiwanese industry. Its current areas of focus include microelectronics systems key technologies (see Figure 22), deep submicron technology, and RF integrated circuit technology. ERSO also provides "information services to assist local industry and entrepreneurs in making managerial and investment decisions.[317] January 2000 ERSO organized a "club" to provide local design houses with a "platform" to exchange intellectual property, the Silicon Intellectual Property Consortium. The objective of the "club" is to promote the intra and intercompany circulation of IP and design reuse.[318]

- ***ITRI-affiliated institutions.*** ITRI's Integrated Circuit (IC) Design Service Center was established in July 1999, to provide industries an advanced IC-design capability and infrastructure specifically directed at system-on-a-chip (SOC) technology.[319] The Center is setting up an electronic design automation (EDA) environment, and a reusable IP database and management system, in addition to its IC design services.[320] In 2003 ITRI established a nanotechnology laboratory with TSMC, UMC, Macronix and over 2 dozen other firms.[321]

- ***Alliance for the Promotion of Silicon Intellectual Property (SIP).*** Formed in January 2000, the Alliance is an ITRI-sponsored consortium to assist Taiwanese firms improving semiconductor designs, consisting of 28 local manufacturers, including TSMC, Winbond and UMC. It monitors the system-on-a-chip protocols being set by the Virtual Socket Interface Alliance and disseminates information to its members, and is expected to integrate and utilize the resources of government, industry, and

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316 The Center assists universities in setting up the research and design environment for integrated circuits and systems. It seeks to provide opportunities of making leading and educational chip design modules, to train IC and system designers, and to promote exchange of IC and system design technology between the domestic and the international industry. NSC Chip Implementation Center's website, http://www.cic.edu.tw.

317 ERSO, Key Project Goals; www.ERSO.ITRI.org.tw.

318 Interview with ERSO, Hsinchu, Taiwan, July 2000; *see also* http://www.sililanip.org.

319 ITRI Annual Report 1999, at 43, http://www.itri.org.tw/eng/corporate/annual99. The Center's goal are (1) to expand IC design capacities for MOEA-sponsored R&D programs; and (2) to accumulate an intellectual property database for the benefit of Taiwan's IC design industry. Ibid.

320 The Center will also work with domestic foundries to establish standard cell libraries for advanced foundry processes which are intended to help planning new ICs for MOEA-sponsored projects. ITRI Annual Report 1999 at 43, http://www.itri.org.tw/eng/corporate/annual99.

321 The purpose of the new laboratory is to provide facilities and an environment for testing, analysis, and processing and promotion of information exchanges and business alliances to explore the applications of nanotechnology, and to reduce operational and production risks for the participating enterprises. "ITRI, Hi-Tech Firms Jointly Set up Nanotechnology Laboratory," *Taipei Central News Agency* (11:05 GMT, July 23, 2003).

Figure 22

Excerpt from ERSO Document: Key Project Goals

Microelectronic System Key Technology Development Project

January 2001-December 2003

Final Project Goals

(1) Device and Process Module Technology Project:

To develop the core technology and platform technology of Si-based high power and high frequency devices

To develop high power and high frequency device and process technology, including 700-1000V IGBT, LDMOS, LIGBT and 100GHz SiGe BiCMOS

Wireless communications micro-system and chip: Wireless communication RF MEMS modules/Passive components.

To develop technology of integrated high-power and high-frequency ASIC and MEMS (Advanced Projects)

(2) SoC Design Automation and Design for Test Technology Product:

To Develop Advanced Design Automation and Verification Environment for SoC Fast Prototyping

To Develop for Reuse Technology and IP Repository System

To Develop Design for Text Technology and Environment

(3) MEMS Key Technology Project:

To establish the core technologies and common lab, including: CMOS Machining, MEMS CAD, MUMPs, Actuator, SCREAM, Package,

To integrate MEMS/CMOS technologies and develop MEMS high value-added key vehicle products:

Micro Photonic Chips and System: Uncooled IR Imager: BMicro Optical Switch (Advanced Project), Micro Display (Advanced Project)

Micro Fluidic Chips and System: Micro Cooler, Micro Cooling Chip (Advanced Project), Monolithic Inkjet Head (Advanced Project).

academic institutes for the development of a better environment for the SoC industry in Taiwan.[322]

- ***Information Appliance Alliance.*** The IAA was formed by the Ministry of Economic Affairs to assist in technology transfer to domestic firms from international sources, and to foster a collective effort by Taiwan's IT industry, government and academia "to consolidate resources to further develop a presence in the international market."[323]

- ***III-V Semiconductor Research and Development Alliance.*** In February 2003, a group of Taiwanese governmental organizations, universities, and private companies formed a "research and development alliance" to develop equipment for making III-V semiconductor compounds such as GaAs, gallium-nitride (GaN) and indium phosphide. The alliance "expects to grab 50 percent of the global market for light-emitting diodes and power amplifiers used in wireless communications."[324]

- ***Precision Instrument Development Center (PIDC).*** The PIDC is a National Laboratory which develops vacuum measurement instruments and provides vacuum calibration services. The PIDC is currently engaged in a 3-year project to develop a micro-flow gas calibration system which will permit monitoring of gas flow to semiconductor production lines with far greater accuracy than is now possible, "raising the yield of Taiwan's semiconductor device processes.[325]

c. ***Other human resources initiatives.*** Apart from and in addition to the Si-Soft project, the government is continuing to devote substantial public resources to education, training, and recruiting from abroad in microelectronics-related fields:

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322 The Alliance will monitor and provide information regarding the development of the Electronic Design Automation (EDA) environment and the Virtual Socket Interface Alliance (VSIA), which serves as the initiator of the SIP standard. "ERSO Sets up Alliance for Promotion of Silicon Intellectual Property," Industrial Technology Research Institute, January 13, 2000, http://www.itri.org.tw/eng/news_events/news/printable/n-20000113-erso-print.html.

323 "Presenting the IA Alliance," Information Appliance Alliance's website, http://www.ia.org.tw/english/sit01.html. The IAA is not funded by the government but a Deputy Minister of Economic Affairs serves as the Chief Counselor, and the Director of MOE's Industrial Development Bureau is one of three Executive Counselors. The other two executive councilors are a chairman of the board of a private enterprise and the president of National Chiao-Tung University. IAA's membership includes organizations from the various industry, government, academic and R&D sectors in the information, telecommunication, consumer electronics, optoelectronics, semiconductor and software industries. Ibid.

324 The alliance includes ITRI; the Department of Industrial Technology of MOEA; National Chiao Tung and Cheng Kung Universities; four foundry service providers, and eight equipment manufacturers. "Taiwan Establishes Semiconductor Compound Development Alliance," *Taiwan Journal* (February 21, 2003).

325 According to one report, John Wolfe, President of Wolfe Engineering, a well-known U.S. semiconductor process gas supply facility system manufacturer, visited PICD in September 2002 and "realized that this system can successfully calibrate the micro-flow control instruments needed in next-generation processes, and … expressed great interest in cooperating with PIDC." "Opportunities at the Junction of Nanotechnology and Biotechnology: Use of Nanoparticles in Biological Testing," *Taipei Science Bulletin* (March 15, 2003).

- ***Science park sponsored programs.*** The administration of Hsinchu Science-Based Industrial Park is providing training courses with respect to topics such as management, technology, and intellectual property rights to employees of firms based in the park (an estimated 5,000 annually).[326]

- ***ITRI-sponsored programs.*** ITRI offers over 1000 professional training services annually, including lectures, workshops, seminars and symposia, as well as customized contracted training courses for the government and individual industries.

- ***Recruiting from abroad.*** The government is making systematic efforts to recruit skilled personnel from overseas, principally Taiwanese who have been studying and working abroad in relevant areas.[327] The government sponsors recruiting missions in the U.S. and other countries featuring "job matchmaking workshops" and presentations by ITRI and Taiwanese companies, targeting "overseas residing ROC citizens" as well as "foreign nationals and mainland Chinese citizens residing in the United States and other areas beyond mainland China."[328] The National Youth Commission maintains a database of overseas graduates, with engineers comprising the largest single category. Government incentives are offered to returnees, such as funding for the establishment for laboratories for returning researchers.[329]

4. ***Redirected government financial support.*** The government is redirecting financial support offered through its main promotional institutions away from semiconductor manufacturing operations and toward microelectronics R&D, design, and "headquarters" functions. While overall levels of government funding to the semiconductor industry are declining, the R&D and design segments of the industry are receiving substantial public funding.

- ***Executive Yuan Development Fund.*** The EYDF is diversifying with respect to the industries it supports, de-emphasizing the semiconductor industry in favor of other promising sectors.[330] Its new equity investments in microelectronics are being made

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326 Teachers and teaching materials are provided by ITRI, National Tsing Hua and Chiao Tung Universities, and companies based in the Park, http://www.sipa.gov.tw/en/seconde/indus-e/indus-2e.htm.

327 "Cabinet Adopts Measures to Lure Sci-Tech Personnel from Abroad," *Taipei Central News Agency* (12:10 GMT, November 12, 2002).

328 "Taiwan to Hunt Hi-tech Talent in U.S.," *Taipei Central News Agency* (09:01 GMT, November 2, 2001).

329 The Ministry of Education and the National Science Council have each published regulations establishing guidelines for recruiting scientists and engineers abroad. NSC, *Rules on Supporting Recruitment of Post-Doctoral Researchers*; MOE, *Rules on Expanding Recruiting of Overseas Graduates*. National Science Council Yearbook (1998), http://www.nsc.gov.tw/pub/book98/down/3/5/2.htm.

330 The EYDF stated its changing priorities in 2002 as follows: "In the past, investment has been focused mainly on the major productive industries include[d] in the nation's economic development plans, primarily petrochemicals and semiconductors. In recent years, investment has been focused mainly on the Ten Emerging Industries, including information, telecommunication, aerospace, and biotechnology industries." Executive Yuan Development Fund, *Introduction to the Executive Yuan Development Fund,* "Investment Priorities."

in IC design and distribution, not manufacturing The EYDF is contributing NT $30 billion to the establishment of 40 new R&D centers on the island by the year 2006, to be matched by NT $100 billion in private funds.[331] The EYDF has, however, provided preferential loans to four semiconductor manufacturing operations since the end of 2001.

- ***Chiao Tung Bank*** **(CTB).** Chiao Tung bank's equity arm "strategically nurtured the growth of the island's high-tech industry and had taken stakes in many semiconductor companies, including Winbond Semiconductor and United Microelectronics."[332] Although, "IC and related industries" continue to represent the largest share of Chiao Tung's equity holdings, with more than 18 percent of the Bank's portfolio,[333] this ratio has fallen from a level of 34 percent in 1999.[334] The total value of investments in semiconductor companies has declined, as well as semiconductor's share of Chiao Tung's equity portfolio (Figure 23).

- ***The China Development Industrial Bank (CDIB).*** The China Development Industrial Bank (CDIB) provides long term credit and equity funds to strategic industries, investing in sectors "that the government's economic development policies promoted and supported," including the semiconductor industry.[335] CDIB officials have made clear that in the semiconductor industry that CDIB's investment focus is no longer on fabrication facilities but will be directed toward design houses, back-end companies, and semiconductor-related distribution channels (which CDIB officials believe are "very high margin" investments).[336]

Extension of the tax holidays. The DPP government took power in 2000 having campaigned on a pledge to reduce tax holidays to favored strategic sectors. Efforts to implement this policy proved controversial and problematic, and instead of reducing the tax holidays the

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331 *Implementation of Resolutions Adopted at the Economic Development Conference* (November 28, 2000). The conference included key members of Taiwan's Cabinet.

332 "Taiwan's Chiao Tung Bank Is Privatized," *Financial Times,* September 13, 1999.

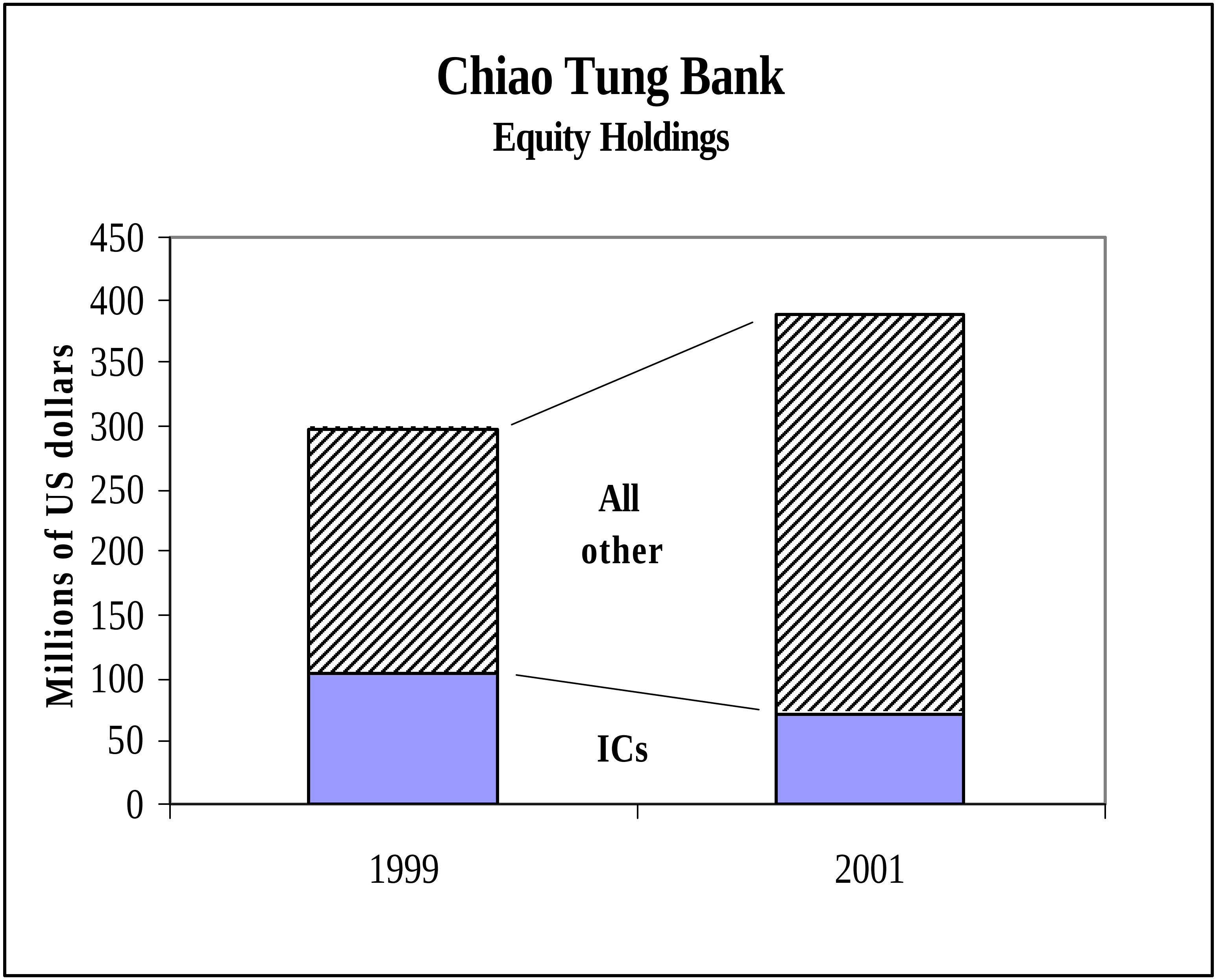
333 Chiao Tung *Annual Report* (2001).

334 While some of this decline is likely due to falling equity values for IC companies, stock values of non-IC sectors have fallen in Taiwan as well, yet the total equity in "all other" industries has increased.

335 CDIB has been a key investor in TSMC-Acer Semiconductor Corporation; Worldwide Semiconductor Manufacturing Corporation; Asustek Computer Inc.; VIA Technologies; Vanguard; and Powerchip. "Investment Rides on Taiwan's Economic Growth," China Development Industrial Bank, http://www.cdcdpbnk.com/english/e-4-2.html. "China Development Industrial Bank," *Banks,* Taiwan Ratings Reports, at 3, http://www.taiwanratings.com/reports/banks/develop_China.html.

336 Figures 6 and 7 indicate that while fabs were the focus new equity purchases in the 1990s, since 2000 CDIB has been a net seller of foundry stock and has increased its purchases of equity in other semiconductor-related firms. It is likely that these investment patterns are representative of those investments being made, but not publicly available from, the EYDF and Chiao Tung Bank.

Fig. 23


Chiao Tung Bank
Equity Holdings
Millions of US dollars
450
400
350
300
250
200
150
100
50
0
All
other
ICs
1999
2001

DPP has narrowed their availability.[337] The tax benefit is preserved intact for the most advanced technology levels -- any fab producing ICs with line widths finer than 0.175 microns still qualify for the tax holidays. However, fabs producing ICs at line widths of 0.18 or larger no longer qualify. Critics of the new policy charge that it is "driving high tech companies overseas."[338] In fact, while the narrowing of the tax holidays may give lower end semiconductor manufacturers an incentive to move offshore, the preservation of the benefit for high end manufacturing is designed to ensure that leading edge manufacturing remains in Taiwan.

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337 In June 2000, it was reported that the CEPD (the central planning organization) had recommended "a deep cut" in the tax holidays. The semiconductor industry and its allies vociferously protested the proposed curtailment of its tax benefits, which industry regarded as the single most important government promotional measures.

338 "Taiwan Manufacturers Receive Multi-Year Tax Breaks," *Taipei Journal* (January 31, 2003); "High-Tax Incentives Cut Back," *Taiwan Headlines,* (July 13, 2000), http://www.taiwanheadlines.com; "Chip Industry To Lose Tax Breaks," *Taipei Times,* (June 9, 2000).

V. MICROELECTRONICS IN CHINA: THE EMERGING LANDSCAPE

With the implementation of a broad array of new policies at the national and local level under the Tenth Five Year Plan, China is rapidly emerging as a major player in the global semiconductor industry. With the removal of longstanding restrictions on inward investment, foreign investment is pouring into the country's semiconductor industry, and new semiconductor enterprises are being established which resemble western multinational corporations. Controls imposed on technology imports from western countries have eroded, and Taiwan's remaining restrictions on investment in the mainland semiconductor industry are not proving a significant impediment to Taiwanese investors. The formerly primitive infrastructure for semiconductor manufacturing is being significantly upgraded at a number of high tech industrial parks in the Shanghai and Beijing areas. The government has demonstrated an increased commitment to the protection of intellectual property rights in this sector. Foreign engineers and entrepreneurs and returning Chinese with semiconductor-related skills are entering the country in large numbers, motivated by new incentives and the opportunities presented by China's growing semiconductor market and industry.

A. Enterprise structure: a new flexibility.

One of the most important aspects of China's current promotional effort in semiconductors is the degree to which the government has relaxed its stance toward ownership, structure, and operation of enterprises in the semiconductor industry. Until 2000 Chinese semiconductor manufacturing enterprises were either wholly owned by the central government or were joint ventures with foreign firms in which the Chinese partner was usually a government entity or state-owned enterprise and the Chinese partner exercised significant if not dominant control over operations. Since 2000, however, the government has demonstrated that it now welcomes 100-percent foreign owned semiconductor manufacturing and design enterprises, and is promoting a new "corporate" model of autonomous, jointly-owned Chinese/foreign enterprises in which the state's role is limited to that of a passive minority investor (Figure 24). Consistent with this trend, state-owned research institutes are being privatized. China's "limited market liberalization policy has been like a rain shower on drought-stricken soil: flowers are blooming everywhere."[339]

1. *100% foreign-owned enterprises.* The Chinese government has abandoned its longstanding opposition to foreign 100 percent ownership of domestic enterprises in strategic industries like semiconductors. Until recently, only a few exceptional cases of wholly foreign-owned enterprises existed in any major Chinese industry, but the government is making clear that in the semiconductor industry such investments are now welcome. Several 100%-foreign owned semiconductor producing enterprises now exist or are being established:

- ***Motorola*** has established an 8-inch fab in Tianjin, the Motorola Tianjin Integrated Semiconductor Manufacturing Complex ("MOS-17), which became operational in 2001. Total investment was reportedly in the range of $1.5 billion. In 2003 Motorola

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339 Laum Li, "Shanghai or Bust! Taiwanese High-tech Descends on Eastern China," *Sinorama* (June 2001).

was reportedly looking for other companies to share the MOS-17 fab's capacity. "Because local manufacturing in China removes some portion of the value-added tax levied on chip imports, other major chip manufacturers are interested in sharing MOS-17's potential output."[340] See discussion of Semiconductor Manufacturing International Corporation below for that company's possible take-over of Motorola's Tianjin fab.

- ***Matsushita*** has established a 100-percent owned subsidiary, Suzhou Matsushita Semiconductor, to produce discrete devices in Suzhou, Jiangsu Province.[341]

- ***Toshiba*** is transforming an existing JV in which it participates, Wuxi Huazhi Semiconductor Co., into a 100% owned subsidiary performing assembly and test operations for bipolar and Bi-CMOS ICs used in televisions and audio communications devices.[342]

- ***TSMC*** will establish an 8-inch wafer fab in the newly-created Songjiang Hi-Tech Park near Shanghai. While the ownership structure of this new entity has not been disclosed, all indications at the present time are that it will take the form of a 100 percent wholly-owned subsidiary. TSMC first announced the opening of a Shanghai office in 2001 and in September 2002 submitted a plan to Taiwan's Investment Committee to invest $898 million in a new subsidiary, TSMC (Shanghai) Corporation.[343] By January 2003, Taiwan's Ministry of Economic Affairs had granted its initial approval for an 8-inch fab on the mainland[344] and by June 2003, TSMC had signed an agreement with Shanghai's Songjiang District authorities for the planned 8-inch fab using 0.25 and 0.35 micron processes.[345] It is unclear whether ground has already been broken on the TSMC Shanghai fab, and some reports indicate that the SARS outbreak had slowed TSMC's efforts.[346] Nevertheless, a Songjiang Technology Park manager indicated that the city is banking on TSMC and is seeking

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340 David Lammers, "Motorola Pares Plants, Seeks 300-mm Partner," *Silicon Strategies* (January 15, 2003); "Motorola Cleared to Build 0.25-Micron Fab in China," *Electronic Engineering Times* (August 12, 2000). SMIC reportedly acquired an equity stake in MOS-17 in July 2003. "Motorola Sells Stake in Tianjin MOS-17 Fab to China's SMIC," *Electronic Engineering Times* (July 14, 2003).

341 *Nikkei Sangyo Shimbun* (February 1, 2002).

342 *Dow Jones* (July 9, 2002).

343 "TSMC to Open Office in Shanghai," Taiwan Economic News, September 5, 2001 and "TSMC Files Application for IC Fab Faciltiy in Mainland China," press release, September 9, 2002.

344 "TSMC Gest Preliminary Nod to Invest in China," Taipei Times, January 23, 2003.

345 "Taiwan's TSMC Signs Investment Contracts with Shanghai Authorities," Agence France-Presse, June 8, 2003; "TSMC Signs Shanghai Wafer Fab Deal, Says Report," Silicon Strategies, June 10, 2003; "TSMC Inks Shanghai Fab Deal," Online Staff Electronic News, June 10, 2003, www.reed-electonics.com.

346 "Taiwan Hon Hai Precision Industry Company Will Build Factory in Shanghai," The China Post, June 3, 2003.

to set up a third IC industrial base built expressly around the TSMC facility.[347] Production at the plant is scheduled to commence toward the end of 2004 and monthly capacity is expected to be between 35,000 and 40,000 wafers.[348]

- ***Ultimate Semiconductor***; a Malaysian enterprise, signed an agreement with the Municipal Government of Shanghai in 2003 to invest $400 million to establish a 6-inch, 0.35 wafer fab in Shanghai, the first phase of an investment plan that will eventually see establishment of an 8-inch fab.[349]

2. ***The new multinational foundries.*** The new semiconductor foundries being established in China are unique in a Chinese context not only because they separate the design function from production, but because the enterprises themselves much more closely resemble western multinational corporations than any prior Chinese semiconductor enterprises, all of which have been at least partially government owned and controlled. SMIC and Grace each have close ties with the central government and the Shanghai municipal government, but Grace is entirely privately owned. While minority blocks of SMIC's equity shares and those of its subsidiary, Beijing Semiconductor Manufacturing Corporation, are held by government entities, majority ownership remains in private hands and neither entity can be accurately characterized as state-owned or controlled.[350] Most of these firms' senior managers and a majority of their owners are Taiwanese. While their establishment and operation may be fully consistent with China's industrial development strategy, each firm's own objective appears to be simply to generate wealth for its owners, the majority of which are private entities or individuals.[351]

a. ***Semiconductor Manufacturing International Corporation (SMIC).*** SMIC was established in Shanghai by Richard Chang, an experienced Taiwanese

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347 "Chip-Makers Converge on Shanghai's Songjiang District," China Daily, June 17, 2003.

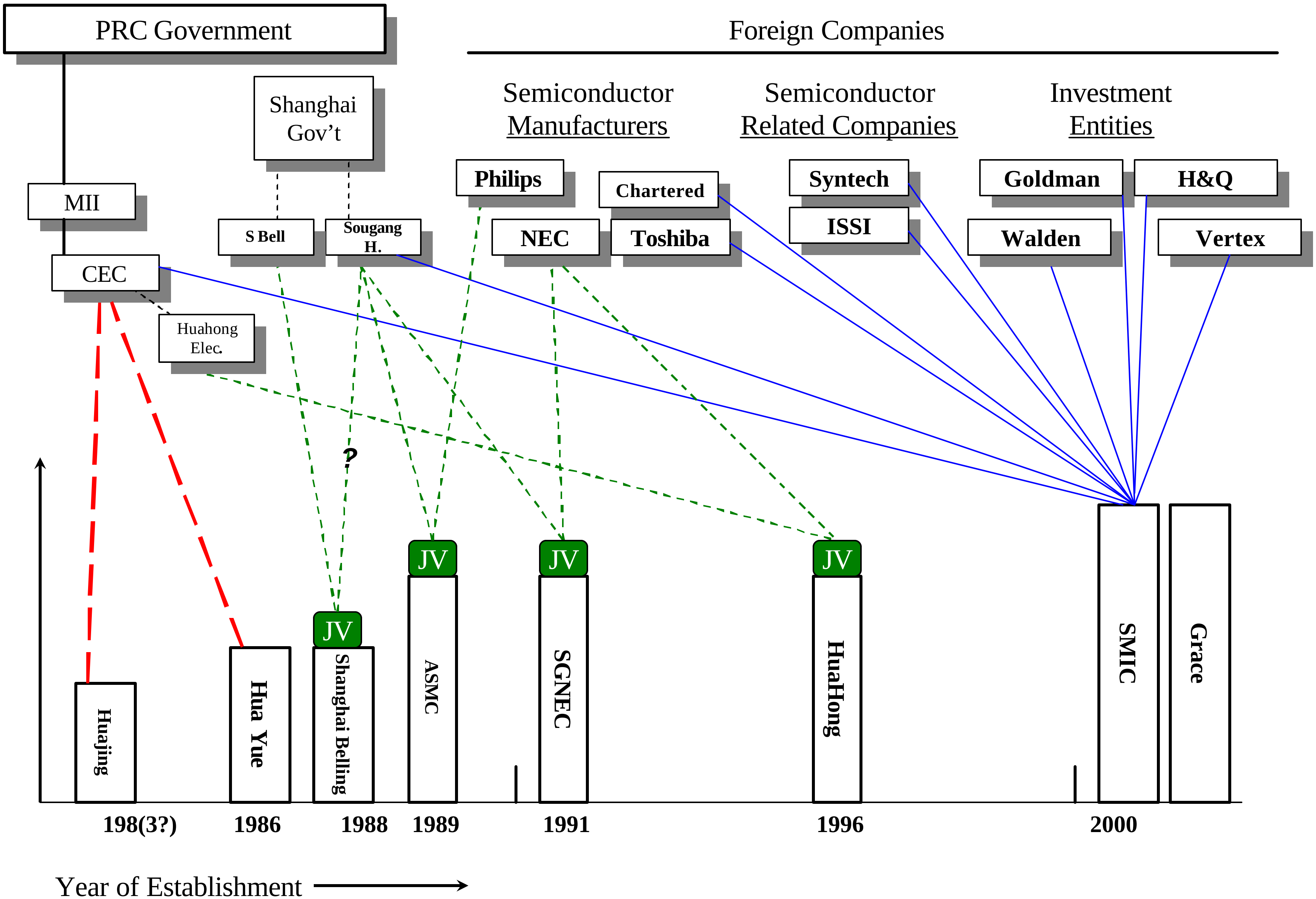
348 "Taiwan's TSMC Signs Investment Contracts with Shanghai Authorities," Agence France-Presse, June 8, 2003 and "Chip-Makers Converge on Shanghai's Songjiang District," China Daily, June 17, 2003.

349 "Shanghai to Get Foreign Chip Plant," *China Daily* (00:32 GMT, April 9, 2003).

350 The state-owned enterprise Huajing Electronics holds a 49 percent stake in Wuxhi CSMC-HJ Semiconductor Company, but the controlling majority stake is held by Taiwanese investors through a Hong Kong-based holding company.

351 Li Lanqing, Vice Premier and Deputy head of the State Steering Group of Science, Technology and Education, commented in a July 2002 speech that the transformation of organizations in the high-tech sectors is not just to 'change the signs,' even less to have more state-owned enterprises in the traditional sense; instead, the transformation means hard work to establish a modern enterprise system and to change into having a corporation system based on diversified shareholding and centered on a legal-person governing structure. For smaller start-up firms (such as IC design firms), Li Lanqing said, "the government would work diligently to study and establish a venture capital market system suited for the small and medium enterprises…a system of small enterprise credits and guarantees characterized by sound risk sharing on the basis of enhancing the construction of innovation funds for small and medium sized science and technology enterprises." Li Lanqing, "Implement the Strategy of Achieving National Rejuvenation Through Science and Education in an In-Depth Manner and Accelerate the Reform and Development Cause of Science and Technology," *Beijing Qiushi*, July 16, 2002.

Figure 24
China: Ownership Patterns Reflect Changing Government Strategy



semiconductor executive, with the backing of a multinational array of managers and engineers, the majority of whom are Taiwanese. Its first two fabs, 1 and 2, located in Shanghai's Zhangjiang Semiconductor Industry Base, were operational and producing 45,000 wafers per month in late 2002, with an eventual planned combined capacity of 85,000 wafers per month.[352] Fab 1 celebrated its first anniversary of production in September 2002 and by May 2003 was named "Top Fab of the Year" by Semiconductor International.[353] Fab 2 and Fab 3B, which offers advanced copper processes, finished equipment move-in and commenced volume production in September 2002.[354] These first three fabs, all located in Shanghai, have reportedly received ISO9001: 2000 certification and ISO4001 Environmental Management Certification,[355] and are to have a combined monthly capacity of approximately 60,000 chips by the end of 2003.[356] In addition, SMIC is reportedly in negotiations with Motorola to purchase Motorola's Tianjin fab, MOS-17, and had already swapped $260 million for an unspecified share in that facility as of July 2003.[357] Shanghai officials indicate that SMIC's longer range plans envision a total of nine fabs in the Shanghai area[358] and Richard Chang did reportedly announce in the spring of 2003 that SMIC Fabs 4 and 5 were under construction and would commence production by the end of 2003, but few specifics are available about these new facilities.[359] SMIC has already secured numerous orders for commissioned production by leading foreign integrated device manufacturers, some of them involving transfer of advanced process technology.[360]

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352 Fab 3B will perform back-end processing for Fabs 1 and 2. In the third quarter of 2004, SMIC plans to begin Fabs 4, 5 and 6B, the latter also being a back-end facility. Interview with SMIC executives, Shanghai (September 2002).

353 "SMIC's Fab 1 Awarded Top Fab Honor," SMIC press release, Shanghai, May 1, 2003.

354 "SMIC Fabs Production Celebration," SMIC press release, Shanghai, September 26, 2002 and "About SMIC: Milestones," www.smics.com.

355 "SMIC to Postpone HK and NY Listing to Early Next Year," Sinocast China IT Watch, July 30, 2003.

356 "SMIC to Postpone HK and NY Listing to Early Next Year," Sinocast China IT Watch, July 30, 2003. The 2003 capacity figures were estimated by company spokespeople. The general consensus, as reflected in recent press reporting, is that the combined capacity of Fabs 1 and 2 will not reach the 85,000 chip mark until the end of 2004. "SMIC Aims to Raise Monthly Wafer Capacity," RDSL, April 3, 2003; "SMIC Targets to be No 1 Chip Manufacturer in Mainland China," Sinocast China IT Watch, August 15, 2003; "SMIC Plans to Retool First 12-Inch Fab at Year-End," *Taiwan Economic News*, March 27, 2003.

357 "Motorola Likely to Sell Tianjin Wafer Plant to SMIC," AFX News Limited, July 21, 2003 and "Motorola likely to sell China Fab to SMIC," SBN team CMPNETASIA.COM, July 28, 2003.

358 Interview with officials of Shanghai Zhangjiang Semiconductor Industry Park Co. Ltd., (Shanghai, September 2002); interview with SMIC executives (Shanghai, September 2002).

359 "SMIC to Complete 12-inch Silicon Wafer Plants in Shanghai and Beijing," *Sinocast China Business Daily News*, April 8, 2003.

360 As of early 2003 SMIC had received orders for 256 Mbit DRAM production from Infineon, which transferred 0.14 micron process technology to the foundry, and Elpida was transferring 0.13 micron process technology to SMIC for the commissioned manufacture of DDR and Rambus DRAMs. N. Jinbo, "Chinese LSIs Approaching a Crucial Moment, New Fabs Become a Turning Point," *Nikkei Microdevices* (February 2003).

An examination of SMIC's capital and management structure and equity investors indicates that it bears no resemblance to either state-owned enterprises like Huajing or the 50-50 Chinese foreign joint ventures established in the 1990s. In contrast to the Chinese bureaucrats who dominated management of domestic semiconductor producers through the 1990s, SMIC's management team is multinational and experienced in the business of semiconductor manufacturing.[361] "Management [of SMIC] beginning with President Richard Chang on down, is completely western style, and IP (intellectual property) protection is sound."[362]

SMIC is incorporated in the Cayman Islands. Its initial capitalization is about $1 billion in equity and $480 million in loans from Chinese government banks. The company was reportedly planning an initial public offering amounting to $750 million in Hong Kong and New York at the end of 2003, but has decided to postpone that until early in 2004.[363] SMIC's equity investors to the extent they are known, are a diverse array of Taiwanese and American private investors and quasi-public investment organizations based in Shanghai and Singapore (Figure 25):

- ***Shanghai Industrial Holdings Inc.*** Shanghai Industrial Holdings invested US$183 million for a 17% stake in SMIC and is the largest stockholder.[364] Shanghai Industrial has been described as a "government-backed" syndicate of approximately twenty strategic investors and as the "investment arm" and "commercial arm of the Shanghai municipal government."[365]

- ***Avant!***, a software company, headed by Mr. Gerald C. Hsu, authorized a subsidiary of Avant! to invest up to $100 million in SMIC, which would result in the acquisition

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361 Richard Chang was formerly president of Taiwan's Winbond Semiconductor Manufacturing Corporation and a former project manager in charge of various Texas Instruments and TI joint venture fab startups and IC operations in Taiwan, Singapore, and Italy. Prior to founding SMIC he had accumulated 24 years of practical experience in semiconductor-related R&D and operations. Hwa-Nien Yu, a SMIC advisor, was formerly senior manager of IBM's Research Center with over 35 years of experience in IC R&D, and he currently serves as chairman of the Advanced R&D Steering Committee, ITRI (Taiwan's government Industry Technology Research Institute), and the chairman of Technical Advisor Committee, ITRI. Mr. Yang-Yuan Wang, SMIC's chairman of the board, is currently Department Director and professor at Beijing University's Micro-Electronics Research Center and a fellow with the Chinese Academy of Sciences, IEEE and IEE. Another eminent advisor is Tsuyoshi Kawanishi, who was formerly Group head of Toshiba Semiconductor Business and former Chairman of Taiwan's Winbond Semiconductor Manufacturing Corporation.

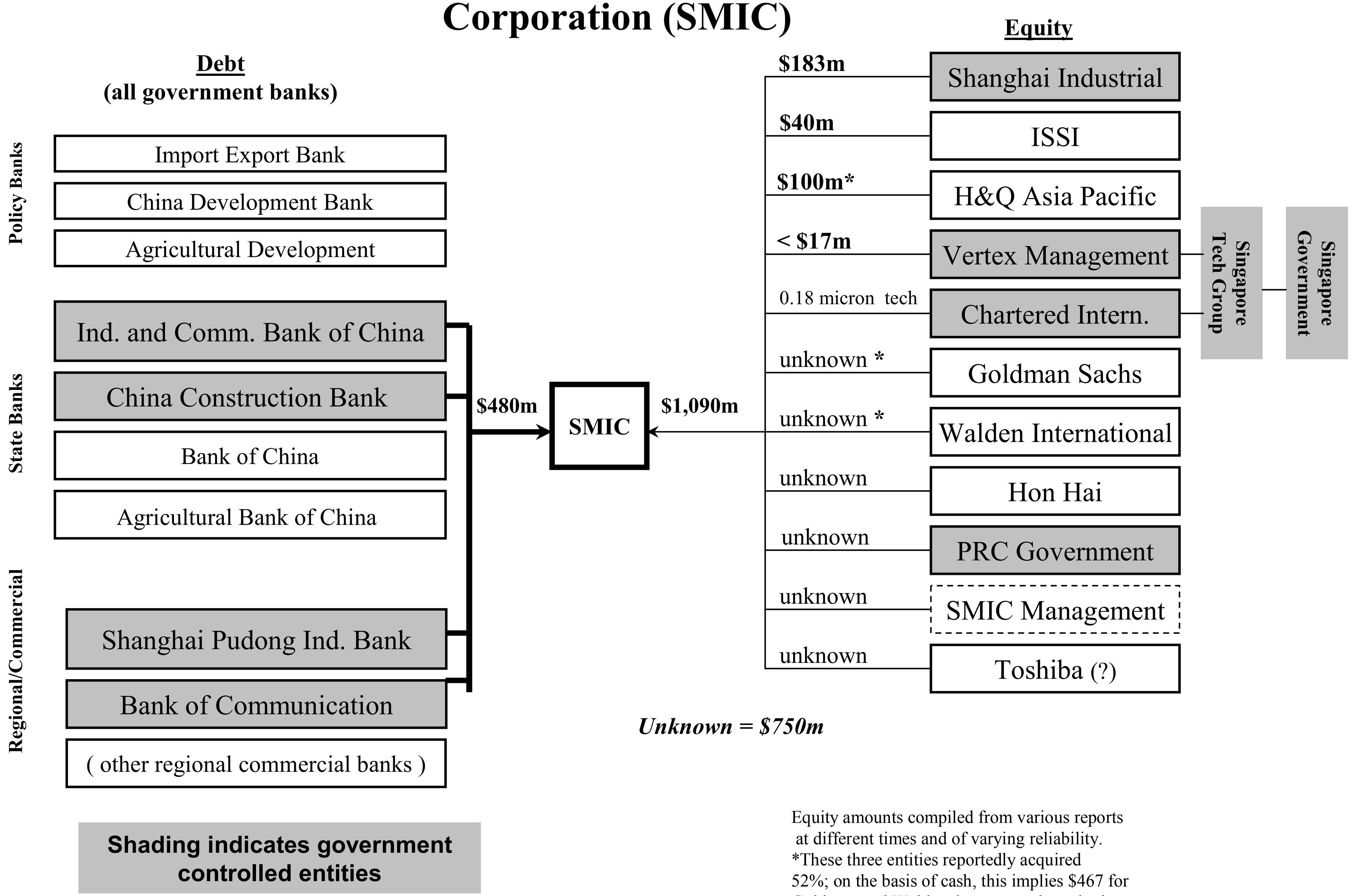
362 "Business Strategy of Key Foundry Manufacturer Outlined," *Tokyo Semiconductor FDP World* (May 2003).

363 "SMIC to Postpone HK and NY Listing to Early Next Year," Sinocast China IT Watch, July 30, 2003; "For SMIC, Rumblings of an IPO," Electronic Engineering Times, August 4, 2003; and "Semiconductor Manufacturing Delays Sale," *Bloomberg*, July 9, 2003.

364 Shanghai Industrial Holdings, Merrill Lynch Capital Markets, Xue, L., April 12, 2002; Shanghai Industrial Holdings, November 12, 2001 at 1.

365 *The Daily Deal* (November 20, 2001); *Computerwire* (November 16, 2001).

Figure 25
Financing the Semiconductor Manufacturing International Corporation (SMIC)



Equity amounts compiled from various reports at different times and of varying reliability.
*These three entities reportedly acquired 52%; on the basis of cash, this implies $467 for Goldman and Walden, but non-cash equity is present.

of shares totaling approximately 11% of the equity interests in SMIC.[366] Avant! had invested $62.5 million of the $100 million by September 2001, but it terminated its investment in SMIC at that time. SMIC repaid AVANT! in full. Synopsis Inc. and IKOS appear to be 2 subsidiaries/affiliates of Avant that pulled their investments out simultaneously with Avant!.[367]

- ***H&Q Asia Pacific Ltd.*** [368] H&Q was Taiwan's first American-style venture capital firm. Its founder, Ta-lin Hsu, was a founding member of the Executive Yuan of Taiwan's Technology Review Board, which advises the Executive Yuan on all technology matters.[369] As with most of SMIC's investors, H&Q has not publicly announced its shareholding in SMIC, but has reportedly "plowed a large, undisclosed sum" into the foundry. In an interview with a Japanese industry newspaper, *Nikkei Sangyo*, Hsu was slightly more forthcoming when he indicated that his original agreement with SMIC CEO Richard Chang involved an investment of approximately $100 million.[370]

- ***Integrated Silicon Solutions Inc.*** ISSI designs, develops and markets high performance memory semiconductors and is one of largest producers of SRAMs in North America.[371] It does not operate its own fabs, but has developed relationships with foundries for access to advanced wafer process technology, including with TSMC (1990), Chartered Semiconductor (1994), and UMC (1995). Jimmy Lee, ISSI's founder, is a native of Taiwan who started ISSI with Taiwanese funding. ISSI entered into a wafer fabrication facility investment agreement with SMIC in 2001.[372] ISSI is reported to be bringing its investment in SMIC up to $40 million in 2002 and has one seat on the board of directors of SMIC. The company is an investment portfolio company of Walden International.

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366 Avant! invested $7.5 million on December 31, 2000, $15.0 million on January 15, 2001 and $40.0 million on March 15, 2001. Mr. Hsu, Avant!'s CEO, invested $1.0 million in SMIC prior to Avant! s initial investment in SMIC. Hsu became a member of SMIC's board, and SMIC repaid Mr. Hsu his $1 million investment. Avant! 2001 10-K at 55 and 2000 10-K.

367 Synopsys Inc., Form 8-K, December 3, 2001.

368 Shanghai Industrial Holdings, Merrill Lynch Capital Markets, Xue, L., April 12, 2002. H&Q Asia Pacific (H&QAP) is a private, Palo Alto-based equity firm established by a prominent Taiwanese financier, Ta-lin Hsu, in 1985. H&Q invests in technology, branded consumer products, financial services and other high growth sectors. It was founded as a division of Hambrecht & Quist, the U.S. technology investment bank founded in 1962 (now a part of JPMorgan H&Q). Dr. Hsu is also a founder of the Monte Jade Science & Technology organization, the premier non-profit organization promoting technology exchange between Taiwan and the U.S.

369 www.hqap.com.

370 *Nikkei Sangyo* (March 28, 2002); *The Daily Deal* (April 19, 2001).

371 www.issiusa.com.

372 Under the SMIC agreement, ISSI committed to invest $30 million. In April 2001, ISSI committed to invest an additional $10.0 million, raising the total commitment to $40.0 million. As of March 31, 2002, actual investment was approximately $30.1 million. ISSI 10-K at 3.

- ***Walden International.*** Walden International, established in San Francisco in 1987 as a global venture capital firm, has US$2.2 billion under management.[373] Walden was founded by Lip-Bu Tan, a Singaporean, and former Vice President at Chappell & Co.[374]

- ***Goldman Sachs.*** Goldman Sachs has been actively promoting investment in mainland semiconductor foundries.[375] Goldman Sachs' board member, Dr. Morris Chang, was the founding Chairman of Taiwan Semiconductor Manufacturing Company Ltd. (TSMC), the founding Chairman of Vanguard International Semiconductor Corporation, and of WaferTech LLC.[376]

- ***Hon Hai.***[377] Hon Hai is a Taiwan-based manufacturing conglomerate. The group's subsidiary, Hon Hai Precision Industry Co., is the largest private manufacturer in Taiwan, with investments of US$1 billion in a science-based industrial park in Beijing for which it contracted with the Beijing City government in December 2001.[378] With an assembly volume of up to one million units per month, Hon Hai Precision will reportedly produce mobile phones for Nokia.

- ***Syntex Semiconductor Co. = Syntekt Semiconductor of Taiwan.***[379] According to an October 2000 press release, Syntekt was undecided about the investment in SMIC, likely because of SMIC's capital sources, but speculation estimated that Syntekt's share in SMIC could be around $96.09 million, an amount that would be roughly on par with H&Q's investment.[380]

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373 http://www.waldenintl.com/main/index.htm. Prior to joining Walden, Mr. Tan served at Chappel & Co. He began in technical and financial management positions with ECHO Energy Consultants, Inc. and Impell Corporation. Mr. Tan earned his Masters Degree in Nuclear Engineering from the Massachusetts Institute of Technology (M.I.T.), and his Bachelor of Science Degree from Nanyang University. www.usfca.edu/sobam/Directory/USAdvisory/Tan.html.

374 Shanghai Industrial Holdings, Merrill Lynch Capital Markets, Xue, L., April 12, 2002.

375 "Goldman Sachs to Invest in China's Semiconductor Industry," *Xinhua* (00:14 GMT, September 24, 2002).

376 Dr. Chang also served as Chairman of the Board at Taiwan's Industrial Technology Research Institute (ITRI) between 1988 and 1994. http://www.gs.com.

377 Shanghai Industrial Holdings, Merrill Lynch Capital Markets, Xue, L., April 12, 2002.

378 *Taiwan Economic News* (December 21, 2001). The Hon Hai Group has already established electronics manufacturing plants in Guangdong, Jiangsu, Zhejiang, Shanxi, Tianjin, and Beijing. Its mainland-based employees total over 50,000. The firm has invested over US$1.6 billion in mainland China.

379 Syntex Semiconductor is likely "Syntekt Semiconductor", www.syntekt.com.tw, Taiwan's first microcontroller design house founded in 1983 by former RCA engineers. Syntekt, a listed company in Taiwan, is known for trying to invalidate one of Microship Technology's patents. Silicon Strategies, *Semiconductor Business News*, March 22, 2001, http://www.digitimes.com/finance/showchart.asp?reg=chart, www.3dsp.com press release.

380 *Taiwan Economic News*, October 5, 2000.

- ***Toshiba.*** SMIC signed a technology licensing agreement with Toshiba in December 2001 that provided Toshiba a "small stake" in SMIC as partial payment for the licensing arrangement.[381]

- ***SMIC Management.*** Some of SMIC's executive management are reported to be significant shareholders.

- ***Vertex Management.*** Vertex is the investment arm of the Singapore government-owned Singapore Technologies Group, a multi-billion dollar conglomerate and one of the largest industrial and technology groups in Singapore, with 1999 revenues of US$3.4 billion. According to Vertex's 2001 business statement, new investments in 2001 for three companies -- one of them being SMIC -- totaled only $17 million.[382]

- ***Zhangjiang Park Development Corp.*** is a development corporation owned by the Shanghai Municipal Government. It has reportedly made a small equity investment in SMIC.[383]

- ***Chartered Semiconductor.*** Chartered, the Singapore-based foundry manufacturer, has reportedly transferred its 0.18-micron baseline logic process technology and granted patent rights to SMIC in exchange for a small, but undisclosed equity stake and access to capacity over the next five years.[384] Chartered, a so-called "GLC" (government-linked company) in Singapore, is rumored to be taking advantage of the investment restrictions on Taiwanese chipmakers.[385] The Chartered deal reportedly reflects a trend set by Toshiba and Fujitsu among the SMIC technology partnerships: tech transfer in exchange for equity participation stake, and increased market access in China.[386]

b. *Grace Semiconductor Manufacturing International (GSMC).*

Grace Semiconductor Manufacturing International (GSMC) was founded in November 2000 by an unnamed consortium presumed to have registered in the Cayman Islands.[387] Press reporting reflects a general understanding that GSMC is a 50-50 endeavor between the so-called

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381 www.Itworld.com, December 20, 2001.

382 Shanghai Industrial Holdings, Merrill Lynch Capital Markets, Xue, L., April 12, 2002 and http://www.vertexmgt.com/news/nw_news.html; *Computerwire*, November 16, 2001 and Vertex 2001 Business Statement.

383 Interview with officials of Shanghai Zhangjiung Hi-Tech Park Development Corp. (Shanghai, September 2002).

384 Chartered Semiconductor's financial statements, 2001 20-F, did not reveal the extent of its holdings. *Business Wire*, (December 20, 2001).

385 *Taipei Times* (April 8, 2002); "Paper Tiger," *Far Eastern Economic Review* (February 14, 2002).

386 "Paper Tiger," *Far Eastern Economic Review* (February 14, 2002).

387 Company Profile, www.gsmcthw.com, undated GSMC power point presentation, interviews with industry executives and government officials (Shanghai, 2002). SST's SEC filings refer to a Cayman Island parent.

"two princes," Winston Wong, the son of Taiwan's Formosa Group Chairman Wang Yung-Chang, and Jiang Mianheng, the son of China's former President Jiang Zemin.[388] GSMC wholly owns a second company, a foundry known as Shanghai Grace Semiconductor Corp. ("Grace"), whose chairman is a professor of computer science at Taiwan National Chengchi University.[389] Both GSMC and Shanghai Grace, the foundry, are located in Shanghai's Zhangjiang Hi-Tech Park. GSMC is establishing a subsidiary called Ninbo Sinomos Semiconductor (NSSI) in the Ningbo Free Trade Zone.[390] GSMC's first phase investment totaled $1.63 billion, reflecting construction of fabs 1 and 2, with completion expected by the end of 2003.[391] Fab 1, the 8-inch facility, was scheduled to commence production in April 2003, while the progress of Fab 2, the 12-inch facility, is currently unknown.[392] GSMC has been contrasted with SMIC in terms of the speed of its roll-out. Compared to SMIC, Grace is "a company that is cutting back on its plans."[393] Some might attribute the delay to fines imposed by Taiwan's Ministry of Economic Affairs on two Grace chairmen for illegal investments in the mainland.[394] The two fabs eventually are expected to have a production capacity of 100,000 wafers per month.[395]

Grace does not disclose the identities of its shareholders.[396] However, Dr. Yeoung Ruey Shiue, Executive VP for Operations and the most senior operations person at Grace, states "that

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388 *Taipei Times*, March 7, 2002 and January 13, 2001. Initial indications were that Wong and Mianheng would invest a combined $643.5 million in GSMC, or about 40 percent of the initial investment. No subsequent press reporting confirmed this amount, but generally all press reporting has treated Wong as one of the two principal investors, backers, or owners of GSMC. Given that Jiang owns approximately 10 percent of two of Wong's other Grace TWH Group units, Grace Technology and Grace Fabric, Jiang may be following the same pattern with respect to GSMC. If so, his investment would total approximately $160 million. www.taiwan.com.au; "Chip Plant Venture Discussed", *Wall Street Journal*, August 21, 2000.

389 *ZD Net Japan* (March 27, 2001); Oki Press Release (March 27, 2001), sun2mis.mis.nccu.edu.

390 AsiaInfo Daily China News (April 17, 2002).

391 UBS Warburg, *Grace Semiconductor: 10 Key Take-Aways* (March 15, 2002); Bear Stearns Asia Tech and EMS Tour (March 13, 2002); undated GSMC powerpoint presentation.

392 "GSMC to Install Eight and 12-inch Lines at Same Wafer Fab," Taiwan Economic News, March 27, 2003.

393 "Chinese LSI's Face Crucial Period in Business, New Fabs Become a Turning Point," Nikkei Microdevices, February 2003. See also "China's Chipmaking Focuses on Yangtze River Delta," Semiconductor International, February 1, 2003.

394 "Taiwan Seeking Middle Ground on Chipmakers Going to China," Taipei Times, February 21, 2003; "Taiwan Fines Four Firms for Illegal Investments in China," Taipei Times, January 19, 2003; "MOEA Fines Businessmen for Unregistered Investments on M'land," Taiipei Central News Agency, January 18, 2003.

395 "China Is not for Everyone," Purchasing, April 17, 2003 and "GSMC to Install Eight and 12-inch Lines at Same Wafer Fab," Taiwan Economic News, March 27, 2003.

396 Grace's sources of private equity capital are "mostly from Taiwan, but also from China, North America, Japan, and South Korea." Officials at Shanghai's Zhangjiang Hi-Tech Park have reported that about 50% of the capital investment in GSMC is from Taiwanese investors via various offshore routes. *Tokyo Semiconductor FPD World* (May 1, 2001); *Far Eastern Economic Review*, November 23, 2000 as reported at www.1stsilicon.com.

there is no state or local Chinese government investment in Grace," unlike SMIC.[397] Grace does, however, receive debt financing from Chinese government-owned banks. Its capital structure includes $800 million in equity with the balance of $830 million financed through a loan syndicate that was expected to include Shanghai Pudong Bank, Shanghai Industrial and Commercial Bank, and China Construction Bank.[398] The initial bank loan deal appears to have either been finally sealed, or funds actually disbursed, in August 2002.[399] The Chinese government has reportedly agreed to an "additional" $2.5 billion in funding for GSMC after the first phase, through the Bank of China, China Construction Bank, and China Commercial Bank.[400] Total financing for GSMC is ultimately expected to reach approximately $7.5 billion, although some reporting places the final investment number much lower, at $6.4 billion.[401]

c. ***He Jian Technology Corporation.*** He Jian has been established in the China-Singapore Suzhou Industrial Park in Suzhou, Jiangsu Province, by retired executives from Taiwan's semiconductor industry, with capital and management backing from Taiwan.[402] Phase 1 investment in He Jian is reported to be approximately $1 billion, with total investment expected to reach $5 billion.[403] Invest League Holdings Inc. is reported to be the largest shareholder with $52.5 million in the company. Invest League is a British Virgin Islands-based holding company headed by Chen Chun-ku who was formerly a UMC executive and was still sitting on the boards of several UMC affiliates when he appeared on He Jian's incorporation documents filed at the Shanghai Municipal Government early in 2002.[404] Reports are widespread to the effect that He Jian is affiliated in some manner with UMC and that He Jian's Suzhou operation constitutes what will at some point become UMC when the pretenses are dropped ("He Jian is UMC").[405] UMC chairman Robert Tsao refuses to discuss He Jian, and UMC has issued

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397 Interview with Grace Semiconductor Manufacturing International (Shanghai, September 2002).

398 UBS Warburg, *Grace Semiconductor: 10 Key Take-Aways*, March 15, 2002. At least one press report described state-owned financing amounting to almost three times the $800 figure ($2.5 billion). *Hong Kong Kai Fang* (December 5, 2000).

399 *Shiji Jingji Baodao* (August 2, 2002).

400 *Business Week* (November 27, 2000).

401 http://www.pconline.com.cn/news/0008/0821c8.html, August 21, 2000.

402 He Jian is styled as a "British" company, but the only evident link with the UK is He Jian's incorporation in the British Virgin Islands. Interview with officials of Suzhou Industrial Park (Suzhou, September 11, 2002) and *Taiwan Economic News* (June 26, 2002); He Jian website, http://www.hjtc.com.cn/8n-english/index.asp.

403 *Asian Wall Street Journal* (January 28, 2002), *Dow Jones International News* (January 25, 2002).

404 *Asian Wall Street Journal* (April 1, 2002).

405 Interviews in Suzhou (September 2002). He Jian is often described in the press as a "front" for UMC. He Jian's top executive is J.H. Shyu, a 15-year veteran of UMC, and its top management consists of many senior professionals previously working at UMC. *Taiwan Business News* (April 3, 2002).

formal denials regarding investment in He Jian in response to an investigation of UMC's investment in China-Singapore Suzhou Industrial Park (CS-SIP).[406]

He Jian is constructing an 8-inch fab in the CS-SIP which will operate as a foundry. Construction began in December 2001, pilot production was successfully commenced in June 2003, and volume production is expected to begin in September 2003.[407] Monthly output capacity in the near-term is expected to be 10,000 chips per month.[408] The ultimate volume will be 60,000 wafers per month. He Jian has reportedly bought 1.2 sq. km. of land in the CS-SIP and will build a total of six fabs there. He Jian expects to be mainland China's second largest chip supplier after SMIC.[409] The CS-SIP administration reportedly has given the enterprise preferential treatment, including the grant of 40 hectares of land free of charge.[410]

d. *Beijing Semiconductor Manufacturing Corporation (BJSMC).* SMIC has established BJSMC in collaboration with the Municipal Government of Beijing, which is an equity investor in the project. SMIC reportedly holds about one-third of the equity in BJSMC, and the Municipal Government, the Beijing Economic and Technical Development Area (BDA), and the government-owned Shougang Iron and Steel are all contributing equity, although the government shares are expected to be reduced or diluted as new capital is injected by private investors based in the U.S., Japan, Europe and Taiwan.

BJSMC's first phase, undertaken in the Beijing Economic Development Area (BDA) involves the construction of two 8-inch lines, as well as an "introductory" 12-inch line that will conduct test runs using 12-inch wafer technology.[411] By February 2003, SMIC had reportedly broken ground for three Beijing fabs,[412] one 200 mm fab, one 300 mm fab, and one back-end

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406 Mr. Tsao indicates that he is not violating any Taiwan investment laws by promising partners in China that UMC will take over operations of He Jian once the investment ban is lifted. *Asian Wall Street Journal* (April 1, July 25, 2002); *South China Morning Post* (July 31, 2002); *EBN* (April 2, 2002); *The China Post* (June 4, 2002); and *Taipei Times* (June 4, 2002).

407 "Suzhou He Jian to Ramp Up Chip Production in September," *Taiwan Economic News*, July 29, 2003.

408 "Suzhou He Jian to Ramp Up Chip Production in September," Taiwan Economic News, July 29, 2003.

409 "Suzhou He Jian to Ramp Up Chip Production in September," Taiwan Economic News, July 29, 2003.

410 *Taiwan Business News* (April 3, 2002). Part of the deal is reported to have been an agreement between UMC and the CS-SIP authorities that "rival TSMC would be kept out of the [Suzhou Industrial] park." SMIC and Grace are reported to be concerned about the competitive challenge posed by He Jian and the latter is described as vying with Grace for the number two spot in the dedicated wafer foundry market.

411 Phase 2 envisions the establishment of three 12-inch lines, each of which it is estimated will require investments totaling $3 billion. Groundbreaking for the BJSMC phase 1 construction took place in September 2002. According to a BDA official who helped negotiate the deal with SMIC, the BJSMC fabs will eventually exceed the capacity which SMIC has planned in Shanghai, which would mean establishment of 7 or more fabs at the Beijing site. Interview with Beijing Economic-Technological Development Area (Beijing, September 2002).

412 "China's Rapid Ascent in Chip Industry Could Displace Manufacturing Worldwide," Knight-Ridder Tribune Business News, February 3, 2003.

facility.[413] Reportedly, the Beijing-based 300 mm fab is intended to accommodate a newly signed cooperation agreement between SMIC and Infineon Technologies AG, whereby SMIC will receive 0.11 µm DRAM trench technology and 300 mm production know-how in exchange for producing approximately 15,000 wafer starts per month for Infineon.[414] The fab is expected to be equipped by the end of 2003, to commence pilot runs by mid-2004 and volume production by the end of 2004.[415] Regarding its Fab 4 facility in Beijing, SMIC reportedly is placing an order for approximately $1 billion in tools and equipment as of fourth quarter 2003.[416] Richard Chang, SMIC's founder, has stated that "there was powerful support from the Beijing city government" for the establishment of BJSMC.[417]

e. *Wuxhi CSMC-Huajing.* Wuxhi CSMC-HJ, China's first operational pure-play foundry, has been run by Taiwanese managers since 1997.[418] It is a joint venture between the Hong Kong-based Central Semiconductor Manufacturing Corporation (51%), which is owned by Taiwanese and overseas Chinese investors, and China Huajing Electronics Group Corporation (49%), a Chinese state-owned semiconductor manufacturer. Taiwan's UMC is reportedly planning to take an equity stake in CSMC-HJ in return for providing CSMC-HJ with used equipment.[419] Wuxhi CSMC-HJ has deliberately avoided pursuit of state-of-the-art technology in favor of an attempt to become the world's largest producer of integrated circuits using 6-inch wafer technology, concentrating on low-end products such as general logic and high voltage devices.[420] CSMC-Huajing announced in August 2003 receipt of $67 million in a first round of funding to expand an existing 6-inch fab in Wuxhi that would double its current capacity of 20,000 wafers a month to 40,000 wafers a month.[421] CSMC-Huajing is also planning to establish a second 6-inch line to produce 30,000 wafers monthly.[422]

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413 "China Foundry Latest to Use Chipmaker's DRAM, 300 mm Technologies-- Infineon Empowers Asian Fabs," Electronic Engineering Times, March 31, 2003.

414 "Infineon Expands Foundry Agreement with SMIC," SMIC press release, Shanghai, March 27, 2003.

415 "China Foundry Latest to Use Chipmaker's DRAM, 300 mm Technologies-- Infineon Empowers Asian Fabs," Electronic Engineering Times, March 31, 2003.

416 Based on reporting from Susquehanna International Group LLP. "China's SMIC to Place $1 Billion Equipment Order," EETimes, August 27, 2003 and Solid State Technology Web Exclusive, September 2, 2003.

417 N. Jinbo, "Chinese LSIs Approaching a Crucial Moment, New Fabs Become a Turning Point," *Nikkei Microdevices* (February 2003).

418 "China's Chip Binge," *Business Week Online* (January 21, 2002).

419 "UMC May Be Making Chips in China in 2003," *Taipei Times* (April 12, 2002).

420 "China's CSMC Aiming for World's Largest LSI Maker Using 150mm Wafer Lines," *Nikkei Microdevices* (June 2002). CSMC operates mostly with used equipment. It has been described as a "joint venture between an Chinese electronics company and a U.S.- incorporated venture capital fund backed by a Taiwanese chief executive." "Taiwan to China," *CFO Asia* (July 2002).

421 "CR Logic in Mainland Chip Tie-Up," Hong Kong IMAIL, World Sources, August 6, 2003.

422 "CR Logic in Mainland Chip Tie-Up," Hong Kong IMAIL, World Sources, August 6, 2003.

f. ***Dunnan Science and Technology.*** The Lite-On Group, a Taiwan-based multinational, reportedly plans to invest $200 million to build a semiconductor production facility in Wuxi, Jiangsu Province, to be called Dunnan Science & Technology Co.[423]

B. Mobilizing capital

In contrast to China's prior promotional efforts, which emphasized support for state-owned enterprises and state-invested JVs, the present effort emphasizes the importance of mobilizing private capital, which is expected to provide the predominant share of new investments in the semiconductor industry. State banks are providing loans to semiconductor firms; a number of the new foundries have government equity investments; and local and national government organizations are providing venture capital funding. But all of the big new semiconductor projects are being driven primarily by private capital, and it is anticipated that such government shareholding as currently exists will be reduced over time. Government investments primarily serve a "moral" or "rallying" function, signaling that the government favors the project in question as inducement to private investment.

Nevertheless, despite the somewhat reduced role of government financial organizations, their continuing efforts in assisting enterprises to secure financing remains very important because of the underdeveloped state of both China's financial system and its private sector.[424] At the end of 1999, China's private sector accounted for only 1 percent of the country's bank lending, and only 1 percent of the companies listed on the Shenzhen and Shanghai stock exchanges were private. A 2001 survey of private firms in 'China revealed that 80 percent considered lack of access to finance to be a serious constraint; they relied heavily on self-financing for start-up and expansion, and over 90 percent of their initial capital came from the principal owners, the start-up teams, and their families.[425] Most Chinese venture capital companies are still government entities. The growth of a private venture capital industry is impeded, among other things, by the absence of a NASDAQ-type secondary market which would permit public trading of the equity shares of start-up companies ("there is no exit mechanism for investors") and the fact that foreign investors are discouraged from establishing Chinese venture capital operations because of restrictions on the repatriation of earnings.[426]

1. ***Bank Lending.*** The Chinese government owns the banking system and influences its lending policies in order to support government industrial policy priorities. Loans from such banks form an important component of the capital financing for the new mainland foundries. Reforms implemented in 1995 divided China's major national banks into two groups: three "Policy Banks" that explicitly make loans for policy purposes, and for "State Banks" that

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423 *Zhongguo Gaoxin Jishu Chanyu Daobao* (January 18, 2002); *ChinaOnline* (February 15, 2002), http://www.chinaonline.com/topstories/cs-protected/020211/1/B202012113.asp.

424 With respect to both points see "Private Sector Investment: A New Engine of the Economy," *Jeifang Ribao* (December 17, 2002).

425 "The Financing of Private Enterprise in China," in *Finance and Development* (March 2001).

426 Interview with Shanghai Foreign Investment Commission (Shanghai, September 2002).

are to operate more along strictly commercial lines.[427] Most of the loans to Chinese semiconductor firms in recent years have been made by the State Banks, not the Policy Banks, and that fact may be cited to support the proposition that current lending by government -owned banks to the semiconductor industry is a reflection of normal market considerations. However, the lending policies of the regional branches of the State Banks are influenced by the policies of the regional governments, which in Shanghai, Beijing, and Suzhou emphasize promotion of the semiconductor industry.[428] The central government's catalogue of "national encouraged industries," which includes semiconductor manufacturing and design, serves as a reference book for Chinese banks considering loans to domestic industries.[429]

2. *The interest rate subsidy.* The Tenth Five Year Plan provides that the government will "provide a favorable interest rate" to the semiconductor industry.[430] In practice, with respect to manufacturing enterprises, this policy is being implemented in the form of a central government subsidy of one percent of the interest rate payable on domestic bank loans. This is being matched, in some cases, by another one percent subsidy offered by regional or local governments, or some combination of the two.[431] Beijing Municipality offers an interest rate subsidy which may run as high as 1.5 percent, and in "industries guided by the government the loan interest subsidy may be increased to 2%."[432] However, according to a number of government and industry representatives, the total combined national/regional/local interest rate subsidy does not exceed 2 percent in any case.

3. *Equity infusions.* Governmental equity participation in the current round of semiconductor projects now resembles investment patterns found in Singapore, Taiwan, and elsewhere where the government is at most significant minority shareholder rather than the full

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427 In 1999, reflecting the fact that the total of nonperforming loans at the State Banks had become so large, the government created an "assets management company" (AMC) for each State bank, which acquired the bank's non-performing loans.

428 Chi Hulin, "Rise and Fall of the Hainan Development Bank," *World Bank Transition Newsletter* (undated)

429 *Catalogue of Present National Encouraged Industries, Products, and Technologies for Development* (Jointly promulgated by the State Economic and Trade Commission and the State Development and Planning Commission, August 31, 2000)

430 Tenth Five Year Plan, Section 3.6.11.

431 In the Suzhou New District, the government provides a one percent interest rate subsidy to match a comparable subsidy by the central government. Interview with official of the New District Administrative Committee, Suzhou People's Municipal Government (Suzhou, Jiangsu Province, September 2002). In Shanghai, new production lines for the manufacturing of integrated circuit chips will be included in the Municipal People's Government's list of major engineering projects. During their period of construction, there will be a one-percentage-point cut in loan interest for all loans to them in renminbi for fixed assets investment. Shanghai Circular 51, January 2001, Article 21.

432 *Proposals of the People's Government of Beijing Municipality for the Implementation of Some Policies of the State Council on Encouraging the Development of Software Industry and Integrated Circuit Industry* (No. Jing Zheng Fa [2001] 4), Article 32.

owner.[433] The most substantial equity investments in semiconductor businesses are being made at the regional and local level, by municipal governments in Shanghai and Beijing, and by the development corporations associated with the Hi-Tech Parks and Economic and Technical Development Zones.[434] Shanghai Industrial Holdings, for example -- the investment vehicle of the Municipality of Shanghai -- holds the largest equity stake in SMIC valued at $183 million.[435] These investments are commonly made on a basis under which the government may not exercise its voting right or receive dividends.[436]

4. ***The new venture capital companies.*** Venture capital companies (VCCs) are being established by the national and regional governments in response to China's underdeveloped venture capital system.[437] The VCCs are of principal importance to semiconductor design firms seeking to commercialize the products which they develop.[438]

The VCCs emphasize that they are "committed to follow market principles and international business practice," but also make clear that they will be "guided by government policy and economic regulations."[439] Venture capital executives envision a progressive government withdrawal from the venture capital markets over the next five years, but the

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433 Shanghai's Circular 54 and Beijing's Circular 2001-4 call for direct government equity investment in private semiconductor enterprises at a level of about 15 percent of total registered capital, with no exercise of voting rights.

434 The wholly state-owned Shanghai Zhangjiang Hi-Tech Park Development Corp., for example, holds equity investments in Shanghai Belling, SMIC, and ASE as well as in some fabless IC companies -- and "the fabless are our favorites." Interview with Shanghai Zhangjiang Hi-Tech Park Development Corp. (Shanghai, September 2002).

435 Shanghai Industrial Holdings, Inc. has been described as a "government-backed" syndicate of approximately 20 strategic investors and as the "investment arm" and "commercial arm" of the Shanghai Municipal Government. *Computerize Deal* (November 16, 2001); *The Daily Holdings, Merrill Lynch Capital Markets*, Xue, L. (April 12, 2002)

436 Article 32, *Proposals of the People's Government of Beijing Municipality for the Implementation of Some Policies of the State Council on Encouraging the Development of Software Industry and Integrated Circuit Industry* (No. Jing Zheng Fa [2001] 4).

437 Central Government entities which have established VCCs include the Chinese Academy of Sciences and the MII as well as a number of universities. Municipal governments in Shanghai and Beijing have established VCCs, as have several Hi-Tech Parks in which semiconductor design firms are located. A number of VCCs are layered under other VCCs, with the parent (government-owned) VCC retaining a controlling interest in secondary and tertiary firms. While governments provide funding for the VCCs, the VCCs also attract private capital from inside China and abroad, as well as domestic bank loans.

438 The VCCs offer semiconductor startups more than mere direct infusions of capital. The existence of VCC funding for an enterprise facilitates lending and other support from state-owned banks. Some (but not all VCCs) also offer management oversight and training, setting up management systems, legal advice and support, risk assessment, assistance in structuring IPOs, "finding the key person," and other management support services. Interview with officials of Shanghai Zhangjiung Hi-Tech Park Development Corp. (Shanghai, September 2002). Also see e.g. Shenzhen Venture Capital Corp. website, http://www.szvc.com/ /english/english.htm.

439 Shenzhen Venture Capital Co., http://www.sz.vc.com.cn/english/english. htm.

government's pervasive role in existing VCCs acts as a deterrent to the formation of purely private alternatives.[440] At present, government-controlled VCCs pitch themselves to private investors, in part, by touting their close connections with key government ministries and state-owned enterprises. Existing rules on Chinese/foreign joint venture VCCs limit the foreign share to 33 percent (49 percent in 2005), suggesting that the VCCs will continue to serve as a mechanism for increasing the flow of foreign capital into the domestic semiconductor industry while retaining government oversight of the entities receiving such funds.[441]

C. Creating a tax-free environment.

China has a complex, multi-layered system of taxation, characterized by problems such as the lack of transparency, arbitrary manipulation of levels of taxation by local authorities, and the imposition of ad hoc taxes and charges by localities (*tanpai*). With respect to the semiconductor industry, however, China's central and local governments have implemented tax policies that are so generous that it is fair to assume that new semiconductor enterprises will pay few, if any, taxes for most of the coming decade. The low burden of taxation of semiconductors relative to other sectors is a major advantage and a factor encouraging investments in this industry both by domestic and by foreign investors.

China's tax regime. Despite numerous reforms, the complexities and ambiguities of China's taxation regime are regarded as problematic by foreign investors doing business in China. In 1994, the PRC substantially reformed its entire tax system in an effort to eliminate the extremely complex, unpredictable, and non-uniform regime that had developed during the preceding decades.[442] Prior to the 1994 reform, virtually every large enterprise was subject, in effect, to its own tax formula that arose out of the tax code's complexity and the particular situation – often negotiated – of the enterprise itself. Despite the 1994 reforms, tax rules have remained complex, making it difficult to draw conclusions regarding how a given enterprise might be taxed in a particular situation. Tax rules are subject to frequent change, particularly for

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440 "In 3 to 5 years [from 2001], the legal framework for the development of funds, including venture capital funds, in the country will be established; a group of talented venture capitalists will grow up and people in China will have a better understanding of venture capital investment…. By then the government might retreat from its current role as an active participant in venture capital investment in China." Hua Yuda, President, Shanghai Venture Capital Co. Ltd., www.chinadaily.com/cn/star/2001/0524/b210-2.html.

441 *China Daily*(June 26, 2002), www.chinadaily.com/cn/cndy/2002-06027/75433.html.

442 Before 1994 tax-enforcement responsibility was decentralized to such a degree that local governments often determined enterprises' tax liability, often on a negotiated, *ad hoc* basis. Local tax authorities typically set their own tax rules, often to support local industrial development at the expense of tax revenue destined for the central government's treasury. As one academic summarized the problem, "In fact, the way the system was administered led to a significant degree of competition among local governments." To address this problem, the 1994 reform placed authority for collection of central-government taxes -- the proceeds of which accrue to the central government or are shared with local governments by formula -- squarely in the hands of the central government's State Administration of Taxation (SAT). The new structure called for SAT to operate a "national tax bureau" (NTB) in each of the provinces, autonomous regions, and municipalities. In parallel, the 1994 reforms created "local tax bureaus" (LTBs) that would collect those taxes over which the local governments have sole right to the proceeds.

foreign-invested enterprises, with complex grandfather clauses and temporary exceptions to the new rules. Despite efforts at reform, local officials continue to apply central-government tax rules in a discretionary manner in support of their own industrial-policy initiatives.[443] The ability to avoid significant taxation in such an environment is thus a major advantage for an enterprise.

Enterprise income tax rates. Semiconductor-specific income tax benefits are based on a reduction of the marginal tax rate as well as a shortening of semiconductor equipment's depreciable life for tax purpose. These two tax policies interact to make the combined tax benefit larger than the sum of the two benefits -- in effect, creating an indefinite tax holiday.

China's basic enterprise tax (corporate income tax) base rate is 33 percent. Typically semiconductor enterprises are located in High-Tech Parks or Economic and Technical Development Zones, and as a result 1) the base rate of taxation is 15 rather than 33 percent; 2) enterprises are eligible for a 2 year tax holiday and 3 additional years of taxation at half the preferential rate, or 7 1/2 percent; and 3) the holiday does not begin to run until the first year an enterprise is profitable. Circular 18 established even more favorable tax treatment for the semiconductor industry, providing that IC manufacturers which invest over $1 billion and utilize technology with design rules of 0.25 microns or less are eligible for the same preferences available to the energy and transport sectors.[444] These are:

- A five year tax holiday beginning in the first year in which an enterprise is profitable;
- A subsequent five year period of taxation at half the normal rate, e.g., assuming location in a preferential zone, an effective rate of 7 1/2 percent.[445]

The Chinese government has reduced the depreciable life of IC manufacturing equipment used to calculate taxable profit in the first instance. The conventional benefit of a shorter depreciable life -- reduced taxable profit in the short term through increased annual depreciation

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443 In theory, the problem of local officials interpreting and enforcing central-government tax policies – particularly the VAT and the Foreign Enterprise Income Tax – has been resolved because the central government now has authority over collecting these taxes. However, local authorities' *de facto* ability to modify these taxes for industrial-policy purposes remains quite strong – and quite evident in the semiconductor sector. As a recent analysis on the 1994 reforms concluded, "Whether central administration will achieve national uniformity in application of the value-added tax is still an open question… [On the one hand,] NTB officers would appear to have little incentive to circumvent the process. Local officials of the NTB, however, are more or less the same people who were previously in the local bureaus of the SAT, and the oversight difficulties from the provincial level are no less severe than before… the SAT still faces the daunting task of overseeing the work of four hundred thousand tax officials who operate from local offices. There is no adequate management information system to support this oversight. And because the VAT is so significant a tax, local officials will be under a great deal of pressure to find ways to relieve the tax burden." Bahl, *Fiscal Policy in China* (1999) p. 51. As recently April 2001 the central government felt the need to issue yet another law further clarifying that local authorities should not be involved in setting policy for central-government taxes. Cheung and Jaing, "China's New Tax Administration and Collection Law," in *International Tax Journal* (Spring 2002) p. 3.

444 Circular 18, Article 42.

445 The rate may vary depending on the rate of taxation applicable to the zone involved.

Figure 26
Summary of China's Differential Enterprise Tax Rates

	Rate of Taxation (%)
Normal tax rate	33
Economic and Technical Development Zones (ETDZs)[1]	15
Shanghai Pudong New Area[1]	15
Special Economic Zones (except Pudong)[1]	15
Hi-Tech Parks/Zones[2]	
- New enterprises, first 2 years of profitability	0
- New enterprises, years 3-5	7 1/2
- Others	15
Qualifying Foreign-Invested Enterprises[1]	
- New enterprises, first 2 years of profitability	0
- New enterprises, years 3-5	(half normal rate depending on location)
Qualifying Integrated Circuit Enterprises[3]	
- New enterprises, first 5 years of profitability	0
- New enterprises, years 5-10	(half normal rate depending on location)

1 Source: World Trade Organization, *Accession of the People's Republic of China*, WT/L/432, November 23, 2001, Annex 5A, "Notification Pursuant to Article XXU of the Agreement on Subsidies and Countervailing Measures."

2 Source: *Regulations on the Tax Policy for the National New and High Technology Parks*, (Approval by the State Council, March 6, 1991; Promulgated by State Administration of Taxation, March 6, 1991).

3 Circular 18, June 24, 2000, Article 42.

charges -- applies here but with magnified impact given the tax holiday rules. The 5-year "eligibility clock" for tax holidays begins in the enterprise's first year of taxable profitability. A shorter depreciation schedule can be utilized to postpone the year in which the "clock" begins by pushing the enterprise's taxable income below zero in the early years when it might otherwise be positive. This dynamic underlies the observation by industry observers that the new mainland foundries are unlikely to pay significant taxes for the next decade.

Other domestic taxes. Normally business enterprises in China must pay an array of local taxes and charges. Typically, however, with respect to new semiconductor investments, these are substantially reduced or waived altogether. [446] The problem of *tanpai* (*ad hoc* assessments of fees and charges by local authorities), while not eradicated, has been contained, reflecting efforts at both the national and local level. [447]

D. Building a viable infrastructure

The lack of an adequate infrastructure to support advanced semiconductor manufacturing operations has long been cited by foreign semiconductor producers as a major deterrent to investment in mainland manufacturing operations.[448] Basic factors of production, such as clean water and industrial gases were not necessarily available, and the array of supporting enterprises commonly found in "clusters" around semiconductor manufacturers in advanced countries -- materials, equipment, logistics, assembly, testing and packaging firms -- were not present or were underdeveloped.

Improvement of China's infrastructure for semiconductor manufacturing and design is an important element of the central government's current promotional effort. Circular 18 provides that funds will be allocated from the state budget for "infrastructure construction and industrialization projects…in the IC industry."[449] In contrast to prior efforts to establish high technology clusters, which saw the creation of over 100 "Hi-Tech Parks," the current effort focuses on a handful of sites which are being rapidly upgraded under the direction of local authorities. The clustering of semiconductor manufacturing operations within these parks

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446 For example, the China-Singapore Suzhou Industrial Park (SIP) in Suzhou, the site of He Jian's planned 8" fab and a variety of foreign-invested semiconductor assembly, test, and equipment companies, promotes its "zero fee" policy. In effect SIP has reduced over 100 fees and charges normally imposed by central, provincial and local governments to 7. The park administration itself pledges to "waive" fees and charges stipulated by provincial and local governments and all administrative fees and charges. Moreover, with respect to "fees and charges that have to be collected, but actually do not relate to enterprises" operation, we will pay on [their] behalf through financial subsidies." SIP, *Brief Introduction on Suzhou and Suzhou Industrial Park*, (September 2002), pp. 6-7.

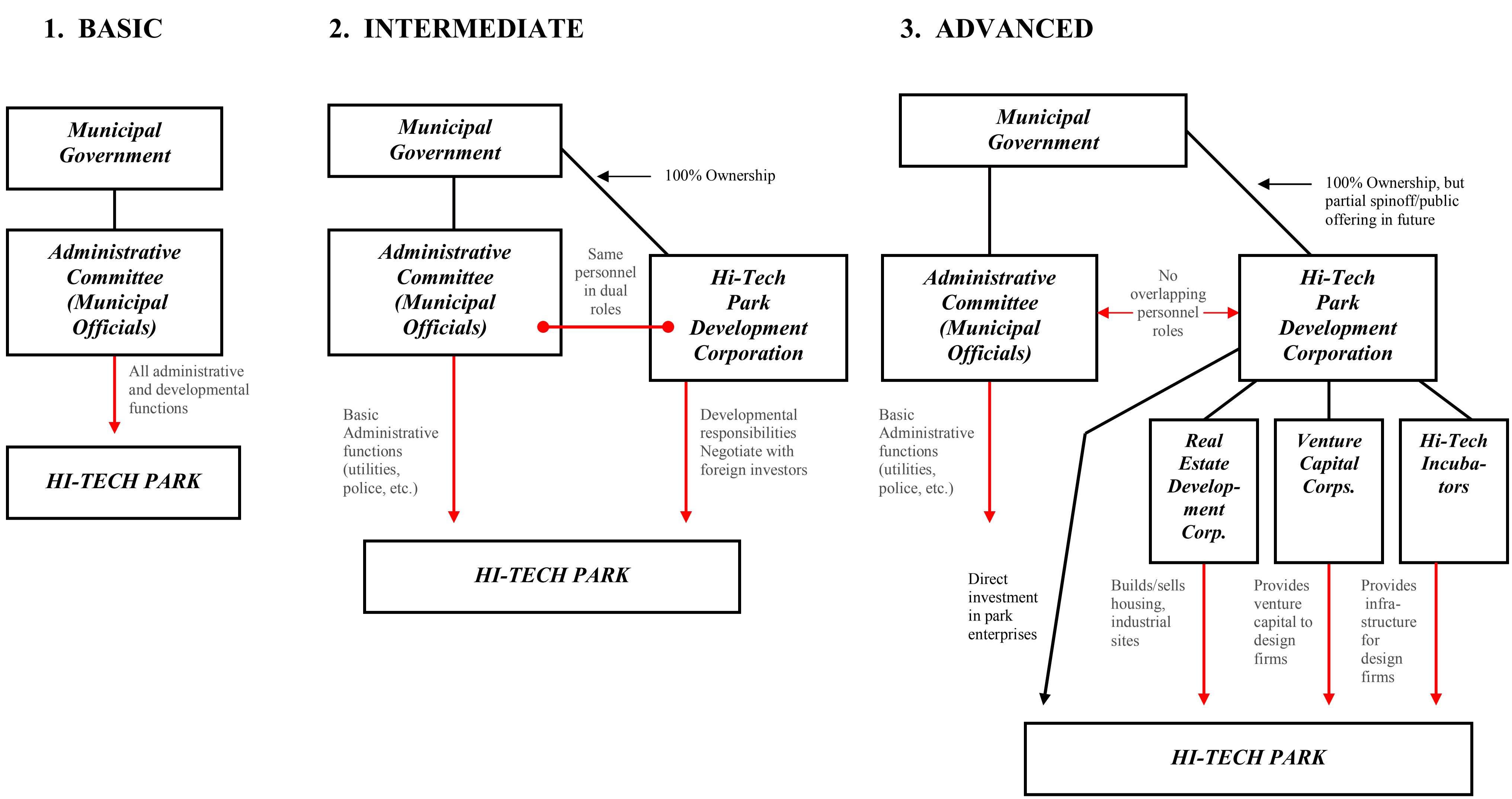
447 Responding to complaints by foreign enterprises, the State Council issued a circular prohibiting the imposition of unauthorized fees, charges and "taxes." Foreign enterprises are authorized to refuse payment of any tax levied by a government entity that cannot produce a valid license for fee collection issued by China's Finance Ministry. Sally Harpole, "New Developments: Collecting Fees from Foreign Investment Enterprises," 11 *China Law News* 16 (may 29, 1998).

448 "Taiwan Chip Makers Want Freedom to Operate in China," *Taipei Times* (January 12, 2002).

449 Circular 18, Article 3(2).

Figure 27

China's Hi-Tech Parks



facilitates the provision of factors of production such as pure water, industrial gases, and stable power supply through centralized facilities established by the Parks' administration.[450] A Japanese observer who toured these areas in late 2001 commented that "There seems to be little doubt that the technical levels and industrial scope of the infrastructure to support the semiconductor industry will be growing rapidly in the days to come."[451] A modern infrastructure capable of supporting advanced semiconductor manufacturing is emerging in at least three locations.

- The **Shanghai** Zhangjiang Semiconductor Industry Base (ZSIB) is a sub-unit of Shanghai's Zhangjiang High-Tech Park, where new fabs by SMIC, Grace and Belling are being located.[452] The Hi-Tech Park is itself a jurisdictional subunit of the Pudong New Area (PNA) which comprises four national-level economic development zones in the Shanghai municipality.[453] ZSIB consists of a rectangular area on the eastern side of Zhangjiang Park, subdivided into four development areas. Area A is the so-called Silicon Port, set aside for IC design related activities. Area B, 990,000 sq. meters, is set aside for IC manufacturing (Figure 28) within this area. SMIC reportedly enjoys government support in getting priority supplies of water, land, gas, electricity and other supporting infrastructure, and it is likely that Grace and Belling enjoy similar commitments. Land use and utilities fees are partially subsidized by the PNA.[454] Area C is set aside for industrial support activity and Area D is for "living support services."[455]

- The China-Singapore **Suzhou** has established a site for supporting 10 wafer fabrication lines. "We can supply all of the industrial gas, steam, power from underground cables, an abundant supply of clean water (nearby Tai Lake)."[456] The new fabs will be located adjacent to a design center, and assembly, test, and

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450 Thad Evans, "Securing a Reliable Process Gas Supply in China," *Solid State Technology* (August 2002).

451 Kyoji Kinokiri in *Nikkei Microdevices* (January 2002).

452 ZSIP is a joint venture between the Zhangjiang Development Corp. and Shanghai Pudong Land Development Holding Corp. ZSIP was formed under the guidance of the Shanghai Municipal Government as part of a broader "Focusing on Zhangjiang" strategy for developing local high technology industries.

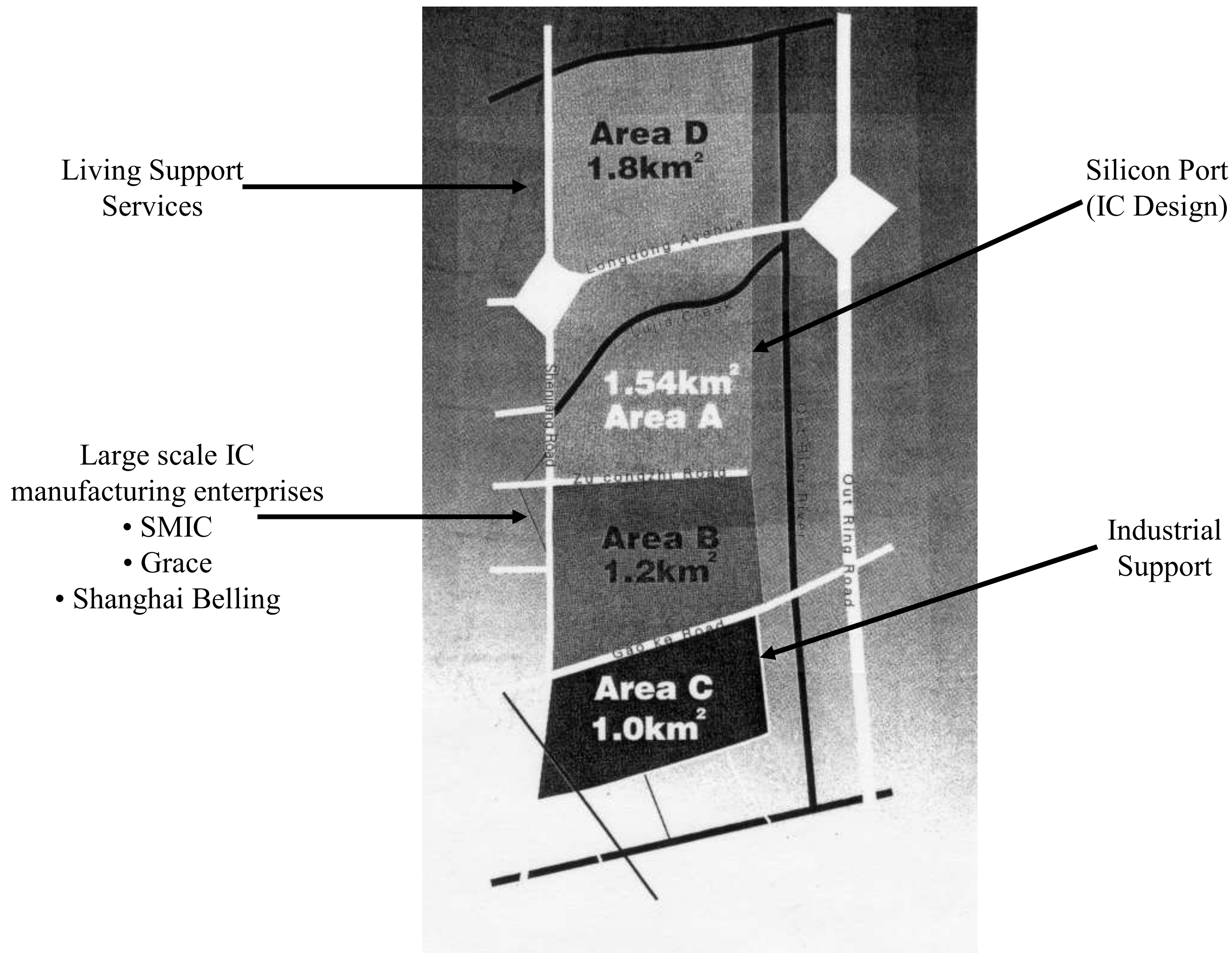
453 See Appendix 1.B.1.

454 Interview with officials of Shanghai Pudong New Area (Shanghai, September 2002).

455 Credit Suisse First Boston (January 11, 2002).

456 Interview with executives of China-Singapore Suzhou Industrial Park Development Co., Ltd., and China-Singapore Suzhou Industrial Park Administrative Committee (Suzhou, September 2002). According to the Park management, SIP has the best waste water treatment facilities in China; its treated water exceeds WHO 1993 drinking water standards, and its concentration of chlorine and fluorine is far below U.S. levels. SIP has built an entire network of pipelines supplying industrial gases, LPG and steam. It has oxygen storage facilities and specialized pipelines. Power is supplied through three separate transformer stations and 8 substations (2 220KV and 6 110KV). All power equipment is imported and brand named. 5 more 120KV and 6 110KV substations are planned. Suzhou Industrial Park, *Brief Introduction on Suzhou and Suzhou Industrial Park* (September 2002), p. 10; *China-Singapore Suzhou Industrial Park Facts and Figures* (July 2002).

Figure 28
Shanghai Zhangjiang Semiconductor IndustryPark (ZSIP) Pudong New Area



Source: SZIP (September 2002)

packaging firms. Attractive housing is being constructed, with markets and community centers, international schools, and recreational facilities. Lake Tai, which borders the park, has been meticulously landscaped and is popular with the community for leisure activities. There is no earthquake or flood risk. CS-SIP has an independent customs area, and an export processing zone. The "Suzhou International Science Park" is a much smaller area designated for IC design, biotechnology, and training inside the industrial park.[457]

- **Beijing's** Circular 2001-4 provides that the municipality "shall allocate the IC enterprises the land with "7 readiness and 1 flatness" (readiness of roads, water supply, drainage, electricity, communication, gas supply and heating supply) and flatness of land.[458] This policy is being implemented in the Beijing Economic Technology and Development Area's (BDA) Yizhuan Hi-Tech Park, where the Beijing Semiconductor Manufacturing Corporation's wafer fabs will be built. The BDA site will provide all of the infrastructural support for semiconductor manufacturing, and will locate IC design, packaging, test, assembly, materials and equipment firms adjacent to the fabs (Figure 29).

Forming a complete industry chain. A traditional source of Chinese weakness in semiconductor manufacturing has been the scarcity or absence of supporting upstream and downstream enterprises -- makers of semiconductor equipment and materials, and assembly, test, packaging, logistics and support firms. This longstanding problem is rapidly being addressed in Shanghai and Suzhou as world-class SME, materials, design, support and back-end processing firms are establishing operations in Zhangjiang Hi-Tech Park and the Suzhou Industrial Park (Figure 30). Taken together, ZSIB appears to be well on its way to achieving its goal of becoming "the biggest semiconductor manufacturer in the country" in 5-10 years.[459] Similarly, the Beijing Economic-Technical Development Area plans to establish a "complete industry chain" surrounding the new semiconductor foundries being established there.[460]

Other support services. A related impediment to the development of high-technology firms in China (and other developing countries) has been the lack of "business services" industries, such as legal advice, accounting, insurance, PR, and financial services. This shortage is particularly problematic in China, where rules are, in the words of one observer, a "maze."[461]

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457 Interview with China-Singapore Suzhou Industrial Park Development Co., Ltd., and China-Singapore Suzhou Industrial Park Administrative Committee (Suzhou, September 2002).

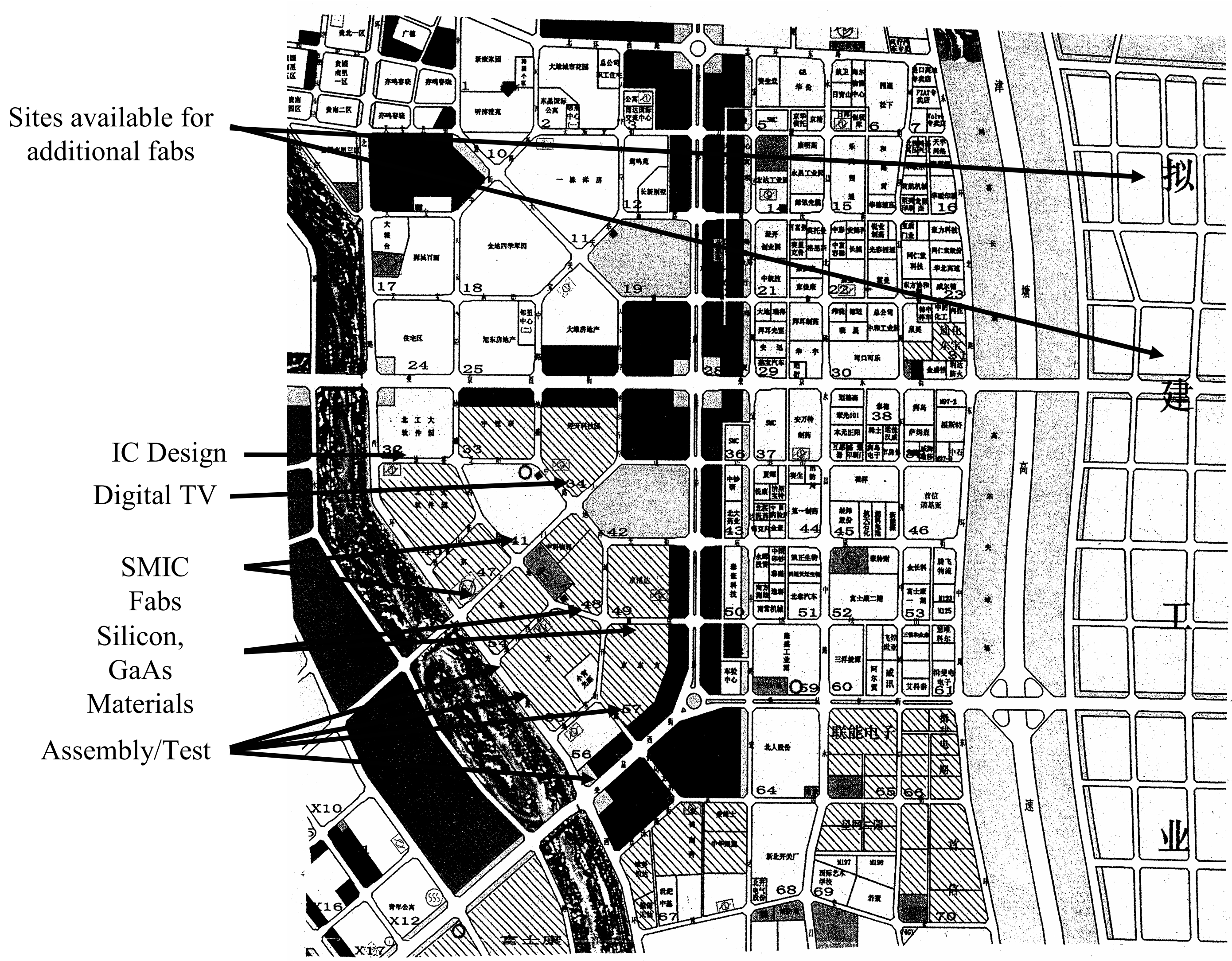
458 Beijing Circular 2001-4, Article 35.

459 Zhangjiang Hi-Tech Park, *Investment Guidebook*. Seven fabless IC companies are currently operating in the Zhangjiang Semiconductor Industry Base as well as, six package and test, five technical and support service companies (including Applied Materials) and six R&D centers, most of which appear to be affiliated with universities.

460 Interview with Beijing Economic - Technological Development Area (Beijing, September 2002).

461 "[Government benefits are helpful] but they don't make China an IC investor's paradise. While the [semiconductor manufacturing] hardware is being laid, there are still intangible obstacles hindering development, industry observers in China said. Foreign investors, especially small and medium-sized

Figure 29
Planned Semiconductor Cluster, Beijing
Economic-Technical Development Area (Yizhuang Zone)



Source: BDA (September 2002)

Figure 30

"Existing Semiconductor Industry Chain" in Shanghai Zhangjiang Semiconductor Industry Park (2002)

Fabless

- Integrated Silicon Solution, Inc.
- Huateng Microelectronic (Shanghai) Co., Ltd.
- Sunplus Technology Co., Ltd.
- Hualong Info. (Shanghai) Corp.
- Union Microsystems Technologies Co., Ltd.
- Magima Digital Information Co., Ltd.
- Shanghai Hua Hong (Group) Co., Ltd.

Wafer Fabrication

- Semiconductor Manufacturing International Corporation (SMIC)
- Shanghai Grace Semiconductor Manufacturing Corp.
- Shanghai Belling Corp., Ltd.

Packaging and Testing

- ACE Semiconductor Inc.
- Alphatech Electronics Corporation of Shanghai
- Sino IC Technology Co., Ltd.
- Global Advanced Packaging Technology (GAPT)
- Advanced Semiconductor Engineering (Shanghai) Inc.

R&D Centers

- Legend R&D Center
- Shanghai Fudon Microelectronics R&D Center
- Shanghai Institute, Zi'an Jiaotong University
- National Information Security Base
- R&D Center of University of Science & Technology of China
- Information College of Shanghai Jiaotong University

Technical Support and Services

- Applied Materials
- Towa Shanghai Representative Office
- Prax Air (Shanghai) Co., Ltd.
- Shanghai DEI Computer Co., Ltd.
- Novelius Systems, (Shanghai) Inc.

Source: Shanghai Zhangjiang Semiconductor Industry Park (2002)

To address this obstacle to semiconductor industry development, Chinese government programs have been established to provide "business services" to nearly every segment of the semiconductor industry. The Ministry of S&T's National Science and Technology Venture Capital Development Center provides financial support as well as "relevant business, management and marketing services for the projects of high technology results transformation [sic] which conform to the national science and technology industrialization policies."

E. Protecting intellectual property rights

Chinas has an extremely mixed record with respect to the protection of intellectual property rights. The government has enacted and refined patent, copyright, trademark, and layout design protection laws, and established institutions charged with implementing these laws, but enforcement has been patchy and in some case virtually nonexistent. According to the Business Software Alliance, for example, 92 percent of the software sold in China in 2001 was pirated, and other sectors, such as CDs and DVDs, have also been subject of widespread and relatively open pirating.[462] To date, piracy of semiconductor designs in China has been limited, but according to some observers, this only reflects the fact that until very recently an indigenous capability to copy complex western designs and process technologies did not exist. Intellectual property rights concerns are now increasing as Chinese technological levels close the gap with the global leaders. According to some reports Chinese firms are copying EDA (electronic design automation) software, which are used to design semiconductors, and are beginning to copy semiconductor designs as well.[463] Taiwan's TSMC is currently pursuing patent infringement litigation in Chinese court against SMIC for the alleged transfer of process technology by a former TSMC employee hired by SMIC.[464]

Under the terms of WTO accession, China was required to extend intellectual property protection to integrated circuit designs (masks). In 2001 the State Council passed the *Regulation on Integrated Circuit Layout Design Protection*, which generally conforms to the requirements of the WTO Agreement on Trade-Related Aspects of Intellectual Property (TRIPs). Chinese

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businesses, will face a maze of sometimes conflicting or unclear rules and regulations and an immature financial system through which to route their money, industry observers in China said." Cache of http://www.siliconstrategies.com/story/OEG20011004S0113. "China's drive for IC foundry market unnerves Taiwan," *Electronic Engineering Times* (November 4, 2001).

462 "You just have to take a few steps inside China -- across the border from Hong Kong into the Lo Wu shopping center that sits right on the Shenzhen border crossing -- to make your first acquaintance with China's legendary brand-name pirates. In seconds, you'll be bombarded with offers of fake Rolex watches, pirated CDs and above all computer software. Professional-looking bootleg Microsoft XP packages were available even before its official launch in Hong Kong." "Watching for Chinese Knock-offs," *Electronic Business Asia* (January 2003).

463 A number of known cases of semiconductor design piracy in China have occurred. "Watching for Chinese Knock-offs," *Electronic Business Asia* (January 2003). Byron Wu, a China-based senior analyst for iSuppli Corp., commented recently that "reverse engineering of semiconductors… by the Chinese is a growing problem." "Cisco Claims IP Piracy," *Electronic Business* (April 2003); "Terrorism Trumps Trade," *San Francisco Chronicle* (October 19, 2001).

464 "TSMC Says that Chip Piracy Won't Hurt China Plans," *Taipei Times* (December 4, 2002).

officials initially made comments which suggested an intention that the regulation will not protect discrete semiconductor devices, but later clarified in the WTO that discretes would be protected if they otherwise met the regulation's requirements.[465] A number of Chinese and foreign companies have begun to register integrated circuit designs under the new rules.[466] However, given the experience in other sectors, the most important question is not whether China can create legislation and institutions for protecting IPR in microelectronics, but whether it can and will adequately enforce the rules which it enacts.[467]

In testimony before the Office of the U.S. Trade Representative, SIA's Vice President of Public Policy, Daryl Hatano, stated that "SIA is aware of two cases [in China] where maskwork violations have occurred, one of which remains a problem and needs to be addressed."[468] In that instance, an SIA member company found that Chinese firms were making identical copies of its chips and data sheets, and selling them under the Chinese company's name. "Reverse engineering a chip to design an original and better product is allowed under the layout design laws." Hatano explained. "However in these cases the chips were essentially photocopies of the U.S. design, which we know because they included the U.S. company's part number etched in a submask level and unused circuits that the U.S. firm had placed on the chip to reserve space for future product development."[469] The Chinese firms that engage in piracy are typically thinly capitalized entities that contract the manufacture of the copied chips to foundries that can afford to make the necessary capital expenditures. Utilizing Chinese courts to pursue such cases is extremely difficult because the complaining entity needs to have a notarized statement from witnesses to the sale of the copied goods, and the sale must be to a "legitimate" customer and not a purchase made as part of an anti-counterfeiting investigation. "China's rules put an unreasonable burden on U.S. firms who must find purchasers of the counterfeit product and

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465 "Responses from China to the questions posed by Australia, the European Communities and their member States, Japan and the United States," World Trade Organization Council for Trade-Related Aspects of Intellectual Property Rights, IP/C/W/374 (September 10, 2002), p. 43. Testimony of Daryl G. Hatano, Vice President, Public Policy, Semiconductor Industry Association, before the Office of the U.S. Trade Representative (September 18, 2002).

466 Jerry Zhang, "Protection of Integrated Circuit Layout Designs in China," *China Law and Practice* (November 2001).

467 The Office of the U.S. Trade Representative commented in 2002 that "Although China has revised its IPR laws and regulations to strengthen administrative enforcement, civil remedies and criminal penalties, IPR violations are still rampant. IPR enforcement is hampered by lack of coordination among Chinese government ministries and agencies, local protectionism and corruption, high thresholds for criminal prosecution, lack of training and weak punishments." *USTR, 2002 Report to Congress on China' s WTO Compliance*, p. 35. "Unquestionably the main problem facing firms wishing to exploit intellectual property in China is enforcement." Keith E. Markus, Intellectual Property Rights in the WTO Accession Package: Ascending China's Reforms (Boulder: University of Colorado, unpublished monograph, December 16, 2002).

468 Testimony of Daryl G. Hatano, Vice President, Public Policy, Semiconductor Industry Association, before the Office of the U.S. Trade Representative, September 18, 2002.

469 Interview with Daryl Hatano, SIA Vice President of Public Policy, August 5, 2003.

convince those purchases to sign a statement that they bought the counterfeit goods," Hatano said.[470]

China's government and industry leaders appear to recognize that adequate protection of intellectual property rights is necessary if the country is to become a major manufacturing and design center for the semiconductor industry. Chinese government spokesmen and government publications frequently issue calls for the improvement of protections for intellectual property rights.[471] The example of Taiwan demonstrates that a country once known for extensive piracy of IPR can bring such activities under control through a combination of legislation, vigorous enforcement, and changing industry attitudes -- indeed one reason the foundry business model has succeeded in Taiwan is the fact that IPR protection has been established and enforced to a sufficient degree that foreign firms are prepared to share proprietary designs with Taiwanese foundries. Significantly the new Taiwan-invested foundries being established on the mainland are run by managers with long experience in western semiconductor companies where the importance of IPR protection is thoroughly understood. Daniel Wang, Executive Vice President of Grace Semiconductor Manufacturing Corp., observed in 2001 that

> *Most of the senior management in Grace at one point worked in the United States or in Taiwan, or other western countries where the concept of IP is very clear. It is very important for us to make sure that everything is protected.*[472]

However, with the proliferation of foundries offering manufacturing services in China, the danger still exists that some foundries will agree -- perhaps unwittingly -- to provide manufacturing services with respect to designs which have been pirated, perhaps by entities based outside of China. A U.S. electronics association executive observed in 2003:

> *If a China-based semiconductor company is building chips off pirated designs, they're innocent bystanders. Some of these back-alley [Chinese] operatives -- there's no way they are going to have these designs. Somebody's got to be feeding it to them. Not that this exonerates them, but there are non-Chinese partners feeding the system.*[473]

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470 Interview with Daryl Hatano, SIA Vice President of Public Policy, August 5, 2003.

471 Jiang Ying, Commissioner of China's State Intellectual Property Office, commented in 1999 that "I deeply feel that on the eve of the knowledge economy it is vital for the improvement of the investment environment and improvement of our state economy to enact a good Intellectual Property Rights (IPR) system and constantly perfect it." Interview in *Renmin Ribao* (November 25, 1999). Li Zhiyong, "IPR Protection is a Task that Brooks No Delay," *Renmin Ribao* (Communist Party Central Committee daily newspaper) (July 29, 2002); Cui Ning and Yu Yilei, "Nation Pledges Intellectual Properly Boost," *China Daily* (April 27, 2002).

472 "Can China's Fabs Be Trusted to Play Fair?" *Electronic News* (July 9, 2001). See also Office of U.S. Trade Representative, *2001 National Trade Estimate Report on Foreign Trade Barriers*, p. 55.

473 Kitty McKinsey, "Watching for Chinese Knock-offs," *Electronic Business* (January 2003).

If the massive expansion of foundry facilities now under way in China culminates in an excess capacity, the foundries will confront powerful economic pressures to accept manufacturing contracts from the widest possible customer base, enhancing the prospect that pirated designs will be produced.

In short, the extent to which China will succeed in establishing effective IPR enforcement with respect to semiconductor technology remains unclear. The government appears to be committed to this objective, recognizing the nexus between IPR protection and the success of its long range promotional efforts in this sector. Its ability to implement the necessary levels of protection remains to be tested.

F. Improving human resources

China's ambitious plans for its semiconductor industry will require enormous numbers of skilled semiconductor professionals. According to some estimates China will need 50,000 "IC professionals" to support its planned semiconductor manufacturing operations and "up to 250,000 IC design engineers." At present only about 1,500 students of microelectronics graduate each year from China's universities, and at present "there are only 4,000 professionals working in the industry and available for hire."[474] Moreover, a recent Chinese analysis concluded that the quality gap between these 4,000 individuals and their U.S. counterparts was "wide."[475] The Taiwanese-invested foundries being established in mainland China are incurring substantial costs in order to bring in expatriate managers, engineers, and production workers, because not enough of indigenous Chinese with the requisite skills are available.[476] Rapid turnover of the limited number of skilled personnel is an added operational impediment.[477] The root causes of this problem include China's educational system, which "does not emphasize creative thinking and problem-solving skills," lack of applied work experience by professors teaching semiconductor design, and poor working conditions at many semiconductor-intensive locations.[478]

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474 Lui Baijia, "IC Professionals Badly Needed," *China Daily* (February 10, 2003).

475 Cao Hongyan, "China's Integrated Circuit Industry: Urgent Call for High Level Design Talent," *Keji Ribao* (February 21, 2002).

476 Interviews with SMIC and Grace executives (Shanghai, September 2002).

477 Turnover among employees has been identified as a serious problem for Beijing's Zhongguancun Science Park (ZSP). A recent CCID report concluded that highly skilled personnel are leaving the ZSP at more than half the rate the Park is attracting new talent. Among the problems identified are high commuting times and lagging salary levels, with the workers leaving for similar jobs in "Shanghai and other well-developed areas," recently deregulated sectors, and abroad. CCID notes that Japanese companies are particularly affected by the personnel turnover "headache" because of the Japanese corporate culture, which favors lifelong employment and loyalty.

478 As one industry journal summarized the problem: "the next challenge [Shanghai] faces is finding enough experienced engineers who can guarantee high-yield rates on the production lines. To build such a large number of fabs over the next five years would work from a water or electricity standpoint, but "people are the key issue," said Toshio Ohta, executive vice president of Hua Hong NEC. "Good training is key. If an operator made a mistake on the equipment, it could be a disaster. We could lose big money," Ohta said. "If such a large number of fabs are constructed in the same period [in China], how can we train enough

China's current promotional effort features a broad panoply of initiatives to address the shortage of skilled manpower. New incentives are being offered to attract foreign personnel and returning Chinese with semiconductor-related skills. Education and training programs are being upgraded and expanded. Tax policies similar to those of Taiwan are being put in place which make it possible for successful innovators and entrepreneurs to amass substantial wealth in a relatively short time frame. Finally, a potentially major contribution to China's pool of skilled manpower will be made by Taiwanese who relocate to China not as temporary expatriates, but as permanent residents.

1. ***Incentives for foreign-trained personnel.*** China's Tenth Five Year Plan calls for increased efforts to "bring into the country technical and managerial professionals" in the IT sector, emphasizing semiconductors in particular, and regional and local governments have promulgated and array of incentives to attract qualified personnel from abroad.[479] Beijing, for example, offers residency status to "returned Chinese scholars and scientific research and managerial personnel needed for the development of Zhongguancun Science Park, as well as permanent Beijing residency for their families and schooling for their children."[480] Special funds are set aside from the municipal budget to provide "financial subsidies for purchasing personal residence or car for the first time" for personnel in the software and integrated circuit industries.[481] Awards "in the form of stock equity" are to be given to scientific and technological personnel and business managers who "make outstanding contributions to the growth of the enterprise."[482] Special rules provide that individuals who contribute to development of successful products receive a percentage of the profits ultimately generated.[483] Zhongguancun has established incubators for returned students totaling over 140,000 square meters, and a special

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people to maintain these fabs?" High-quality fab managers are also reported to be in short supply. Cao Hongyan, "China's Integrated Circuit Industry: Urgent Call for High Level Design Talent," *Keji Ribao* (February 21, 2002).

479 Tenth Five Year Plan Section 3.6.4. Foreign-trained professionals include both returning Chinese students who have completed undergraduate and graduate degree programs abroad, and foreign-born and educated people -- many of them ethnic Chinese -- who are attracted to opportunities in China. As of mid-2002 approximately 130,000 Chinese-students who had completed studies overseas and, in many cases, gathered work experience had returned to China, fostering a new phrase, "haiguipai" (returned overseas generation). More than 60 percent of the more than 160 engineers who work at the China Integrated Circuit Design Center (the lead entity of the "909 Project") were trained or have worked outside of China. http://www.cidc.com.cn/English/1.htm . "China Sees Growing Tide of Returning Talent," *Xinhua* (07:12 GMT, June 28, 2002).

480 Regulations on Zhongguancun Science Park, Article 32.

481 *Proposals of the People's Government of Beijing Municipalities for the Implementation of Some Policies of the State Council on Encouraging the Development of Software Industry and Integrated Circuit Industry* (No. Jing Fa 2001:4), Article 18.

482 *Notice of the Economic Restructuring of the People's Government of Beijing Municipality and Beijing Municipal Bureau of Finance Concerning the Circulation of the Procedures of Stock Option Award Experiment in Hi-tech Enterprises Based in Zhongguancun Science Park* (No. Jing Zheng Tigai Fa [2001] 30), Article 3.

483 *Notice of the Beijing Municipality Concerning the Circulation of the Rules on Further Facilitation of the New and High Tech Industries* (No. Jing Zheng Fa [2001] 38), Article 9.

fund was established in 2001 to provide the returnees with rent support and capital. Such measures are cited as an important factor in Zhongguancun's attraction for the 1,546 enterprises -- 10 percent of the total in the Park -- which have been established by returned overseas students.[484] During the first nine months of 2002, an average of two new enterprises per business day were being established in Zhongguancun by returning Chinese students.[485]

2. *Increased domestic education and training.* Chinese universities and research organizations are stepping up their training programs for semiconductor designers and engineers. China's Ministry of Education is planning to establish five "IC Colleges" in the country which will function as "IC professional training centers," established with assistance from U.S. universities and multinational corporations.[486] In Shanghai, Fudan University and the Shanghai Integrated Circuit Design and Research Center (ICC) are establishing their own training organizations.[487] Beijing's Integrated Circuit Design Park, involving an investment of over $60 million, is being established, in significant part, as a training institution.[488]

Beijing's elite Tsinghua University (where electronics engineering and software engineering are the most popular courses) has sent generations of graduates to the U.S. Silicon Valley, where many of them have started businesses, and Tsinghua graduates "represent possibly the best-connected network of foreign entrepreneurs and engineers in Silicon Valley."[489] Tsinghua's profile in China increasingly resembles that of a U.S. research university in a high technology area. Tsinghua "just about requires" that its instructors also establish venture companies. An admiring Japanese observer commented in 2001 that

> *A structure [like Tsinghua's] that is premised not merely on academic pursuits but expansion into an industry is close to that of America's Stanford University, which plays a leading role in Silicon Valley.*[490]

Foreign firms are playing an increasing role in training. In May 2003 the U.S. firm Agilent Technologies and Shanghai's highly-regarded Fudan University announced the establishment of the opening of the "Fudan and Agilent Joint IC Testing Education Center" in

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484 Liu Jie, "Back Home for Business," *China Daily* (04:04 GMT, January 2, 2003).

485 "Students Returning from Abroad Set Up More Firms in China's Silicon Valley," *Xinhua* (06:33 GMT, October 30, 2002).

486 The first IC college is being jointly established by Via Technologies of Taiwan, Florida International University of the U.S., and the Beijing University of Aeronautics and Astronautics. Liu Baijia, "IC Professionals Badly Needed," *China Daily* (February 10, 2003).

487 Cao Hongyan, "China's Integrated Circuit Industry: Urgent Call for Design Talent," *Keji Ribao* (February 21, 2002).

488 "IT Businesses Move Into Beijing," *China Daily* (April 30, 2002).

489 Junko Yoshida and George Leopold, "China's Top Grads Invigorate to the Valley," *Electronic Engineering Times* (August 13, 2001).

490 "Special Projects -- Part One -- Industry, Government and Universities United in Enthusiasm and Talent for LSIs and then LCDs," *Nikkei Microdevices* (March, 2001).

Zhangjiang High-Tech Park, which will provide "systematic IC testing training to both new and experienced engineers." The Center will serve over 60 adjoining IC design houses, foundries, and packaging and test houses. The Center's curriculum will include semiconductor testing fundamentals, testing product, and applications training.[491] In August 2003 Agilent disclosed it would establish an SOC Testing Education Center and an SOC Testing Engineering Center in Beijing, which would "[cultivate] more talented people."[492]

3. *Tax incentives to individuals.* One of the advantages that Chinese state-owned semiconductor entities will enjoy as they transition from status as government departments and institutes to publicly traded corporations is the ability to offer employees stocks and stock options -- in other words, to offer individuals the possibility of benefiting directly from the success of the enterprise. This policy was established in the Tenth Five-Year Plan, in which entities are directed to "encourage the inclusion of capital and technologies in the rationing of revenue, introduce bonus and share [stock] options to the remuneration of company directors…"[493]

Stock options and stock given as compensation are taxable as income under Chinese tax law. However in practice they are frequently not taxed. Stock and options are commonly given as bonuses rather than as regular income and have proven difficult for Chinese tax authorities to track. A common practice is for companies to issue stock to employees as bonuses which is held by the company in an account on the employee's behalf. At some point the employee may opt to "cash out" this stock and is simply paid a lump sum in cash by the company equivalent to the value of the stock in the account, which then reverts to the company. Notionally the employee should report this cash payment as income and pay tax on it, but commonly this does not occur. Employees who have acquired stock as compensation (whether or not they pay tax on it) may sell shares of stock which have appreciated in value without paying tax on the marginal gain.[494]

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[491] Agilent Technologies and Fudan University School of Microelectronics Open IC Testing Education Center to Train Engineers for China's Booming Semiconductor Industry," *Business Wire* (May 27,2003).

[492] Chen Zhiming, "Centres Set Up to Develop Semiconductors, " *China Daily* (August 21, 2003).

[493] Tenth Five Year Plan Section 3.6.4. An example of this policy in practice is Fudan Microelectronics, which was launched as a corporation in 1998 using the facilities and personnel of the Fudan University national laboratory. The new entity was listed in an initial public offering on the Hong Kong Growth Enterprise stock exchange. As *Electronic Engineering Times* noted, "The successful public offering not only showed the value of Fudan but also has helped Chinese companies attract top design talent by offering stock options. 'We know people are the most important factor in this industry,' said Yu Jun, deputy general manager of Fudan Microelectronics." *Electronic Engineering Times* (October 4, 2000).

[494] There is no capital gains tax in China and none is planned or likely because such a tax might impede the development of Chinese securities markets. *ChinaOnline* (April 8, 2002). Chinese tax law treats as taxable ordinary income profits gained from the sale of "property." Arguably the sale of stock constitutes disposition of property and is therefore taxable, but in practice, profits on the sale of stock are not generally taxed. Mukesh Butani of the accounting firm Ernst & Young stated in June 2003 that China does "not levy tax on both long and short term capital gains from sale of securities, even though [it levies] tax on gains from other capital assets." "Do We Need a Long Term Capital Gains Tax?," *Business Standard* (June 18, 2003). Other accounting firms suggest that at least under some circumstances such gains may be taxable. In any event the common practice by individuals receiving stock as compensation is simply not to report

The Hi-Tech Parks often offer their own tax incentives to individuals. The Beijing Economic-Technological Zone (BDA), where BJSMC is building a wafer fabrication plant, will refund the local portion of the income tax of an individual with a high-tech job in the park as a credit against the purchase of a house or a car. The local share of total tax varies from year to year but in 2002 was 75 percent of total individual income tax liability.[495] Such refunds are a form of unpublished tax benefit that vary from case to case, depending on factors such as the level of technology associated with the individuals' work and the size of the enterprise at which they are employed.

G. Addressing China's weakness in design.

While China is rapidly expanding its semiconductor manufacturing capacity, its weakness in semiconductor design is lamented by virtually every government official and industry representative who discusses the present state of China's semiconductor industry.[496] The Tenth Five Year Plan observed that China's indigenous development of components under the Ninth Five Year Plan was "backward."[497] Neither Grace nor SMIC plan to produce significant numbers of indigenous Chinese designs or to rely heavily on Chinese design organizations in their initial phase of operations, although they expect to be able to do so as Chinese capabilities improve.[498] The number of Chinese IC design firms has more than doubled since 2000, but from a very small base of 100 to about 300. While these entities are "sprouting like bamboo shoots after a rain, there is an acute shortage of design personnel, particularly high-level design engineers." As a result, some new IC design firms "have registered and even hung out their signs," but cannot find engineers, with the result that a "nasty struggle" has developed between design firms for scarce talent. Most of the IC design firms which do exist in China lag behind the global state of the art.[499] A Shanghai Municipal Government official overseeing the development of the local semiconductor industry observed in 2001 that IC design was the weak link in Shanghai's promotional plans for the industry.[500]

China's strategy with respect to design places heavy emphasis on attracting design firms and design centers from overseas, as well as individual designers who have worked or studied

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the income. When China eventually clarifies the tax status of profits derived from the sale of securities, it is likely to rule that such capital gains are not taxable, following the practice at Taiwan and Hong Kong.

495 Interview with BDA Administrative Committee (Beijing, September 2002).

496 Most original Chinese designs are for ASICs, MCUs, DSPs and power supply management ICs for use in communications systems and consumer electronics products. Lisa Lafoya, "Issues to Consider When Putting China in Your Business Plans," *Solid State Technology* (February 2003).

497 http://www.trp.hku.hk/infofile/china/2002/10-5-yr-plan.pdf.

498 Interviews with senior executives at SMIC and Grace, Shanghai (September 2002) "China's Mircochip Juggernaut Slowed by Road Bumps," *Reuters* (April 26, 2002).

499 Comments of Cao Hongyan in "China's Integrated Circuit Industry: Urgent Call for High-Level Design Talent," *Keji Ribao* (February 21, 2002).

500 Ying Zhigang in "Shanghai Boosts IC Sector," *China Daily* (January 8, 2001). See also "Lack of Design Centers in China Reported," *Tokyo Semiconductor FDP World* (June 1, 2001).

overseas who can start new design firms in China.[501] Chinese government entities and the administrators of the special zones are establishing IC design centers and incubators which offer to provide infrastructure, expertise, capital and connections for established and start-up design firms. IC design incubators and design parks are being established in the Hi-Tech Parks and ETDZs in Shanghai, Beijing and elsewhere. While some incubators consist of nothing more than a building offering low rent to start-up design firms, the more sophisticated ones provide a full array of support services and preferential measures. These include:

- Use of EDA and other design tools at very low cost, sparing start-up entrepreneurs the cost of purchasing such systems;
- Management training, which is provided free or at low cost;
- Assistance in arranging venture capital, government subsidies, and bank loans;
- Introductions to potential customers and other key relationships essential for the success of a start-up.[502]

1. ***Regional promotional programs.*** Regional governments are establishing or expanding significant IC design centers. A leading example is the Beijing IC Design Park, located in Zhongguancun Science Park's Haidian Zone. Capitalized by the Beijing municipal government at 500 million RMB, roughly a dozen IC design companies were operating in the Park in mid-2002. The "Park" itself is actually a single high-rise building in which IC design houses are located. It is operated by a government-owned development corporation, Beijing IC Design Park, Ltd., and was created to provide support services and infrastructure for IC design houses.[503] The Park provides lower than normal rents for companies that locate in the building. It makes Electronic Design Automation (EDA) tools available to design firms in the Park -- an indispensable system which would cost several millions of dollars to acquire, but which is available in the Park for much less (about $100 thousand).[504]

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501 In 1998, the Ministry of Education created SCOBA, an organization which consists of Chinese specialists in high-tech industries in Silicon Valley. CCID sponsors exchanges between SCOBA and Chinese companies and some SCOBA members have returned to start their own firms in China, which typically receive the whole array of government support programs targeted at the IC design sector in particular. http://www.incubase2000.com/en/index.htm.

502 Interviews with Investment Service Department, Shanghai Zhangjiang Hi-Tech Park Investment Service Center (Shanghai, September 2002); executive of Beijing IC Design Park Co., Ltd. (Beijing, September 2002).

503 The Beijing IC Development Corp. is owned and funded by the Municipal Government of Beijing's State Assets Management Corp. It operates at cost and does not make a profit from providing services to design houses in the Park. The Development Corp. does not yet have its own affiliated venture capital company (it is preparing to launch one), but it serves a liaison function to broker deals between venture capital companies and design houses in the Park. Interview with executive of Beijing IC Design Park, Co., Ltd. (Beijing, September 2002).

504 Interview with executive of Beijing IC Design Park, Co., Ltd. (Beijing, September 2002).

Using Shanghai's National IC Design Center as a nucleus, the municipal government of Shanghai has built a 1,000 employee IC Center ("ICC") with an initial investment of $12 million and a total planned investment of $130 million over five years.[505] The Park includes:

> *215,000 square feet of office space with low rents. ICC will also offer amenities designed to attract startups, including facilities equipped with the latest tools, workstations and test equipment that can be rented at low cost. ICC officials said companies moving to the park would receive favorable treatment from the government… .*[506]

Regional governments also provide direct funding to private IC design firms. The Shanghai ICC, for example, commits funds to individual projects with commercial promise.[507] The Pudong New Area administration has an S&T fund at its disposal of roughly 100 millon yuan which is used, among other things, to fund the development of proprietary semiconductor designs by local enterprises.[508] Beginning February 1, 2002, IC design entities in Beijing were eligible for direct R&D funding from a "special fund" established by the Beijing municipal government.[509]

2. *Spinoff of government research institutes.* An important element in the rise of Taiwan's semiconductor industry was the privatization of pieces of the government-owned institute of applied electronics research, the Electronic Research and Service Organization (ERSO).[510] Chinese planners have come to realize that the Chinese IC design industry's heavy governmental orientation is a serious weakness. A Chinese venture capital executive commented in November 2001 that

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505 *Electronic Engineering Times*, in an October 4, 2000 article, put the figure at $15 million.

506 "China to Fund IC Design Complex," *Electronic Engineering Times*, March 8, 2000.

507 The vice director of [Shanghai's] ICC, Mr. Wangye, commented that, "If it is a good thing, we will do it and made regulation time by time. Based on the spirit of hard work, since the establishment of ICC, we have invested 14 million Yuan RMB to 47 projects. The technology service saves 20 million Yuan RMB and we provide 1000 professional staff. All these effectively promote the development of IC industry of Shanghai." http://www.bjic.org.cn/english/01zttq/2001huiyi/013.html.

508 Interview with Shanghai Zhangjiang Hi-Tech Park Investment Service Center (Shanghai, September 2002).

509 "The IC Design and Development Fund totals 70 million RMB each year, and use time is limited to 3 years. 30 million RMB comes from the city economic committee, 20 million comes from the city science committee, and 20 million comes from the Zhongguancun S&T park management committee." It appears from the Fund's regulations that the disbursements are outright grants, with no requirement for repayment or the provision of ownership rights back to the fund or any other government agency. "Beijing IC Design and Development Special Project Fund Management and Use," North Microelectronics Industrial Base Portal, sponsored by Beijing Semiconductor Industry Association (http://www.bjic.org.cn/02zcfg/23.html), 28 December 2001.

510 UMC, now one of the world's two most successful foundry operations, was created in 1980 by spinning off a large segment of ERSO's staff and equipment. Other ERSO spinoffs include Taiwan Mask Corp., EMT Systems Corp. and the Electronics Testing Center. Many of Taiwan's semiconductor design houses were started by ERSO engineers moving into the private sector. Mead Ventures, *Taiwan Semiconductors Report 1990*.

We have also seen the challenges [in finding commercial Chinese investments]. The difficulties are bigger than we imagined. [One reason is that] IC design companies in China today are oriented not toward the market but toward the government. They are unable to commercialize their research results, but can only use them to apply for government subsidization. This has no practical significance.[511]

As a result, the Chinese government is now beginning to emulate Taiwan, spinning off pieces of the state-owned electronics research and manufacturing complex into private enterprises.[512] The Chinese Academy of Sciences (CAS), which owns China's principal semiconductor research institutes, is planning to allocate greater resources to some of its more successful, commercial oriented organizations and convert them into stand-alone companies -- in effect, entire CAS institutes and laboratories are being transformed into corporations in which the government's stake will be progressively reduced.

A prominent example of this policy is the China Integrated Circuit Design Center (CIDC), which was preparing in late 2002 to spin off much of itself as the "Huada Electronic Design, Inc., Ltd." The CIDC was established in Beijing in 1986 at the first state-owned IC design house in China. It subsequently achieved stature as one of the foremost IC design organizations in China.[513] The spin-off, Huada, will concentrate all of CIDC's best, most commercially valuable assets in the new corporate entity in preparation for an initial public offering. All commercial properties of CIDC will be transferred to Huada, with CIDC retaining its design capabilities. The Chairman and CEO of CIDC, Wang Qin Sheng, is becoming the Chairman of Huada. Initially CIDC will hold 70 percent of the shares of Huada and employees 30 percent, but these percentages will be diluted as additional shares are sold to private foreign investors, who are eventually expected to hold 25-30 percent of the shares. An IPO in Hong Kong -- when such an initiative is feasible -- will further dilute the CIDC and employee shares.[514]

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[511] Translation of http://www.authosis.com/IC%20VC.ht."'IC'faces "VC' [venture capital] 15 Nov 2001, China Science and Technology Information (an interview with two of the founders of Authosis).

[512] CAS hold a large share in several of China's leading semiconductor companies and owns a large portion of China's IC-consuming electronics industry through such companies as Legend Holdings, which is a major owner of Legend, China's largest PC firm.

[513] The lead lab for the "909" project, CIDC employs 180 people, over 160 of whom are engineers, 35 with PhDs. CIDC was intended from the outset to operate like a commercial enterprise and design marketable products, in contrast to the activities of university and government laboratories. CIDC developed three generations of indigenous IC design tools, Panda, Panda 2000, and Zeni, as well as roughly 400 IC designs. Most of its designs have been for Chinese customers, with an emphasis on consumer and white goods applications and circuits for IC cards. CIDC is a subsidiary of CEC, which holds a 100 percent stake. It is part of the Zhongguancun Science Park. http://www.cidc.com.cn/English/1.htm; Interview with executive of Huada Electronic Design Inc. Ltd. (Beijing, September 2002).

[514] Interview with executive of Huada Electronic Design Inc. Ltd. (Beijing, September 2002). Similar spin-offs have occurred or are under way in Shanghai. Shanghai Fudan Microelectronics Co. Ltd. was established as a "fabless" design company in 1998 by Shanghai Commercial Investment Company and the "ASIC & System State-Key Laboratory" of Fudan University. The company is now publicly traded on the

Beijing's Institute of Computing Technology is a research institute administered by the Chinese Academy of Sciences (CAS). In 2002 the Institute spun off the BLX IC Design Corp. Ltd., which has been concentrating on designing semiconductor logic devices. It designed a 32-bit microprocessor in 2002, "Godson-1," and will circulate samples of a 64-bit microprocessor, Godson-2, in early 2004. BLX is moving "quickly to rally domestic industry support around the Godson architecture, launching an alliance that intends to attract 100 members and create 100 designs within two years."[515]

3. *Foreign IC design centers.* China has succeeded in attracting a significant and growing number of design centers established by semiconductor multinationals and substantially staffed with Chinese scientists and engineers.[516] NEC, for example, established an IC design joint venture with a Chinese venture capital firm under the name Beijing Hua Hong NEC IC Design Co. Ltd., with a staff which totaled 150 people as of mid-2002.[517] Motorola recently established an IC design center in the Suzhou Industrial Park employing 70 senior semiconductor professionals from various parts of China, most of whom hold advanced degrees.[518] Foreign firms are motivated by a variety of considerations, which include the need for a local presence to develop products tailored to China's market demands, the expectation that China will evolve as a source of design talent, and the availability of incentives offered by the national and local governments.[519] The presence of these design centers in China inevitably "foster[s] local technological advancement."[520]

Hong Kong exchange. The company has an engineering staff of about 40 professional designers. http://www.fmsh.com/r-aboutuse.html.

515 Alliance members include Great Wall Software and Red Flag Linux. "Startup Crafts China's First 64-bit MPU," *Electronic Engineering Times* (March 10, 2003).

516 A number of foreign design houses run by overseas Chinese have recently began operations in the Shanghai area, including ESS, Silicon Storage Technology, and Trident. Toshiba recently announced plans to transfer "hundreds" of its IC designers to China. Infineon reportedly plans to increase its workforce of designers in China to 1000 engineers over the next several years. Paula Doe, "Downturn Pushes China Foundries Toward Smaller Geometries, More Emphasis on Service," *Solid State Technology* (April 2002); Mike Clendenin, "Sees No Reason to Bar Export of Advanced Chip-Making Equipment -- Infineon CEO Backs Tech Transfers to China," *Electronic Engineering Times* March 3, 2003).

517 "Semiconductor Fabs Flock to Shanghai," *Nikkei Asia Biz Tech* (May 2002).

518 "Transnationals Companies Locate More Research, Development Centers in PRC," *Xinhua* (06:16 GMT, Mach 29, 2003).

519 "By locating their research and development centers in China, most transnational firms… aim to draw elite local professionals who will contribute tremendously to their business development," *Xinhua* (06:16 GMT, March 19, 2003).

520 Ibid. "Few engineers are being hired in China to do intensive R&D work but engineers still are gaining valuable experience that may help the launch their own companies. The 20 or so engineers who work at TI's Shanghai [wireless integration R&D] center are gaining systems knowledge as well as project management skills-expertise that many Chinese engineers still lack. And returning Chinese expatriots are bringing home know-how for turning ideas into cash." Mike Clendenin, "Homegrown Talent Works to Dismantle Obstacles to China's Progress -- Huge Nation Girds for Great Leap," *Electronic Engineering Times* (January 13, 2002).

According to some observers China is already making noticeable progress in improving its capabilities in semiconductor design. A survey on comparative Taiwan/China IC design capabilities conducted in 2002 by Gartner Dataquest and the *Electronic Engineering Times-Asia* concluded the "China doubled its IC design speed in six months and was making remarkable progress in its Application Specific Integrated Circuit (ASIC) design capability."[521] China was generally seen as rapidly gaining on Taiwan with respect to the IC design process -- "in the last two years we have seen how fast the (design capability) gap is narrowing."[522]

H. Addressing the "red tape" problem.

China's excessive bureaucracy and complex regulatory environment have long constituted a barrier to inward foreign investment and a drag on the development of high technology industries.[523] The new developmental effort in microelectronics features central government measures designed to cut through red tape as well as the establishment of new organizational structures at the local level to expedite regulatory decisionmaking and approvals. Circular 18 provides with respect to the IC industry that "relevant departments shall step up their examination and approval according to procedures."[524] Customs houses are directed to provide "customs-clearance convenience" to qualifying IC manufacturing firms. IC design firms are made eligible for special benefits available to software companies, which include more flexible administration of foreign exchange rules so that the needs of enterprises "to engage in international commercial activities can be fulfilled;"[525] country entry and exit procedures for high level managers and personnel will be simplified and "valid dates shall be moderately extended."[526] Shanghai has now established a "one stop shop" office in its Foreign Economic Relations and Trade Commission which provides all necessary approvals for foreign-invested start-ups on an expedited basis. Shanghai is implementing new arrangements for expediting

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521 Nancy Wu, Gartner Dataquest, cited in "Taiwan Analysts Say China Narrowing Gap in IC Design Capability," *Taiwan News* (October 2, 2002).

522 Gary Smith, Chief Analyst, Gartner Dataquest, cited in "Taiwan Analysts Say China Narrowing Gap in IC Design Capability," *Taiwan News* (October 2, 2002).

523 Foreign companies establishing business operations in China encounter a welter of complex and confusing approval requirements that constitute a significant initial impediment to market entry. These include, among other things, the need to obtain a business license (valid for only 3 months), to secure approvals from tax, foreign currency control, customs and finance agencies, and a capital verification report certifying that required initial capital has been deposited in a designated financial institution. In Shanghai, before reforms were undertaken, foreign investors were required to secure multiple approvals needing "over 100 chops" from officials on their documents. Even after a business was up and running, bureaucratic obstacles such as slow customs, clearance of imported equipment, semifinished goods and materials constituted significant operational impediments. Andrew Lee and Michael D. Smith, "Doing Business in China: Potential Outweighs Obstacles," *Solid Sate Technology* (August 2002); interview with official of Approval and Administration Department, Shanghai Foreign Economic and Trade Commission (Shanghai, September 2002).

524 Circular 18, Article 40.

525 Circular 18, Article 16.

526 Circular 18, Article 15.

customs clearance for semiconductor related reports.[527] Local officials cite with satisfaction the fact that

> *Because the review and approval links have been streamlined and government services are in place, the SMIC integrated circuit project that had a total investment in excess of $1.5 billion took only 13 months from the time work started to completion and being put into operation, setting a world record for the construction of a production line of that type.*[528]

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527 In Shanghai, a round-the-clock appointment-making system is being set up at the Customs, the entry and exit control and quarantine control, the airport, etc. with a special fast-service customs-declaration window for export and import goods of integrated circuit enterprises and with a "10 hour or less" convenient service for picking up or sending out goods. Shanghai Circular 51, Article 23 (January 2001).

528 "China's WTO Accession Once Again Place Pudong Area at Forefront of Participating in International Cooperation," *Xinhua* (00:41 GMT, May 4, 2002).

VI. CONCLUSION AND RECOMMENDATIONS

Maintaining U.S. leadership in microelectronics is critically important to the economy and national security of the United States. The development of a modern semiconductor industry in China will not pose a national security threat to the United States or competitive threat to the U.S. semiconductor industry in the foreseeable future. However, over the longer term, the prospect exists that China's growing "gravitational pull" will draw capital, people, and ultimately, leading edge R&D and design functions away from the United States as China is now doing with respect to Taiwan. Government policy measures in any country or region which induce significant migration of the U.S. microelectronics infrastructure -- capital, enterprises, individuals -- warrant careful scrutiny by U.S. policymakers. Several aspects of China's current developmental effort in microelectronics are problematic because over time they could erode the U.S. microelectronics infrastructure and contribute to an eventual loss of U.S. leadership in this field. The U.S. needs to identify and implement a series of appropriate responses.

China's discriminatory Value-Added Tax (VAT) regime should be revised by lowering the VAT on imported semiconductors, and China should increase enforcement of its intellectual property laws. China's current VAT policy creates a discriminatory preference in favor of domestic products and against imported products in a manner which is inconsistent with Article III of the General Agreement on Tariffs and Trade (GATT), the principal WTO agreement. China's use of a WTO-inconsistent measure to attract semiconductor investment that would otherwise take place elsewhere is a matter of serious concern. The U.S. government should raise the VAT issue with China and insist that China eliminate the discrimination against imported semiconductor devices by lowering the VAT on imports. China has passed many of the intellectual property laws required by the WTO, but enforcement remains problematic. The U.S. government should encourage China to set up a fast track enforcement mechanism for semiconductor intellectual property violations, and to review its court procedures to eliminate bureaucratic barriers to enforcement.

The U.S. government needs to increase spending on basic microelectronics R&D. A country's success in international semiconductor competition depends in large part on its ability to attract and retain the most talented entrepreneurs, engineers, and researchers in the field. The United States has traditionally been the world leader in this respect, but it is now being challenged by other countries. China and Taiwan are offering tax and other incentives to individuals in the microelectronics field and are encouraging overseas students and graduates to return, such as support for establishing a new business. They are not the only countries to do this, but have enjoyed the greatest degree of success. While the migration of a considerable number of talented people to China and Taiwan is inevitable, it is not in the interest of the United States to lose its leadership as a desirable location for leading talent in the microelectronics field to any other country or region. The U.S. government may not be able to match some of the incentives being offered by other countries, but through increased federal spending on cutting-edge microelectronics R&D, particularly in the universities, it can ensure that the U.S. remains fully competitive in the intensifying global struggle over the limited pool of sophisticated talent. One specific action that can be taken is to implement the recommendations of the National

Research Council's Board on Science, Technology and Economic Policy, including increasing Defense Department funding for universities working through the semiconductor focus center research program.[529]

The U.S. needs to develop policy responses to foreign tax holidays which are inducing inward foreign investment. China is replicating Taiwanese policies which virtually exempt semiconductor firms from payment of corporate income tax. Such tax rules were a primary factor underlying massive semiconductor investments in Taiwan in the 1990s and are now being implemented in China. While it is virtually inconceivable that the United States would match such policies, the fact remains that differences in national tax policies are becoming an important factor underlying locational decisions in the semiconductor industry, and absent a U.S. policy response, such differences will increasingly determine where semiconductors are designed and produced. Affirmative Federal government policy measures, coupled with aggressive state economic development efforts, are needed.

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529 NRC, *Securing the Future: Regional and National Programs to Support the Semiconductor Industry*, 2003, p. 89.

APPENDIX 1

CHINA'S PRINCIPAL INSTITUTIONS OF INDUSTRIAL PROMOTION IN MICROELECTRONICS

China's promotional efforts in microelectronics are implemented at three levels of government -- national, provincial, and local (municipal/district/county), with the secondary and tertiary governmental entities augmenting, refining and occasionally overreaching the broader guidelines established at the national level. The municipalities of Beijing and Shanghai have second-tier (provincial) status. Broadly speaking, the national government articulates policies of general application that will affect the semiconductor industry in a relatively uniform basis nationwide. The regional governments (notably the municipalities of Shanghai and Beijing) augment these national policies with their own measures, some of which closely track the national policies and some of which are unique to the particular regional government. Local government measures are usually tailored to the specific of individual investments and projects and are substantially differentiated from locality to locality with the most important concession generally the land use fees offered. The central government has attempted simultaneously to encourage such local case-specific initiatives and to avoid the eruption of an "incentives race" between regions and localities to attract semiconductor investments.

The picture is further complicated by the existence throughout China of various types of investment promotion zones, in which differing rules apply with respect to such basic factors affecting competition as rates of taxation, eligibility for preferential financing, ability to import and export goods and materials, and terms of land and infrastructure use. Most of these investment zones have been established by the central government, which has set standard policies applicable to all zones in a particular category, but in practice the zones are administered by officials of provincial or local governments, who may fashion additional specific policies for particular zones, often based on long term development plans which they have drawn up for particular zones. Local authorities and administrators of the special zones commonly use case-by-case concessions on factors such as land use fees and utility rates to attract semiconductor investments. Many of the parks have affiliated Development Corporations, owned by regional or local governments, which invest in infrastructural projects and in some enterprises located in the parks. One type of special zone may also overlap and/or incorporate other zones.[1] There are four main types of investment promotion zones:

- ***Special economic zones (SEZs)*** are China's oldest development zones, established since 1980 as one of China's first efforts to attract foreign investment. SEZs are primarily located in southeast China along coastal areas and focus mainly on the promotion of the export of processed goods. Shanghai's Pudong New Area is an example of an SEZ.

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1 The Pudong New Area is a vast SEZ that includes, among other things, the Zhangjiang Science and Technology Park, a Hi-Tech Zone. Beijing's Economic and Technical Development Area (BDA) is an ETDZ but also claims status as a Hi-Tech Park because portions of the BDA are incorporated in Beijing's Zhongguancun Science and Technology Park.

- ***Economic and Technical Development Zones (ETDZs)*** in 1984, the government began establishing ***Economic and Technological Development Zones (ETDZs)*** in coastal cities, which gradually spread into inland areas. The ETDZs have the highest concentration of preferential policies for foreign investment and are linked to the highest national priorities. The Beijing Economic and Technological Development Area and Shanghai Caohejing High-Tech Park described below are examples of ETDZs.

- ***High-Tech Zones (or Parks)*** were created as a major thrust of the Torch Program beginning in 1988, primarily to promote the commercialization of achievements of high-technology projects. [2]

- ***Free Trade Zones (FTZs)*** have been created by the central government as laboratories for testing liberal trade policies and practices before such policies are adopted by the rest of the country. Foreign enterprises located in the FTZs enjoy the right to import and export on their own account ("trading rights"), exemptions from tariffs and VAT on operations conducted within the zone, and expedited customs clearance.

China's long range national plans for the semiconductor industry have been expressed in periodic Five Year Plans, which establish broad, long range developmental objectives and identify resources that will be mobilized to achieve those objectives.[3] Polices for the information sector, including the semiconductor industry. are developed by the Ministry of Information Industries (MII) in consultation with other relevant ministries and incorporated in the economy-wide plans drafted by the State Planning Commission. Sector-specific policies for the semiconductor industry are implemented pursuant to "Circulars" issued at the national government level, augmented by circulars issued by key provincial-level governments and by regulations and plans issued by local (district/county) level authorities.[4] The current Five Year

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2 In addition to the three types of "national" level zones, there are numerous provincial and municipal level development zones. Three of the zones discussed in this study, Beijing Linhe Industrial Development Zone and the Shanghai Songjiang Industrial Zone, are municipal level development zones. It should be noted that, as a general matter, development zones can begin as municipal level zones and graduate, through an application procedure, to national status. State Economic and Technological Development Zone, WEF, www.wefchina.org/etdz/default_en.htm and ATIP98.062.

3 While the promotional policies are taken pursuant to concurrent five year plans, the activities, measures and market effects set in motion under successive plans tend to overlap. Thus in late 2002, the results of China's Project 909, the major semiconductor program under the Ninth Five-Year Plan (1996-2000), are still unfolding in the form of R&D in government-run labs and the establishment and expansion of companies, such as the Huahong-NEC joint venture established in 1997. The most important new developments in China's semiconductor industry, however, arise from the themes developed in the late 1990s and manifested in the 2000 publication of China's Tenth Five-Year Plan and the follow-on policy "circulars" of the central and local governments.

4 The national-level circulars are drafted by MII with input from Chinese industry representatives, and circulated for comment with key ministries and members of the State Council prior to adoption and publication.

Plan, the Tenth (2001-2005) sets forth a vision for the semiconductor industry which is being implemented by a state-level “Circular 18” issued in 2000, and -- thus far -- two ancillary provincial Circulars (Shanghai Circular 54 of 2000 and Beijing Circular 2001-4). Some implementing regulations and plans have been issued at the local level, most notably Shanghai’s Pudong New Area, but the process of local implementation of national policy is incomplete as of this writing.

A. Central government.

While the central government continues to play the leading role in implementing a promotional strategy for the semiconductor industry, the present effort is noteworthy precisely because of the diminution in direct government involvement. To an unprecedented degree, the central government is delegating functions and decisionmaking power to regional and local governments, industry associations, and private enterprises. The central government's role increasingly resembles that of governments in "mixed" economies elsewhere in East Asia.

1. ***State Council.*** The State Council is the highest executive organ of state power and administration. It spearheads the formulation and implementation of Five Year Plans and issues implementing plans (such as Circular 18). It must also approve large-scale strategic investments, such as the establishment of wafer fabrication facilities.

2. ***Ministry of Information Industry (MII).*** The MII is a super-agency formed in 1998 through merger of the Ministry of Electronics Industry with the Ministry of Ports and Telecommunications. MII develops and oversees promotional strategies for industries under its jurisdiction, including semiconductors. Typically it drafts proposed policies for the semiconductor industry, circulates them to other key Ministries for comment and concurrence, and secures approval from the State Council. MII controls a number of significant subordinate organizations. These include:

- ***China Electronics Information Group (CEIG)***. This is a wholly-owned group of information technology enterprises with assets of over 30 billion yuan. It was formed by the reorganization of the former China Electronics Corp. (CEC).

- ***Center of Computer and Microelectronics Industry Development (CCID)***. CCID is a policy research organization which played a major role in drafting Circular 18 and other policy measures directly affecting the semiconductor industry.

3. ***Ministry of Science and Technology.*** MST develops and implements national strategy for high technology R&D, including education, research in government laboratories, human resources allocation, and establishment of national level policies for the Hi-Tech Parks. MST has managed key R&D projects aimed at upgrading the capabilities of the semiconductor and other strategic industries, such as the Torch Plan and the 863 Plan.

4. ***Ministry of Foreign Trade and Economic Cooperation.*** MOFTEC administers foreign trade and the promotion of inward foreign investment. MOFTEC has developed many of the investment incentives that are now being enjoyed by the new semiconductor foundries being established in China.

5. ***Chinese Academy of Sciences.*** CAS administers a vast array of government research institutes, employing 60,000 scientists and engineers, 17,800 with advanced degrees. It administers microelectronics research institutes in Beijing and Shanghai and university research institutes performing microelectronics R&D (Tsinghua, Fudan, Hungzhou Electronic Industry College, and Shanghai Jiaotung University).

B. People's Government of Shanghai Municipality

Shanghai has been at the forefront of the development of the semiconductor industry in China since the industry's beginnings over forty years ago. The Shanghai area is a production base for a large number of PC, consumer electronics, and telecommunications equipment firms which constitute a natural market for local semiconductor production. The Shanghai area was the site of the first manufacturing joint ventures between Chinese and foreign semiconductor makers, Shanghai Belling and Shanghai Huahong-NEC. Shanghai is the site of China's first operational semiconductor foundry, SMIC, and enjoys the largest concentration of operational and planned 8-inch fabs in China.

The Shanghai Municipal Government has issued its own major circular augmenting the central government's promotional policies in Circular 18.[5] It has undertaken direct equity investments in semiconductor manufacturing enterprises like Shanghai-Huahong, Shanghai-NEC, Shanghai Belling, and SMIC (although not Grace). The municipal government channels venture capital to IC design startups through a variety of venture capital companies. Shanghai Municipal Government officials also play a major role in administering the various special zones in the Shanghai region, which in turn offer their own incentives to the semiconductor industry, including, in some cases, equity investment.

While district-level governments in the Shanghai region have the authority to approve new investments, the really big ones (usually anything over $100 million) must be approved by the Shanghai Municipal Government. This rule has applied to all wafer fab investments. In the case of TSMC, the negotiations over where its fabs would be located were conducted by TSMC directly with the Shanghai Municipal Government. The municipal government apparently directed TSMC to build in Songjiang because it wanted to balance and spread semiconductor investments around the Shanghai region, and not put all projects in one park. These zones include the Pudong New Area, an SEZ which contains four specialized promotional zones; the Waigaoquiao Free Trade Zone; the Caohejing Hi-Tech Park; and Shanghai Songjiang Industrial Zone.

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[5] Shanghai Circular 54, Some Policy Guidelines of this Municipality for Encouraging the Development of the Software Industry and the Integrated Circuit Industry, December 1, 2002.

1. ***Pudong New Area (PNA).*** China's central government began the development of Pudong New Area, a 533 sq. km. tract of land across from the center of the city of Shanghai and located on the eastern side of the Huangpu River, in 1990.[6] Pudong New Area is not an economic development zone per se, actually consisting of four smaller national-level development zones -- Lujiazui Finance and Trade Zone, Waigaoquiao Free Trade Zone, Jinqiao Export Processing Zone (JEPZ), and Zhangjiang High-Tech Park ("ZJ Park"). As national-level development areas, these four key zones afford foreign enterprises established there preferential tax, import duty, and other incentives articulated by Pudong, but in accordance with the central government's Ninth Five-Year Plan (1995-2000) and its product catalogues. Jinquao EPZ is the site of Shanghai Huahong's wafer fab facility; ZJ Park is the site of operational or planned fabs by SMIC, Grace, and Belling.[7]

Following the issuance of Circular 18 by the central government, PNA issued a series of IC-specific incentives and measures, and developed a 3-year and a 10-year plan for development of the semiconductor industry in Pudong. PNA has allocated 22 sq. km. to a "Microelectronics Industry Belt," which is being dedicated to wafer fabs, design houses, and assembly, test and packaging enterprises. While most types of incentives for semiconductor firms are uniform throughout the region, PNA has discretion to negotiate concessionary land use fee arrangements with semiconductor enterprises (this is done by PNA, not Shanghai Municipal Government). Companies pay lower land use fees than prior to Circular 18 (i.e., national policy has found expression at the district as well as provincial level in the form of reduced land use and utilities fees). PNA land use rates, utilities are very favorable, but virtually identical for SMIC, Grace and Hua Hong.[8] Specific incentives have been authorized for semiconductor firms in ZJ Park (see below).

PNA has an S&T and R&D fund at its disposal, about 100 million RMB derived from the PNA's budgetary allocation from the government.[9] This is used for applications development

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6 Both Deng Xiaoping and Jiang Zemin have promoted Pudong New Area. The Chinese government invested $3.02 billion between 1990 and 1995 at today's rates in infrastructure projects in Pudong. The Shanghai Pudong New Area Administration was established in 1993. www.gluckman.com/Pudong.html, ATIP, December 14, 1998, www.comnex.com.

7 Foreign high-tech manufacturing firms in the Pudong New Area enjoyed the following incentives through 2000. (1) a 15 percent, as opposed to 33 percent, corporate income tax (this is the Central government's incentive, etc.); (2) a complete tax holiday if the company is older than 10 years for the first two years of profitability, and a 50 percent reduction thereafter, from the third to fifth years. Only if the foreign enterprise is high-tech, add to this a reduced income tax rate of 10 percent for years six through eight; (3) a full refund on all income taxes paid on the portion of profits a high-tech company has reinvested in the business; (4) a five-year property tax holiday. "Foreign Investment Incentives Offered by Pudong New Area," pudong.shanghaichina.org/html and ATIP, December 1998.

8 Interview with official of Economic and Trade Bureau of Shanghai Pudong New Area (Shanghai, September 2002). Land use rights, however, vary from case to case. Hua Hong, for example is located in an export processing zone, and enjoys certain privileges with respect to trading and hard currency retention.

9 Interview with official of Economic and Trade Bureau of the Pudong New Area (Shanghai, September 2002).

(i.e., products, not basic R&D). It is also used to promote commercialization of findings. In semiconductors, these funds are usually used to support development of proprietary designs.

2. *Zhangjiang High-Tech Park (ZJ Park) (site of SMIC, Grace, Belling).*

The leading site in Shanghai for semiconductor manufacturing is the Zhangjiang High-Tech Park, established in 1992 in the central part of Pudong New Area covering 25 sq. km.[10] It is by far Shanghai's most important high-tech development zone. ZJ Park is managed by the Zhangjiang Development Corp. (ZDC), a holding company which is wholly owned by the Municipal Government of Shanghai. The Development Corp. has subsidiaries which are JVs with different owners; one of them is publicly traded. Governmental functions are exercised by a management committee of municipal officials, some of whom hold positions in the Development Corp.

According to its officials, this Park is succeeding because of its superior infrastructure, its "idea" or "plan," good service, and proximity to market, which enables producers to react quickly to changes in demand. Clustering a large number of fabs in one place is "part of the vision" and results in more efficient provision of water, power, and gas. There are approximately 230 companies established in the park, two dozen of which are semiconductor-related. Notable such tenants include, SMIC, SMIC investor, ISSI, GSMC, Shanghai GSMC, and GSMC investor Silicon Storage.[11]

ZDC has made equity investments in SMIC, ASE, and Belling but not Grace.[12] ZDC's longer term vision is at least 15 fabs.[13] According to ZDC officials there will be nine SMIC fabs (three are finished now, and six more will be built in the Park, so whatever SMIC builds in Beijing is additional); four Grace fabs (two under construction, two planned); and two Belling fabs (one built, one under construction). ZDC also has "big plans" for fabless companies. ZDC says it has 44 and wants 100 by 2010. ZDC explains that it also wants enough fabless capability to "support the needs of all the fabs we have here."

A total of eight high-tech venture capital companies (VCCs) are affiliated with the Park.[14] Most of them were set up by the government and have government funds invested in them, but also draw private investment from inside and outside of China. Investors in these funds include Softbank of Japan, IBM, Cisco, Acer, TSMC and large individual investors. The funds provide financial support, help set up management systems, "help networking," activities, "find key

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10 www.zjpark.com/new-html/htmls/en/htmls/about.htm.

11 www.zjpark.com.

12 The ASE Group consists of two key members: ASE Inc. and ASE Test Limited, and Universal Scientific Industrial, ISE Labs (80.4%), ASE Chung Li, ASE Korea, both acquired from Motorola in 1999, and 51.9% of ASE Materials.

13 Interview with Shanghai Zhangjiang Hi-Tech Park Investment Service Center (Shanghai, September 2002).

14 Interview with Shanghai Zhangjiang Hi-Tech Park Investment Service Center (Shanghai, September 2002).

people," help kids find good schools, and "give companies lots of ideas on how to operate." There is an incubator in ZJ Park for startups, although to date many of the companies spawned in this incubator have failed.[15]

In October 2000 following the issuance of Circular 18, the Pudong New Area promulgated a modified set of investment incentives for foreign IC manufacturers in ZJ Park, *Suggestions on Pudong New Area's Financial Support to the Development of Hi-Tech Industries in Zhangjiang Hi-Tech Park*, which provide some specific additional incentives:[16]

- freedom of the enterprise to determine salaries and salary distribution;
- Pudong government contribution of 20 percent of price of home purchase for any high-level expert executives, such as those from the Chinese Academy of Sciences or Chinese Academy of Engineering;
- a 14 percent tax allowance for profits reinvested in the Park;
- subsidies, low interest loans, and investments from the Pudong technological development fund for further investment in high-tech enterprises.

3. *Shanghai Songjiang Industrial Zone (SSIZ).*[17] Shanghai Songjiang Industrial Zone is a municipal-level industrial zone established in 1992 in the Shanghai suburb of Songjiang. Some 173 foreign-invested projects are located there with a total investment of US$1,600 million, 26 of which are among the top 500 industrial enterprises. SSIZ characterizes itself as the first municipal level industrial zone with a concentration of Sino-Japanese joint ventures.[18] SSIZ Preferential Policies are consistent with standard incentives available at comparable sites in China.[19] According to Songjiang Park officials, the single most important incentive is the park's low land use fees:

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15 "We give them training programs. They learn how to operate a business, finance, marketing, how to apply to the government for financial support. We provide financial support and help them find venture capital. Design tool platforms can be used at low cost. The size of these companies and the number of people involved is small. We provide them with low rental, lower than the market price. Management training can be free or for a fee that is below market. Networking is 'impossible' if these companies are not inside an incubator." Interview with official of Shanghai Zhangjiang Hi-Tech Park Investment Service Center (Shanghai, September 2002).

16 Shanghai Pudong New Area Financial Bureau's "Suggestions on Pudong New Area's Financial Support to the Development of Hi-Tech Industries in Zhangjiang Hi-Tech Park" (10/31/00) as posted on ZJ Park's website (www.zjpark.com.).

17 The zone is located in the east of Songjiang District. It includes an area of 9 sq. km. that has been developed with infrastructure facilities ("seven connections and one leveling"). www.sjiz.org.

18 www.chinamarket.com. Hitachi Cable and Minolta Optical are among SJIZ's Japanese investors.

19 *Songjiang Industrial Park Preferential Policies* attached hereto and available at http://www.sjiz.org/htm/policy.htm.

The lease price of land with complete infrastructure is $30-35 per square meter (within a land use period of 50 years) lower than most counterparts with same conditions in Shanghai.[20]

Companies located in the municipal parks pay enterprise tax at a rate of 24 percent (except when reduced by specific incentives) versus a 15 percent rate in national-level parks.[21] Although enterprises must also pay a local 3 percent enterprise tax on income earned locally, municipal level parks such as SSIZ enjoy much greater leeway in providing local level incentives. SSIZ is not administered by a public corporation, but directly by municipal officials of Songjiang.

TSMC has decided, after a two year search, to locate its first mainland fab in Songjiang.[22] It will not be located in the SSIZ, however, but in a new Songjiang Science and Technology Park that is being created on land now used by the SSIZ for general industrial use. TSMC will establish an 8-inch fab which will go into production by August 2003. It has purchased a very large piece of land and reportedly plans to invest $10 billion here in the next 8 years. It will build an R&D center in the new park.

The terms of TSMC's incentive package are highly confidential, but are said to be "very big" and "generous," but do not include free land (however the regular land use fees in Songjiang are about one third of the level in Pudong).[23] Technically the enterprises located in the new high-tech park will receive incentives identical to those available in the SSIZ. (Two year enterprise tax holiday, half tax for the next three years, duty free import for equipment.) But the municipal authorities offer additional incentives which are not published and may be made known only to the parties, e.g. the investing enterprise and the officials involved. In the TSMC case the only parties were two top officials from the Songjiang municipal government and officials from the Shanghai Municipal Government, whose main role was to guarantee to TSMC that the incentives pledged by Sonjiang would actually be forthcoming. Songjiang does not currently have a university with science or engineering programs but is in the process of establishing two such institutions to support the new high-tech park.[24]

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20 Shanghai Sonjiang Industrial Zone Preferential Policies, Item 8.

21 Interview with official of Shanghai Songjiang Industrial Zone (Songjiang, September 2002).

22 Interview with official of Shanghai Songjiang Industrial Zone (Songjiang, September 2002). "TSMC to invest US$10 Billion in Shanghai in Eight Years. *Commercial Times*, (August 23, 2002); *The Inquirer*, (September 2, 2002 and September 10, 2002); *Business Wire* September 10, 2002; TSMC Press Release, September 9, 2002; *Electronic Engineering Times*, (September 9, 2002).

23 Interview with official of Shanghai Songjiang Industrial Zone (Songjiang, September 2002.

24 Interview with official of Shanghai Songjiang Industrial Zone (Songjiang, September 2002).

4. ***Shanghai Caohejing High-Tech Park (Caohejing).***[25] Caohejing is a 6 sq. km. park in the southwest part of the city of Shanghai, 24 km from ZJ Park, a big advantage with respect to people who work there. Another 5 sq. km. location further out in Pudong has been acquired for development because Caohejing has run out of space. Caohejing was originally established by the State Council in 1988 as a national-level economic and technological development zone and thereafter as a national-level high-tech park in 1991. [26]

Caohejing is operated by the Joint Development Co. Ltd. of the Shanghai New Technology Development Zone, a corporation that is owned by the Shanghai municipal government and exercises some government functions. As is fairly common all of the Development Company management are also Shanghai municipal government officials and are appointed by that government. The park is overseen both by the national government and by the Shanghai Municipal Government. "MOFTEC has jurisdiction over us. We report directly to MOFTEC. But project approval is decided by the Shanghai government."[27]

Caohejing High-Tech Park officials obtained the land for the park directly from the State Council who expropriated farms and residences and allocated them to Caohejing. There are approximately 600 domestic and 300 foreign enterprises, mostly engaged in research and development in Caohejing. The park has attracted GE, Lucent Technologies, Intel, Philips, Toshiba, Epson, Ricoh, NTT, Nortel, Acer, Inventech, Microtek, Shanghai Advanced Semiconductor, IDT, among others. ASMC has its wafer fabrication facilities at Caohejing, and Shanghai Belling operates its older 6-inch fab here, although its new 8-inch fab is located in Zhangjiang.[28]

Caohejing is authorized by the Shanghai municipal government to approve foreign investment projects up to US$30 million, and reportedly processes investment requests very fast. With respect to incentives, the park is at a disadvantage because it reports directly to MOFTEC and unlike district or county level parks under the direction of provincial governments, it does not have the discretion to offer tailored or special incentives. Its land use fees are relatively high because of its in-the-city location. However the city location tends to outweigh these negatives for many investors. [29]

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25 Discussion of Caohejing is based on www.chinamarket.com.cn, www.shtp.com.cn. Interview with official of Shanghai Caohejing Hi-Tech Park Development Corp. (Shanghai, September 2002).

26 Interview with official of Shanghai Caohejing Hi-Tech Park Development Corp. (Shanghai, September 2002).

27 Interview with official of Shanghai Caohejing Hi-Tech Park Development Corp. (Shanghai, September 2002).

28 www.asmcs.com/travel.htm.

29 Interview with official of Shanghai Caohejing Hi-Tech Park Development Corp. (Shanghai, September 2002); www.chinainvest.com.cn, www.shtp.com.cn.

Because it is a national level hi-tech park, the enterprise tax rate in Caohejing is 15 percent. Semiconductor companies qualify for the two year tax holiday and taxation at half the 15 percent rate for another three years. Additionally, after five years if a company is certified as "high-tech" or exports exceed 70 percent of total output, the tax rate after five years is 10 not 15 percent. Caohejing's preferential policies are detailed in *Shanghai Caohejing High Technology Park Preferential Policies on Taxes*.[30]

C. Suzhou Municipal People's government.

Suzhou is an historic and scenic city about 50 miles from Shanghai which has been able to draw an increasing volume of high-technology investment because it is close enough to Shanghai and Nanjing to benefit from their transportation links and universities, but far enough away to enjoy lower costs than the big cities. It is extremely popular as a place to live for people from all over China, and has drawn a large number of Taiwanese from the Shanzen area who value Suzhou's "security" and "social order" (Shenzen has been plagued by crime and other social problems).

Although located close to Shanghai, the Suzhou municipal government is under the provincial government of Jiangsu province. The electronics industry within the Suzhou municipality is growing at a phenomenal rate. Some 25 percent of the world's motherboards, 15-17 percent of the scanners, and 60 percent of the world's computer mouse devices are made within the municipality. With respect to the semiconductor industry, two special zones within the municipality are significant, Suzhou New District and the China-Singapore Industrial Park (CS-SIP). Both parks are classified as national level parks (so that they are subject to enterprise tax at the 15 percent rate) but there are some important distinctions.

1. *China-Singapore Industrial Park (CS-SIP).* CS-SIP was established in Suzhou in 1994 based on the conception of the government of Singapore, which was looking for a site at which to demonstrate its style of development outside of Singapore. It is a joint venture in which the government of Singapore originally held a 65 percent stake and the national government of China a 35 percent stake.[31] CS-SIP is overseen by the governments of China and Singapore through a Joint Steering Council (JSC) which is co-chaired by the Vice Premier of China and the Deputy Prime Minister of Singapore.[32] These officials regularly demonstrate their support for the park with highly-publicized visits.[33]

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30 Caohejing High Technology Park Preferential Policies on Taxes, www.shtp.com.cn.

31 Singapore's share of the SIP is owned by Singapore government entities and public corporations. The Chinese staff and managers of the SIP are sent to Singapore for management training in "transparent, clean, pro-business, efficient government." The training was conducted by the Economic Development Board of Singapore and Singapore state-owned companies. Interview with executives of China-Singapore Suzhou Industrial Park Development Co., Ltd. and China-Singapore Suzhou Industrial Park Administrative Committee (Suzhou, September 2002).

32 Members of the JSC include key Chinese ministries such as MOFTEC, the State Economic and Trade Commission, the Ministry of Finance, the State development and Planning Commission, the general Administration of Customs, and the Municipal Government of Suzhou and the

CS-SIP is administered by an administrative committee of the municipality of Suzhou but in contrast to the SND, commercial activity in the zone is managed by the China-Singapore Suzhou Industrial Park Development Corp., Ltd. The managers of both entities are the same individuals, who "wear two hats" (and have two different business cards).[34]

The CS-SIP has a "Provident Fund" specially furnished by the central government which can be invested in special projects in the CS-SIP. The CS-SIP also hosts venture capital companies which will invest in projects in the park with high potential. With respect to very important projects, the Development Corp. itself will invest as a "silent partner." The purpose of such investment is symbolic -- it shows that the Development Corp. supports the project, which "helps solve short term cash flow problems" by facilitating bank lending and equity investment.[35]

In 1999, the government of Singapore complained that the SND was growing too fast and competing with CS-SIP for investment. In part however, the CS-SIP's lower growth rate was attributable to the fact that the Singaporean developers insisted on much higher prices for the residential and industrial land within the zone, causing companies to locate in the SND. The issue was resolved by a reversal in ownership relationships in the CS-SIP, and land prices in the CS-SIP were sharply reduced.[36] The Suzhou authorities nudged new investors to locate in the CS-SIP. To date most of Suzhou's semiconductor investment has taken place in the CS-SIP, whose planners envision an eventual 10 wafer fabs. As of September 2002 one fab was under construction (He Jian) and five more planned by the same firm. The CS-SIP has 8 assembly and test facilities either operational or committed (Philips, AMD, Hitachi, Samsung, Fairchild, SPIL, Carsem of Malaysia).[37]

CS-SIP is awarded the same status as a Special Economic Zones and Pudong New Area in terms of incentives, which are outlined in its policy document, *China-Singapore Industrial*

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government of Jiangsu Province. Singapore is represented by the Economic Development Board and other government organizations. Interview with executives of China-Singapore Suzhou Industrial Park Development Co., Ltd. and China-Singapore Suzhou Industrial Park Administrative Committee (Suzhou, September 2002).

33 "China, Singapore to Widen Cooperation in SIP Project", *People's Daily*, May 29, 2002.

34 These same officials are also the managers of the newly formed Suzhou Integrated Circuit Association, which represents the IC firms in the municipality.

35 Interview with executives of China-Singapore Suzhou Industrial Park Development Co., Ltd. and China-Singapore Suzhou Industrial Park Administrative Committee (Suzhou, September 2002).

36 The government of China took a 65 percent share, and Singapore's share was reduced to 35 percent. Ibid.

37 Interview with executives of China-Singapore Suzhou Industrial Park Development Co., Ltd. and China-Singapore Suzhou Industrial Park Administrative Committee (Suzhou, September 2002).

Park Preferential Policies,[38] but the park also explains that CS-SIP "will grant more incentives to hi-tech projects."

2. *Suzhou New District (SND).* Suzhou's other special zone is the Suzhou New District (SND). SND has not made a special effort to attract semiconductor investment, although it has a large Motorola design center, largely staffed by Chinese talent. The SND is currently undertaking a mammoth expansion -- the largest of its kind in China -- and as prime sites fill up in other zones, the SND's position (in Suzhou and near Shanghai) make it a like site for future investments by semiconductor firms.[39]

The SND characterizes itself as an entire new city, with housing and other facilities for 130,000 people, plus industrial sites. It has expanded incrementally, gradually taking over residential, commercial and farm land in and around the city and either incorporating existing structures or demolishing them and building on the sites. (By contrast CS-SIP cleared a vast area all at one time and is building its entire plan in a single phase.) SND was the first zone to construct housing for expatriates and now hosts roughly 3000 of them. SND is currently 52 sq. km. but is expanding to 258 sq. km., absorbing or clearing substantial residential and industrial neighborhoods.[40]

The Suzhou New District does not offer incentives at the local level to investors. SND relies on other factors to attract investors, principally its close-in location, which makes commuting by bicycle feasible, low land use fees, and the general attractions of the Suzhou area. The SND's affiliated SND Economic Development Group Co. makes equity investments in domestic and foreign companies in the SND, but so far have not invested in any semiconductor related firms.[41]

D. People's Government of Beijing Municipality

The Beijing municipal government has articulated a comprehensive strategy for promoting the area's IC manufacturing and design industry under the rubric of the "North Microelectronics Industry Base" pursuant to "the Plan of North Electronics Industry Base" and "Blueprint and Development Strategy of Beijing IC Industry,"[42] Beijing's effort is supported by

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38 China-Singapore Industrial Park Preferential Policies, attached hereto and available at www.sipac.gov.cn/cgi-bin/odbget.exe?WIT_Template=BI01000&grOid=173::1090::1047&Cc=.

39 Interview with officials of Suzhou Municipal Government (Suzhou, September 2002).

40 Interview with officials of Suzhou Municipal Government (Suzhou, September 2002).

41 Interview with officials of Suzhou Municipal Government (Suzhou, September 2002).

42 The Beijing Municipal government's "Tenth Five-Year Plan for the Beijing Municipality for National Economic Social Development," February 10, 2001. Beijing's commitment to the North ME Base is reaffirmed in this plan. The North ME Base itself is neither a national nor a municipal economic development zone per se; rather it is a term referring to a critical concentration companies and government policies at the national and municipal levels in at least three pre-existing development regions that comprise the "base": the Beijing Economic and Technological Development Area (BDA), the Beijing Linhe Industry Development Zone (Linhe), and the Badachu High-Tech Park (Badachu). The term is a kind of buzz word and rallying cry devised by

MII, MOST, and the SETC.[43] The Beijing municipal government and MII have formed a working group to spearhead investment efforts there.[44]

Beijing's preferential policies for the integrated circuit industry are divided according to three functions in three geographic locations: IC manufacturing, design and testing in the Beijing Economic and Technological Development Area (BDA); chip packaging at the Beijing Linhe Industry Development Zone (Linhe), and chip manufacturing at the Badachu High-Tech Park (Badachu).[45] Most of the future growth of IC manufacturing industry in the Beijing area is likely to take place in the BDA, where SMIC's subsidiary plans to establish a significant number of fabs in the next eight years.

Beijing's current strength in semiconductors is in the area of design, reflecting the concentration of high quality universities (especially Beijing University and Tsinghao University), large numbers of resident university graduates, and the presence of the Chinese Academy of Sciences. China's best high school graduates go to the Beijing Universities and many subsequently go to the United States to work and study. When they return, because they had Beijing residency status before they left, their first stop is Beijing, and they often simply remain there.[46]

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the Mayor of Beijing. The mayor chairs an executive office under the Beijing Economic Commission to promote the base concept, on which ministers of key ministries serve as vice chairs. This is significant because so many broad policies in China are government controlled (land use, transportation, education etc.) that it is useful to have a committee like this to make sure that everyone is pulling together to promote microelectronics. One example of the concept in action may be the decision to move the Capital Iron and Steel Works out of Beijing, in part in order to make the water it uses available to planned wafer fabs. There is a small coordinating office run by the municipal government to support this effort.

43 www.bjic.org.

44 The North ME Base itself is not an economic development zone per se; rather it is a term referring to a critical concentration companies and government policies at the national and municipal levels in at least three pre-existing development regions that comprise the "base": the *Beijing Economic and Technological Development Area (BDA)*, the *Beijing Linhe Industry Development Zone (Linhe)*, and the *Badachu High-Tech Park (Badachu)*. The term is a kind of buzz word and rallying cry devised by the Mayor of Beijing. The mayor chairs an executive office under the Beijing Economic Commission to promote the base concept, on which ministers of key ministries serve as vice chairs. This is significant because so many broad policies in China are government controlled (land use, transportation, education etc.) that it is useful to have a committee like this to make sure that everyone is pulling together to promote microelectronics. One example of the concept in action may be the decision to move the Capital Iron and Steel Works out of Beijing, in part in order to make the water it uses available to planned wafer fabs. There is a small coordinating office run by the municipal government to support this effort. Interview with People's Government of Beijing Municipality (Beijing, September 2002).

45 The Blueprint and Plan of the North Electronics Industry Base, www.bjic.org.cn.

46 Interview with Division of Innovation and Development Economic Commission, People's Government of Beijing Municipality (Beijing, September 2002).

Some Chinese officials and industry leaders are of the view that Beijing should concentrate solely on design, and leave the manufacturing to other regions. With respect to manufacturing, Beijing currently has only one significant operational fab in the region today operated by the Shougang-NEC joint venture using 6-inch wafers and 0.35 micron design rules. Shougang-NEC also does some packaging but not on a large scale. There are a few small fabs making discrete devices. However, in the next five years Beijing expects to have three fabs (some predict more), and has several advantages in the long term besides its strength in design. A number of major domestic computer firms are based here, such as Stone and Legend, and provide a significant potential demand base (although less than total demand in Shanghai area). In addition, in preparation for the 2008 Olympics, Beijing is moving all smokestack industries out of the city, such as Shougang Iron and Steel, to make room for clean high-tech industries like ICs and software. This will result in many resources and benefits being made available for such industries.

Apart from the preferential policies associated with the North ME Base detailed below -- which include free land for 30 years, a 15 percent government equity infusion, a 1.5 percent interest rate discount on construction loans, and the "Five Free Five Half" tax incentive -- the Beijing municipal government is creating the IC Industry Investment Co., Ltd. to expedite the objectives of Circular 18 and "to guarantee the investment of North Microelectronics Industry Base."[47]

1. ***Zhongguancun Science Park (ZSP).*** Zhongguancun Science Park, located northwest of Beijing, has hosted much of China's semiconductor industry since it was established as a national science park in 1988 as the first, and still the largest, of China's science parks, with more than 6,000 enterprises. ZSP is a Science Park under the jurisdiction of the Ministry of Science and Technology, as opposed to MOFTEC[48] and is administered by an administrative committee of the Municipality of Beijing. The ZSP administrative committee is chaired by the Vice Mayor responsible for promotion of technology.

ZSP actually consists of five geographically distinct science zones.[49] The biggest is Haidian Zone (340 sq. km.) also known as the Science City. It is mainly devoted to R&D (including IC design) but some semiconductor materials manufacturing takes place in one of its subzones, Yang Feng. The Beijing IC Design Park Co. is located in Haidian and is an important incubator for IC design houses. The Changping Science Zone (5 sq. km.) is a manufacturing zone devoted to electronics (but not semiconductors), biotechnology and pharmaceuticals. The Electronic City Zone (10.5 sq. km.) is mainly devoted to reform of old enterprises and development of high technology. The Hua Da IC design center is located there, as well as some

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47 www.bjic.org. The description of the Beijing Municipal Government on the preferential policy to encourage investments in integrated circuits is available at www.bjic.org.cn/english/03bjtzhj/001_06.html.

48 Interview with officials of the International Cooperation Division, Administrative Committee of Zhongguancun Science Park (Beijing, September 2002).

49 Interview with officials of the International Cooperation Division, Administrative Committee of Zhongguancun Science Park (Beijing, September 2002).

small IC packaging operations. The Fengtai Zone is devoted to pharmaceuticals and the integration of optical, mechanical and electrical engineering. Finally, Yizhuang Science and Technology Zone is located inside (and is a part of) the Beijing Economic and Technical Development Area. The new SMIC fabs will be located in Yizhuang, as will other IC fabs.

A recent study identified ZSP's strengths as a superior physical infrastructure; strong governmental promotion policies; effective park management; qualified and abundant human resources; and China's "vast domestic market" for the ZSP's products. The park's weaknesses are cited as an IT network currently inferior to those of other Asian parks; a shortage of skilled professionals in some areas (the study noted that a lack of a legal regime for granting stock options is an important obstacle to creating the proper "motivation"); "lack of global advanced technology"; and "a scarcity of venture capital." Government programs are currently addressing each of these perceived weaknesses.

2. *Beijing Economic Technology and Development Zone (BDA).* BDA was established in 1991 and approved as a national-level ETDZ in 1994. BDA is a vast city-sized area that currently covers about 50 sq. km. and will eventually expand to 195.5 sq. km. Within the BDA a 7 sq. km. area has been designated Yizhuan Sci-Tech Park (or Science Park or High-Tech park depending on the translation) as part of the Zhongguancun Science Park. This makes all of BDA, not just Yizhuan, eligible for incentives available in High-Tech Parks and is a big selling point used with foreign investors.[50]

BDA focuses on attracting IC design, R&D, and testing activities. The Beijing IC Design Park will be located there and "the IC design enterprises are the key projects that will get support from the municipal government." The municipal government is establishing an IC Design R&D Fund for attractive investment opportunities and has set a target of 200 IC design firms for location there.

The committee responsible for administering BDA is headed by the Vice Mayor responsible for foreign investment.[51] But the entire BDA (including the non high-tech part and not just the Yizhuang Zone) is designated part of the Zhongguancun Science Park for purposes of eligibility for incentives. This means that incentives available to companies located in the national High-Tech parks apply to low tech firms located in BDA, such as the 15 percent tax rate etc. Thus BDA is "under" the ZSP roof for purposes of eligibility for incentives and as a mechanism for competing more aggressively for foreign investment, but operationally, BDA runs its own show, including transactions such as negotiations of the deal with SMIC.

BDA is "one of a kind" in that it enjoys simultaneously two sets of preferential policies due to its double status as a national-level economic-technological development area and because of the location of a national-level high-tech garden there. Reportedly, foreign enterprises

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50 Interview with Beijing Economic-Technological Development Area (Beijing, September 2002).

51 Interview with Beijing Economic-Technological Development Area (Beijing, September 2002).

investing in BDA enjoy both sets of preferential policies simultaneously.[52] Several of the BDA preferential policies, which are laid out in *45 BDA Preferential Policies for Investors*, specifically target research and development activities.[53] The BDA provides complete exemption from business tax, a local-level tax levied on services, as opposed to manufacturing, not shared with the central government. The BDA policies provide also for cheap land, preferential customs procedures, and utilities fee discounts.[54]

The Beijing Semiconductor Manufacturing Corporation (BJSMC) a subsidiary of SMIC, Shougang, and various Beijing government entities, will establish a series of wafer fabs in the BDA's Yizhuang Zone.[55] The proposed investment in BSMC is US$1.3 billion, to be raised by H&Q Asia. SMIC will be a one-third investor, while other known investors include SMIC employees, a subsidiary of the steel conglomerate Shougang Group, Beijing University, Cheung Kong Holdings, and the Beijing Municipal Government. Phase 1 will establish two 8-inch lines and one "test" line for an eventual 12-inch line. Phase 2 will be three 12-inch lines, and at some point the original 8-inch lines will be upgraded to 12.

BDA expects to establish an entire IC industry chain in the Yizhuan park. Separate, but adjacent areas have been set aside for IC design houses, assembly and test, and semiconductor materials including GaAs as well as silicon.[56] Although none of this expansion had occurred as of September 2002, the belief was that SMIC would draw the ancillary enterprises. "When Richard comes, they will come." SMIC will itself have an assembly/test facility in the zone designated for that activity. A software college will be located nearby, and an adjacent area is reserved for digital TV manufacture.

BDA offers special incentives to individuals on their income tax who work in high-tech enterprises in the park. They can refund the local portion of the income tax (which varies from year to year, but this year is 75 percent of the total tax) as a credit for expenditures such as the purchase of an apartment or car. These refunds are a form of unpublished incentive that vary from case to case based on the size of the investment and the level of the technology involved.

3. ***Linhe Industrial Development Zone.*** Linhe Industrial Development Zone is a provincial-municipal level development zone established in 1993 and designated the

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52 Director's Message, http://www.bda.gov.cn/English/index1.htm; "Incentives," www.bda.gov.cn/English/gkjtz1/yhzc.htm.

53 *45 BDA Preferential Policies for Investors*, attached hereto and available at www.bda.gov.cn/English/gkjtz1/yhzc.htm.

54 45 BDA Preferential Policies for Investors, www.bda.gov.cn/English/gkjtz1/yhzc.htm.

55 Apparently, SMIC had planned the BSMC initiative in Badachu, but didn't like some aspect of that site and, after construction at Badachu had already begun, cancelled the project and negotiated the deal with BDA.

56 Interview with Beijing Economic-Technological Development Area (Beijing, September 2002).

"production base of micro-electronics of the north" in that year.[57] Linhe is located 25 km from downtown Beijing, in Shunyi county, and is connected by a highway to the Zhongguancun Science Park.[58] Linhe adopts the Beijing Municipal Government's Preferential Policies for Encouraging Investment in the Integrated Circuit Industry.[59] It is currently the site of semiconductor materials producers.

4. ***Badachu High-Tech Park.*** Badachu High Technology Park is located in the south of the North ME Base, Shijingshan District. Under the North ME Base Blueprint, Badachu will focus on integrated circuit manufacturing and ultimately be home to an estimated dozen fabs. The Beijing Municipal government's "Tenth Five-Year Plan for the Beijing Municipality for National Economic Social Development," highlights the municipal government's emphasis on Badachu. The principal high profile occupant of Badachu is Shougang NEC. In addition to the preferential policies for the North ME Base, investees in Badachu will enjoy a 2 percent interest rate discount on construction loans.[60] The first semiconductor-related government-industry partnership in Badachu is Beijing Huaxia Semiconductor Manufacturing Co. (HSMC). Investors include the Shougang group, the Beijing Municipal government, Alpha and Omega Semiconductor, and Joshua Semiconductor.

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57 Introduction of Development Zone, www.bjindustrialzone.co.cn. Recent reporting suggests Linhe may have been promoted to *national*-level development zone status; Industrial Zones, Shunyi, http://english.bjshy.gov.cn/Industry_Zones.asp.

58 Blueprint, www.bjic.or.cn.

59 Notes, www.bjindustrialzone.com.cn.

60 *Beijing Casting the Top Grace IC Industry Chain*, www.bjic.org.cn.

APPENDIX 2

A COMPARISON OF INVESTMENT AND OPERATING COSTS FOR INTEGRATED CIRCUIT PRODUCTION IN THE UNITED STATES, TAIWAN AND CHINA

The concentration of foundry production in South-East Asia has given rise to concern about the future of integrated circuit production in the United States. The two largest foundry producers in the world are based in Taiwan. Taiwan Semiconductor Manufacturing Company ("TSMC") and United Microelectronics Corporation ("UMC") are estimated to account for over 80 percent of total worldwide foundry revenues.[1] But recent announced investments in China and Chinese government promotional policies for IC production (especially in the Shanghai area) have raised the possibility that China will challenge Taiwan for worldwide foundry dominance.[2]

A fundamental analytical task that needs to be addressed in understanding these trends is identifying the factors that have caused the concentration of foundry production in Taiwan and now, potentially, in China. To that end this appendix of the report presents a comparison of investment and operating costs for integrated circuit production in the United States, Taiwan and China. The purpose is to quantify the relative costs of building and operating a state-of-the-art wafer fabrication facility in these different geographical locations to determine the extent of any comparative cost advantages in one region over another. The analysis will thus address the issue of whether the concentration of new foundry investment in Taiwan and the migration to China is due to lower investment or operating costs or whether other factors such as tax policy are driving this concentration of foundry investment.

Methodology

SIA member companies provided confidential estimates for both investment and operating costs to build and operate state-of-the-art wafer fabrication facilities in the United States, Taiwan and China. These costs estimates were then aggregated to arrive at the composite cost estimates presented in this report.[3] Costs estimates were provided for

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1 See *Semiconductor Business News*, "IC Insights Releases Top Foundry Rankings for 2002" (August 21, 2002), See Figure 1.

2 See Mike Clendenin, "China's Drive for IC Foundry Market Unnerves Taiwan," *EETimes* (October 4, 2001).

3 Operating cost data were requested for 12 cost categories. The consolidated operating cost information for the 300mm fab, however, has only 5 categories presented: Direct and Indirect Labor Costs, Other Operating Costs, Building Depreciation and Equipment Depreciation. This consolidation of cost categories for the 300mm fab was required to maintain the confidentiality of the data provided since detailed information for each of the non-labor operating cost categories was not provided by all companies. There was very little reliable information provided for taxes and G&A, so those cost categories were excluded from the analysis. Cost data was also supplied from an IC industry consulting firm, but these data were not aggregated in the composite results because they applied to a different wafer fab configuration.

two different fabrication facilities: one using 130nm technology and 200mm wafers and the other using 90nm technology and 300mm wafers.[4]

In order to maintain the confidentiality of the data provided by each company, consolidated costs contained in the summary tables are based on responses from at least four companies.

The basic assumptions underlying the operating cost analysis are laid out at the bottom of the cost template. Those assumptions are:

1. All production subsidies are excluded from the cost figures.
2. All labor differentials are based exclusively on wage differentials, and not on productivity differences. (That is, productivity differences (if any) across countries are ignored.)
3. The 130nm/200mm production is based upon 8,000 wafer starts per week.
4. The 90nm/300mm production is based upon 6,000 wafer starts per week.
5. All cost figures are stated on an annual basis.
6. Equipment is depreciated using a straight-line method over five years.
7. Structures are depreciated using a straight-line method over 20 years.

In addition, the following other assumptions were also made:

1. The capacity utilization rate is high and constant across countries.
2. The current exchange rate levels remain in place.
3. Yield differences are not considered.
4. Research and development costs are excluded from the analysis.

Results

The composite comparative cost estimates from the SIA member companies are presented in Tables 1-6. The basic conclusion is that from a pure investment and operating cost perspective there is only a small cost difference between Taiwan and China -- and even compared to a U.S. location the cost differences are not large.

There is almost no cost difference between locating a facility in the United States, Taiwan or China with respect to building and equipping new wafer fabrication facilities.[5] The total investment cost for the 200mm fab using 130nm process technology ranges from $1.98 billion in the United States, to $1.96 billion in Taiwan, to $1.93 billion in China. For the 300mm fab using 90nm technology, the investment costs range from $2.42 billion in the United States, to $2.38 billion in Taiwan, to $2.34 billion in China. China has a slight advantage in the construction of physical structures but equipment costs, which represent about 80 percent of total investment costs, are virtually identical so

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4 The fabrication facilities chosen were designed to describe state-of-the-art facilities or facilities that would be the subject of current or planned investment decisions.

5 See tables 1 and 2.

that the total investment costs are very close.[6] Taiwan is 98 to 99 percent of the U.S. total while China is 97 to 98 percent of the U.S. total.

The differences in total manufacturing costs are still small, but larger than for total investment costs.[7] The total annual manufacturing cost for the 200mm fab using 130nm process technology ranges from $820 million in the United States, to $742 million in Taiwan, to $705 million in China. Manufacturing costs in China are 14 percent lower than in the United States while manufacturing costs in Taiwan are 10 percent lower.[8] For the 300mm fab using 90nm technology, the annual manufacturing costs range from $976 million in the United States, to $911 million in Taiwan, to $878 million in China. Manufacturing costs in China are 10 percent lower than in the United States while manufacturing costs in Taiwan are 7 percent lower.[9]

Almost all of the manufacturing cost difference between the different geographic regions is accounted for by labor costs.[10] Labor cost differences, for example, explain over 70 percent of the manufacturing cost difference between Taiwan and China for the 300mm wafer fab and over 90 percent of the cost difference for the 200mm wafer fab.

With respect to operating costs only, labor costs explain 98 percent of the cost difference between Taiwan and China for the 200mm fab and 80 percent of the cost difference for the 300mm fab.

Conclusion

The composite cost data presented in this appendix does not support the hypothesis that the concentration of new foundry investment in Taiwan and the current migration to China is due to lower construction or operating costs. Other factors, primarily the government policies discussed in this report, are driving this concentration of foundry investment.

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6 Other sources have indicated, without providing any quantitative data, that the construction cost differences between the various regions are greater than indicated in this appendix.

7 See tables 3-6.

8 See table 4. The operating cost difference, without depreciation, is larger. Operating costs in China are 23 percent lower than in the United States and in Taiwan operating costs are 16 percent lower than in the United States.

9 See table 6. The operating cost difference, without depreciation, is larger. Operating costs in China are 16 percent lower than in the United States and in Taiwan operating costs are 11 percent lower than in the United States.

10 One caveat about the labor cost estimates. In most instances the labor cost data for Taiwan and China do not reflect the cost of stock payments and other amenities (housing, transportation, etc.) not directly associated with employee compensation costs. As discussed in the Taiwan and China sections of this report, these costs can be significant, especially in the case of Taiwan. Thus the relative labor costs for both Taiwan and China are likely understated with respect to the United States because of these other indirect costs.

The total manufacturing cost differences between the three geographical regions are small, especially for the latest process technology where labor inputs are a smaller portion of total cost. The manufacturing cost differences between Taiwan and China are very small and appear to provide almost no explanation for the migration of state-of-the-art wafer fabrication investment from Taiwan to China.

The composite cost estimates do not take into account regional differences in manufacturing infrastructure (including toolmaker support) that affect overall costs of doing business in a certain location. Outside of the Shanghai area, for example, infrastructure conditions are less than optimal in China. Higher costs due to lack of infrastructure may completely offset the labor cost differences that have been identified.

The labor cost advantage identified for China may explain moving older, depreciated fab lines to China, but not leading edge fabrication lines that have to cover depreciation charges. In fact, TSMC has already indicated that it will move older 200mm fab lines to China and replace those older lines in Taiwan with new 300mm lines.

The analysis of total manufacturing cost differences has important ramifications for the U.S. as well. At the 130 nm, 200mm wafer level, China has a 14 percent cost advantage, and Taiwan a 10 percent advantage, over the U.S. At the 90 nm, 300mm wafer level, China's advantage is 10 percent, and Taiwan's 7 percent. Three important conclusions fall out from this analysis. First, these cost differences do not confer a decisive advantage over the U.S., but can be offset by other factors that were assumed to be constant in the methodology. The cost model assumes productivity levels are identical, but higher yields (percent of good chips on each wafer) can be reached in the U.S. faster because the fab is in closer proximity to the R&D development work. Workforce training can also impact productivity, and is an area of increased focus in the U.S. Second, policy differences such as the tax holidays offered by China and Taiwan and the VAT rebate scheme offered by China can be greater than the cost impact of low labor rates, and must be addressed for the U.S. is to remain in the game over the long haul. Third, the model assumes that current exchange rates remain in effect. China has pegged the yuan to the dollar since the mid 1990's in spite of growing trade surpluses with the U.S. If the yuan were to be repegged at a appreciated rate, or allowed to float, the 10-14 percent cost advantage could easily disappear.

TABLE 1

Wafer Fab Investment Costs

($ million)

	130nm, 200mm Fab			**90nm, 300mm Fab**		
	U.S.	Taiwan	China	U.S.	Taiwan	China
Physical Structures	408	402	379	518	490	453
Equipment	1,570	1,557	1,553	1,906	1,894	1,889
Total	1,977	1,959	1,932	2,424	2,384	2,342

Capacity Assumption:

8,000 wafer starts per week for 130nm/200mm fab and 6,000 wafer starts per week for 90nm/300mm fab.

TABLE 2

Wafer Fab Investment Costs

(U.S. = 100)

	130nm, 200mm Fab			**90nm, 300mm Fab**		
	U.S.	Taiwan	China	U.S.	Taiwan	China
Physical Structures	100	99	93	100	95	87
Equipment	100	99	99	100	99	99
Total	100	99	98	100	98	97

Capacity Assumption:

8,000 wafer starts per week for 130nm/200mm fab and 6,000 wafer starts per week for 90nm/300mm fab.

TABLE 3

Manufacturing Cost Comparison for 130nm, 200mm Wafer Production

	U.S. *($ '000)*	Taiwan *($ '000)*	China *($ '000)*
Direct Labor	67,350	28,874	10,464
Indirect Labor	62,750	29,768	13,694
Production Silicon	51,500	51,864	52,228
Test Silicon	7,533	7,576	7,620
Masks	8,887	9,037	9,187
Chemicals and Gases	69,794	69,987	70,649
Water	5,325	4,809	4,571
Other Operating	212,966	208,451	206,650
Total Operating	486,104	410,366	375,063
Equipment Depreciation	313,900	311,400	310,650
Building Depreciation	20,375	20,088	18,944
Total Manufacturing	820,379	741,853	704,656

Assumptions

1. 8,000 wafer starts per week.
2. All production subsidies excluded
3. All labor differences due entirely to wage differentials, not productivity differentials.
4. Equipment depreciated using straight-line method over 5 years.
5. Building depreciated using straight-line method over 20 years.
6. All costs stated on a total annual cost basis.

TABLE 4

Manufacturing Cost Comparison for 130nm, 200mm Wafer Production Taiwan and China Relative to U.S. Costs

(U.S. = 100)

	U.S.	Taiwan	China
Direct Labor	100	43	16
Indirect Labor	100	47	22
Production Silicon	100	101	101
Test Silicon	100	101	101
Masks	100	102	103
Chemicals and Gases	100	100	101
Water	100	90	86
Other Operating	100	98	97
Total Operating	100	84	77
Equipment Depreciation	100	99	99
Building Depreciation	100	99	93
Total Manufacturing	100	90	86

Assumptions

1. 8,000 wafer starts per week.
2. All production subsidies excluded
3. All labor differences due entirely to wage differentials, not productivity differentials.
4. Equipment depreciated using straight-line method over 5 years.
5. Building depreciated using straight-line method over 20 years.
6. All costs stated on a total annual cost basis.

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TABLE 5

Manufacturing Cost Comparison for 90nm, 300mm Wafer Production

	U.S. *($ '000)*	**Taiwan** *($ '000)*	**China** *($ '000)*
Direct Labor	33,519	15,431	6,414
Indirect Labor	56,400	27,343	12,569
Production Silicon	***	***	***
Test Silicon	***	***	***
Masks	***	***	***
Chemicals and Gases	***	***	***
Water	***	***	***
Other Operating	478,805	464,827	459,055
Total Operating	568,724	507,601	478,038
Equipment Depreciation	381,200	378,700	377,700
Building Depreciation	25,900	24,500	22,669
Total Manufacturing	975,824	910,801	878,407

Assumptions

1. 6,000 wafer starts per week.
2. All production subsidies excluded
3. All labor differences due entirely to wage differentials, not productivity differentials.
4. Equipment depreciated using straight-line method over 5 years.
5. Building depreciated using straight-line method over 20 years.
6. All costs stated on a total annual cost basis.

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TABLE 6

Manufacturing Cost Comparison for 90nm, 300mm Wafer Production

Taiwan and China Relative to U.S. Costs

(U.S. = 100)

	U.S.	Taiwan	China
Direct Labor	100	46	19
Indirect Labor	100	48	22
Production Silicon	***	***	***
Test Silicon	***	***	***
Masks	***	***	***
Chemicals and Gases	***	***	***
Water	***	***	***
Other Operating	100	97	96
Total Operating	100	89	84
Equipment Depreciation	100	99	99
Building Depreciation	100	95	88
Total Manufacturing	100	93	90

Assumptions
1. 6,000 wafer starts per week.
2. All production subsidies excluded
3. All labor differences due entirely to wage differentials, not productivity differentials.
4. Equipment depreciated using straight-line method over 5 years.
5. Building depreciated using straight-line method over 20 years.
6. All costs stated on a total annual cost basis.

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APPENDIX 3

QUANTIFYING EFFECT OF THE DIFFERENTIAL VAT AND OTHER GOVERNMENT POLICIES ON SEMICONDUCTOR INVESTMENT

Chinese and Taiwanese government policies promote semiconductor investment in their economies in two ways. First, both governments provide their own resources, whether in the form of equity, preferential loans, tax reductions, or in-kind "investment" such as R&D results. Second, and much more important, is the effect such polices have on encouraging private investment in these countries' domestic industries. In both countries, promotional policies can both (a) *stimulate* investments that might not otherwise occur absent promotional policies and (b) *shift* investment patterns from one jurisdiction to another, as investment is attracted to higher returns afforded by more favorable policies.

As this section will illustrate, all promotional policies in Taiwan and China stimulate investment in semiconductor manufacturing in this region that might not otherwise occur, but China's preferential value-added tax on domestically produced (as opposed to imported) semiconductors is by far the most powerful policy factor behind the *shift* of semiconductor investment from Taiwan (and elsewhere) to China. China's VAT policies alone can more than double investors' expected rate of return on China

A. Factors Driving Investment Decisions

Most of the capital for Chinese and Taiwan semiconductor investment comes from private sources, despite the role government plays in both countries. Indeed, as described in the China and Taiwan sections of this paper, stimulating private investment is the primary object of government policy, with government capital playing a supporting role to that objective.

Private investment decisions are made based on the *expected* return on investment and its associated risks. To access the effect of Chinese and Taiwanese government policies on investors' decisions to invest in those countries, therefore, it is useful quantify the effect such policies may have on investors' expectations for their returns on investment, and how confident they are in these expectations (i.e., the level of investment risk they perceive). Investors' expected investment returns are, in turn, determined by investors' expectations regarding the net (after-tax) profitability of the enterprise. This section considers the role of three categories of Chinese and Taiwanese government policies on enterprise profitability.

- The Chinese government's preferential value-added tax (VAT) on domestically produced semiconductors.

- Tax holidays for semiconductor enterprises.

- Preferential ("soft") government loans to semiconductor enterprises.

This assessment does not estimate the *absolute* level of profits and investor rates of return; rather, it estimates the *relative* impact of various government policies on such returns.

B. A Simple Model for Assessing the Effect of Policies on Enterprise Profitability

A starting point for estimating the effect of various government policies on the profitability of semiconductor investments would be prospective investors' forecast income statement for the semiconductor company that is the candidate for the investment. For our purposes, it is best to use a Chinese-located semiconductor company because of the importance in examining the effect of the Chinese VAT. (It should also be noted that, as discussed in Section V, below, our survey suggests that there are not significant commercial-cost differences between new fabs in China and Taiwan.)

None of the new Chinese semiconductor foundries in China has published, or even alluded to, their projected or historical financial statements. As the basis for estimating the profit impact of policies, therefore, we have used an estimate of SMIC's 2004 income statement produced by SG-Securities of Singapore, a subsidiary of the major French financial concern, Societe Generale Groupe. Although we have been unable to obtain any information from SG-Securities as to how its forecast was developed, there are three reasons to believe that the forecast is a reasonable starting point for this analysis: (1) Singapore interests are heavily involved in SMIC, and thus SG-Securities is likely to have access to the reliable information; (2) we compared SG-Securities' forecast for SMIC's income statement, the "base case" of which assumed a 71-percent capacity utilization, to TSMC's income statement during two recent quarters in which TSMC had similar rates of capacity utilization, and found the results to be reasonably similar;[1] (3) as discussed above, whether the SG-Securities forecast is "accurate" is less important than whether potential investors *perceive* the forecast to be accurate, because it is on such forecasts -- not eventual outcomes -- that investment decisions are made.

Throughout this section, the quantitative assessments of expected profitability of Chinese semiconductor manufacturing investments will be based on the SG-Securities income-statement forecast for 2004, which we will simply call "the profit model."

Figure 5 shows the sensitivity of annual net profits to the semiconductor manufacturer's average selling price (ASP) per wafer (8" equivalent basis), based on the profit model and assuming a capacity utilization of 71 percent.[2] As can be seen from the figure, the company's breakeven point for operating profits would be under $1,100 per 8" wafer, where the line crosses the zero-profit axis. Because price changes "go straight to

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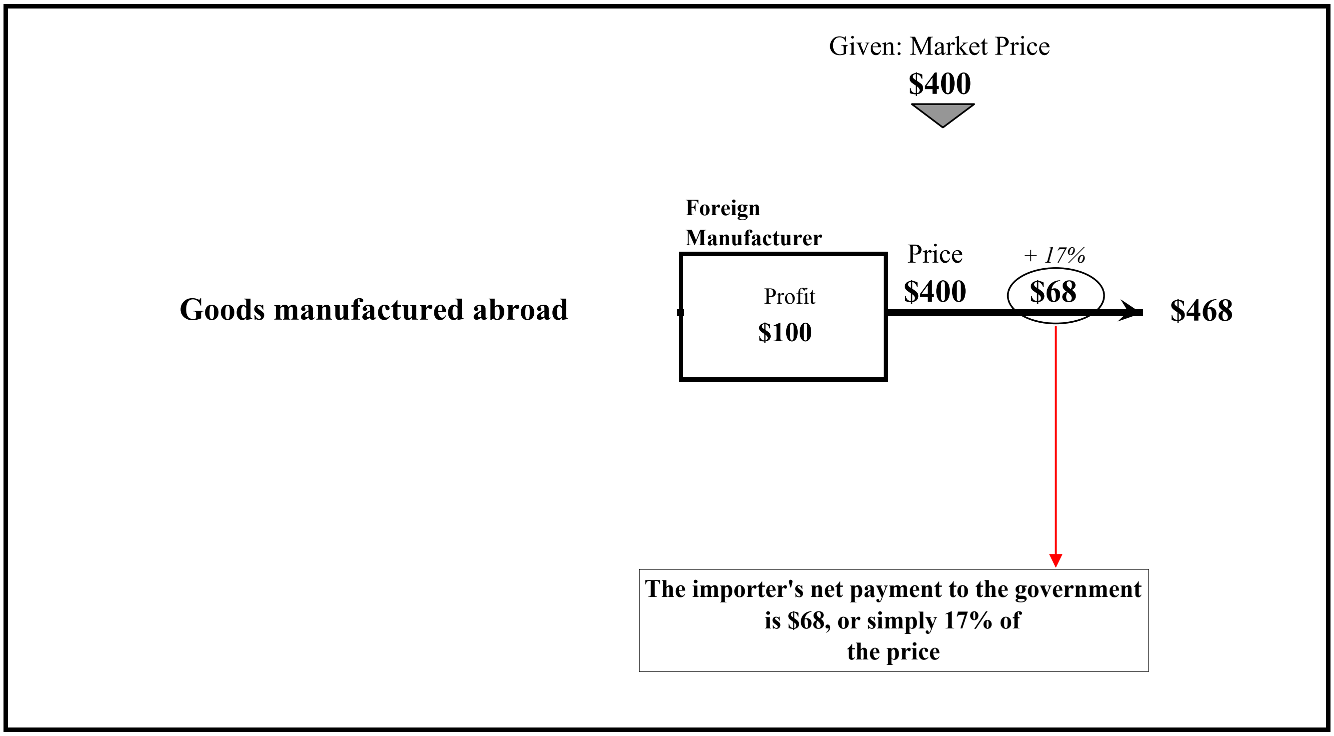
1 The first quarters of 2001 and 2002, both of which reflect TSMC's post-merger financials. TSMC, *Key Historical Statistics*, 2q 2002.

2 This capacity utilization was the "base line SG-Securities" level. The sensitivity of net profit to capacity utilization is explored below.

Figure 1

China VAT: Competitiveness Effects

A Highly Simplified Example for Domestic Final Sales: VAT on Imported Goods



the bottom line" (in other words, they do not effect costs, there is a direct relationship between realized output price and pre-tax profits.

Figure 5 also shows the effect of a 15-percent enterprise tax on net profitability. (Most foreign invested enterprises -- FIEs -- nominally are subject to a 15-percent enterprise income tax; complexities such a loss-carry forwards, etc., are not considered here for sake of simplicity.)

For illustrative purposes only, Figure 5 shows that at a wafer ASP of $1,200, net profitability would be $89 million. Using the profit model, Figure 5 summarizes the effect of government policies -- the VAT, tax holidays, soft loans, and others -- on the company's net profitability, as discussed below.

C. Policy Effects on Investors' Expected of Rate of Return

1. Effect of the VAT. Semiconductor design and manufacturing in China enjoys special treatment under the Chinese value-added tax (VAT) regime, as described in detail in the China chapter of this paper. To understand the effect of these IC-specific preferences on the investment in Chinese semiconductor enterprises, it is useful to review the operation of the "normal" Chinese VAT regime for manufacturing in general and to illustrate how the IC-specific VAT policies differ from the norm, particularly with respect to domestic manufacturers' competitiveness vis-à-vis imports.

a. The VAT preference for semiconductors: an illustration. The regulations governing the application of the VAT to the semiconductor market in China is described in the China section. This section illustrates how these rules operate mechanically to act, in effect, as a tariff barrier to imports to the advantage of the domestic manufacturer for good sold into the domestic market.[3] For the sake of clarity, simple numbers are used to illustrate the VAT concepts in a highly simplified[4] fashion (i.e, these numbers are not applicable to semiconductors *per se*.)

Figure 1 shows the simple effect of the VAT on the final (post-VAT) price of imported goods. Assume there is a foreign manufacturer that brings into China a good

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[3] Because VATs are rebated upon export, Chinese VAT preferences have no effect on inducing investment into China for facilities devoted to export. It should be noted, however, that normally a Chinese exporter would not be rebated the VAT it had paid on equipment purchases, regardless of whether the final product was exported, whereas qualifying semiconductor manufacturers are allowed such rebates. Although this policy does not provide a positive inducement to invest in China as opposed to another jurisdiction, it does remove a disincentive that would apply to all other sectors.

[4] One dynamic that is simplified-away from this model is the fact that the imposition of any sales-related tax, such as a VAT, affects the pre-tax price. The magnitude of this effect is related to the elasticities of supply and demand for the good in question. For purposes assessing the effect of the Chinese semiconductor-VAT policies on investment, this simplification is not important because any reduction of price in response to the VAT effects the foreign manufacturer's profitability in a manner which is the virtual mirror-image to increase in the domestic manufacturer's profitability, as explained below.

for which the market-prevailing retail price *before* the VAT is $400, and that at this price the manufacturer would enjoy a $100 profit. The effect of normal[5] Chinese VAT on such imports would be a 17 percent VAT levied on the $400 price of the good, thus the consumer faces a $400 price plus a $68 VAT, or a $468 post-VAT price.

Figure 2 shows that a <u>domestic</u> manufacturer with an identical cost structure as the foreign manufacturer would normally be in a worse position vis-à-vis an imported good because it must charge the identical 17 percent VAT on the final product price *and pay a non-refundable 17 percent VAT to its equipment supplier*. As a result, the final, post-VAT price is identical to that of the foreign manufacturer selling in China, but the domestic manufacturer's profit is reduced by the $17 non-refundable VAT it has to pay on equipment, to a profit of $83.

Note that this example assumes that the domestic price is, in effect, set by the total price (the manufacturer's price plus the VAT) on *imports*. As with any import tariff, this tends to be more true whenever there is high import penetration into a domestic market and/or there is extremely tight supply for good that is not very price-sensitive (i.e., inelastic with respect to price). For the situation at hand -- the Chinese semiconductor market -- the first of these two conditions certainly holds (import penetration exceeds 80 percent) and the second condition is somewhat true for semiconductors as a product.[6] As domestic Chinese production grows relative to imports, this example will become less representative of the VAT preference's effects because imports will no longer be setting the prevailing price; rather, domestic companies -- presumably all with the same VAT preferences -- will compete against each other to drive the price down.

Figure 3 shows the modifications to the normal VAT that apply to qualifying domestic semiconductor manufacturers.

- First, the manufacturer need not pay[7] the usual 17-percent VAT on equipment, thus not facing the reduction in profit it would suffer under the "normal" VAT regime, leaving a profit of $100 (identical to the similarly situated foreign manufacturer).

- Second, the semiconductor manufacturer need not pay[8] the refundable VAT on raw materials -- if imported, which is largely the case in China. This has

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5 Aside from the semiconductor-related preferences at issue, there are other complexities to the VAT rates, such as lower rates for small businesses and certain goods, that will be ignored here.

6 The demand for semiconductors is a "derived demand"; i.e., it is highly dependent upon the demand for downstream product, such as a computer, and therefore changes in the semiconductor's price has little effect on the demand for the overall product in the market.

7 Or, perhaps, is allowed a refund on.

8 Or, perhaps, is allowed a refund on.

Figure 2

China VAT: Competitiveness Effects

A Highly Simplified Example for Domestic Final Sales: Normal VAT on Domestic Goods

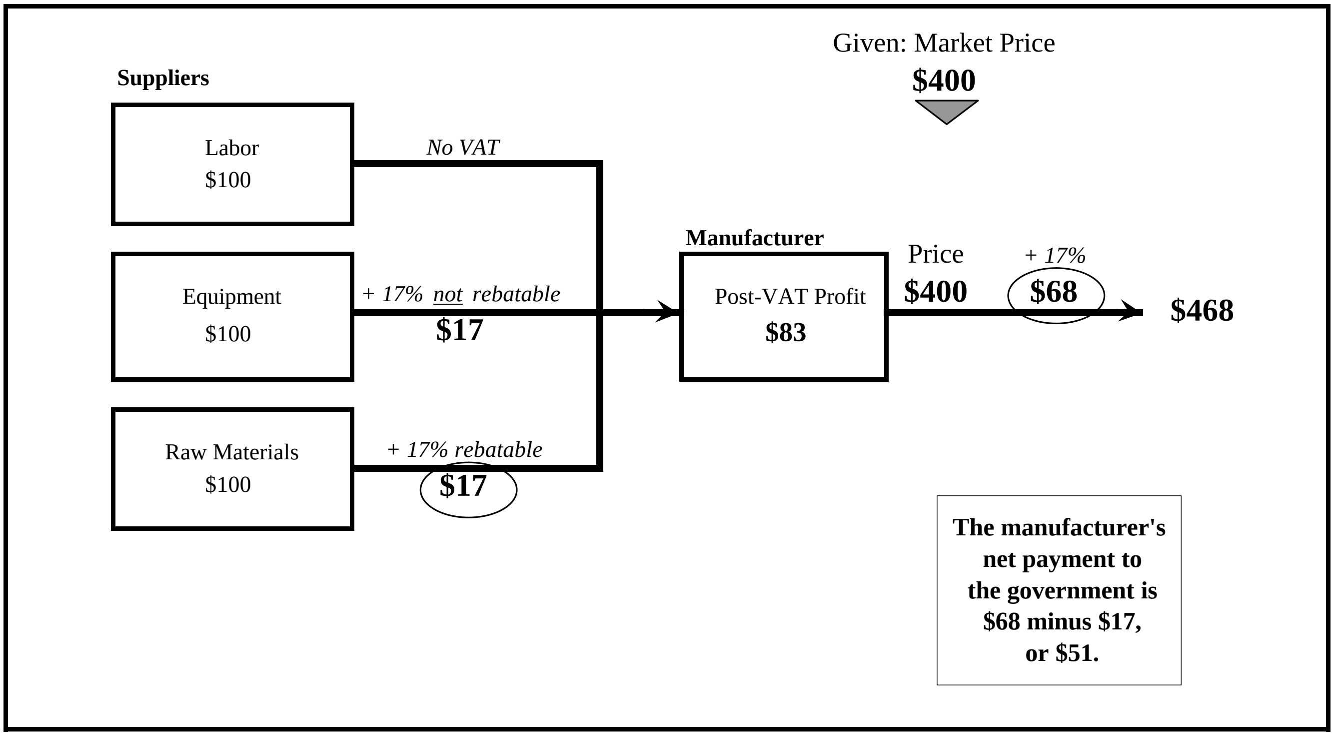
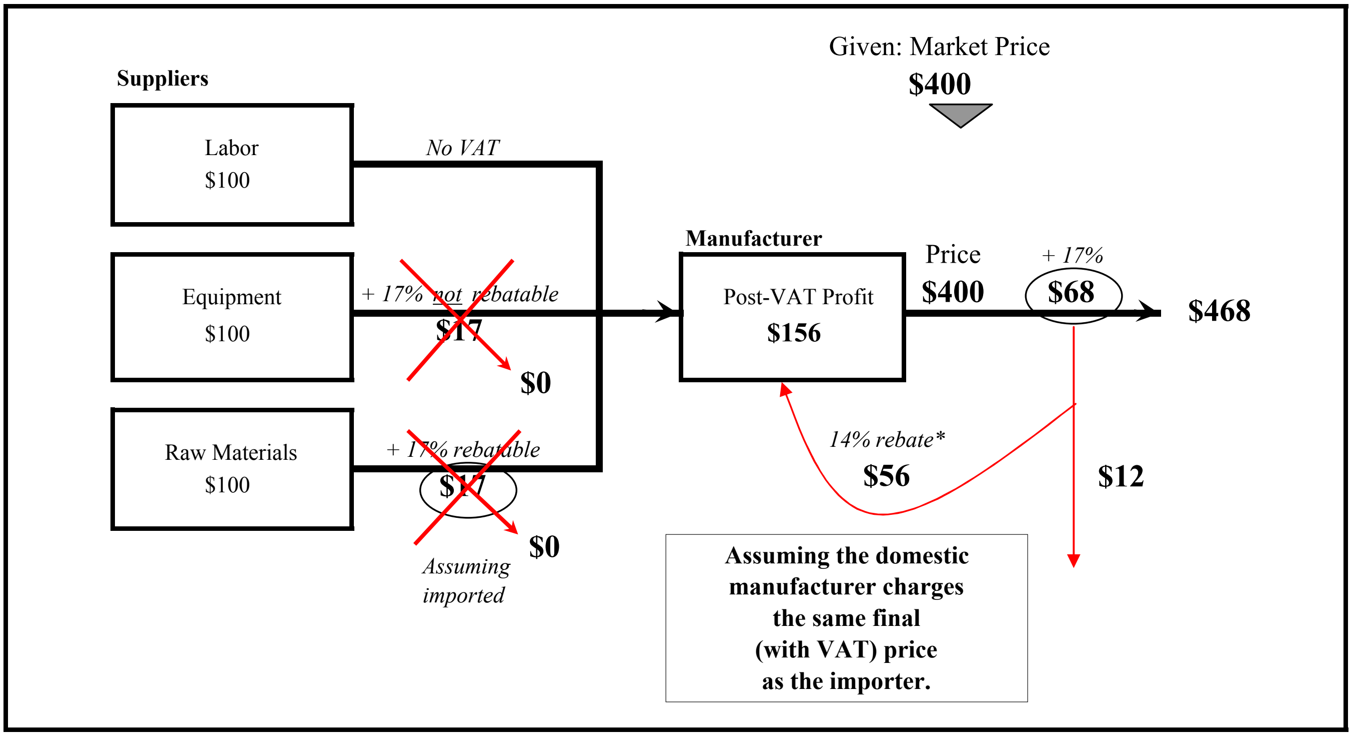


Figure 3

China VAT: Competitiveness Effects

A Highly Simplified Example for Domestic Final Sales: VAT Preference for Domestic ICs



no direct effect on the domestic manufacturer's competitiveness vis-à-vis imports because the VAT paid on raw materials would normally be refundable[9] to the manufacturer.

- Third, and most importantly, the domestic semiconductor manufacturer is rebated 14 percentage points (or perhaps 11 percentage points[10]) of the 17 percent VAT, leaving an effective 3-percent (or perhaps 6-percent) VAT for domestic manufacturers rather than the 17 percent on imported semiconductors. For the example in Figure 3, this equals a $56 rebate from the government to the domestic manufacturer that foreign producers do not receive.

Figure 3 presents the final (post-VAT) profit for the domestic manufacturer of $156, compared to the "normal" domestic profit of $83 (see Figure 2) or $100 for the foreign manufacturer (see Figure 1). ***Viewed from another perspective, this example shows that the semiconductor-specific VAT policy acts like a 14 percent tariff on imports which the domestic producer does not have to pay***. In particular, whereas the consumer will pay $468 for an imported semiconductor that provides the foreign manufacturer with a $100 profit, the same consumer can buy the same device from a domestic producer for $412 -- implying a 3-percent ($12/$400) "tariff" -- if the domestic producer reduces its price to also earn $100. Thus, imports are charging a 17-percent "tariff" while domestic producers are charging a 3-percent "tariff" -- a 14-percent differential in terms of the selling original $400 price.

Although this example shows the domestic manufacturer enjoying the entire VAT refund as profits, this VAT-created advantage could, of course, be used by domestic manufacturer to reduce the final semiconductor price to undercut foreign competitors in the domestic market. For example, instead of an $83 per-unit profit on a $400 price, the company could increase its *volume* of sales by taking an $82 per-unit profit on a $399 price. If truly identical with the foreign competitor in every respect -- such as cost and reliability -- the domestic manufacturer would likely undercut the import price by a small amount to divert customers away from imports based on price, and enjoy most of the refund in terms of a pure per-unit profit. The following section examines the investment-inducement effect of these considerations using a reasonable model of the actual financial structure of the new semiconductor foundries in China.

b. ***VAT's effect on net profitability.*** As noted above, the key variable that drives investors' decisions is, for a given level of risk, the expected rate of

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9 Or, more accurately, credited against the amount of VAT collected by manufacturer on its downstream sales. Here, too, the "normal" Chinese rules regarding the amount of VAT refunds and credits are highly complex, and often vary by enterprise depending on, for example, the year in which the enterprise was legally established.

10 See China section on the ambiguities and inconsistencies in Chinese policy regarding the amount of VAT refund for qualifying domestic semiconductor producers. The numeric examples here will use the 14-percentage-point reduction.

return on the potential investment. To estimate the effect of the Chinese VAT policies on investment in Chinese semiconductor manufacturing companies, it is first necessary to estimate the effect of the VAT policy on the investee's (the manufacturer's) profitability.

The VAT's effect on operating profits through price and volume effects. As explained previously, a domestic manufacturer benefiting from the VAT policy can choose to raise prices (and profits) under the price umbrella created by the 14-percent VAT-generated import "tariff," or it can underprice imports to gain sales volume, or a combination of both. Assuming 100-percent domestic sales:[11]

- ***Raise prices***. Assume, for example, that without any VAT the average selling price (ASP) per 8" wafer in China will be $1,200 in 2004.[12] the company's implied net profit at that level would be $89 million. Then assume that the overall market price rises by 14 percent as a result of the IC-specific differential VAT policy, as explained in section A, above. This lifts the company's ASP by 14 percent (assuming it decides not to underprice imports[13]) to $1,368, thus increasing net profits to $179, or more than double the pre-VAT level, as shown in Figure 5.

- ***Gain volume***. By using the price premium on imports to underprice those imports, the domestic manufacturer can capture additional sales contracts that would otherwise go to foreign manufacturers. This would allow the domestic company to increase its capacity utilization. Although total costs rise because the volume of sales would increase, the high degree of capital intensity of semiconductor manufacturing implies that profits rise disproportionately to volume. As can be seen in Figure 5, an **assumed** increase in capacity utilization from 71 percent to 90 percent would increase net profits to $375 million from $89 million with no VAT preference (or from $179 million from only the price effect of the VAT preference).

Thus, the Chinese VAT preferences for semiconductors can lead to a doubling or quadrupling of net profitability, depending on whether one considers price effects alone or both price and volume effects, and therefore *a similar effect on investors' expected*

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11 Exports receive no advantage from the VAT policy.

12 This appears to be a reasonable assumption for a 2004 scenario (the lower the assumed ASP, the more conservative the assumption for purposes of considering the effect of the VAT). TSMC's ASP has recently ranged in the $1,300 to $1,700 range, whereas UMC and Chartered reported ASP around $1,000 in the depressed fourth quarter of 2001. GSMC has recently used $1,500 as a basis for estimating its breakeven point in terms of capacity utilization. SMIC claims that it will not make a policy of underselling TSMC, although there are reports that SMIC has already done so in the Taiwanese market at ASPs around $700.

13 Note that this depends critically on imports setting domestic prices; see discussion of this issue in section 1. In addition, recall that this assumes 100 percent domestic sales.

rates of return on investment.[14] It is important to recognize that, because of the number of assumptions involved, these results cannot be considered precise; they are, however, indicative of the order-of-magnitude effects of the VAT on enterprise profitability and rates of return.

2. The Effect of Enterprise Income Tax Benefits. As discussed in the tax sections of the China and Taiwan chapters of this paper, semiconductor manufacturing enterprises can *expect* to pay effectively zero income tax for perhaps at least the first decade of the life of the investment. For the enterprise, this creates on obvious cost savings. For the prospective investor, such tax benefits increase the rate of the return on investment; the magnitude of this increase, however, depends on the "benchmark" tax rate, or the normal rate that the investor would expect to pay absent the government policy. Yet this benchmark rate differs depending on the question being asked. If the comparison is to the U.S. or other locations without a tax holiday, the impact is significant. However, if the issue is whether Chinese income-tax policies attract semiconductor investment to China *that would otherwise be undertaken* in Taiwan, the answer is simple and clear: the Chinese policy simply puts China-based investments on the same (zero) level as Taiwanese investments and cannot, considered in isolation, shift investment patterns. Given the worldwide scaling back of semiconductor investment in recent years, perhaps a more germane question is the degree to which the tax-free environment increases rate of return on investment and *therefore the likelihood that the investment is undertaken at all*.

Figure 5 presents the effect on net profits of a zero-tax environment, with the price-effect of the VAT preferences as a starting point. Again, a no-preferences ASP of $1,200 is assumed for illustration purposes. The $179 million net profit under the VAT preference (assuming no volume effects) rise to $211 million, or 2.4 times higher than the profit model indicates for the no-preferences scenario.

Although these figures are only illustrative (albeit reasonable), they do strongly indicate that the effect of China's VAT preference is far stronger than that of the enterprise-income tax preferences. This also suggests that, simply put, the zero-income-tax environment in China puts China on a similar playing field as Taiwan and above non-holiday jurisdictions, and that the Chinese VAT -- for which there's no counterpart in Taiwan or other jurisdictions -- provides China with an overwhelming advantage.

3. The Effect of Government Loans. Government loans to semiconductor manufacturers in China and Taiwan have a moderate direct effect on these companies' income statements, yet likely have a stronger effect on investors' perceptions regarding the risk of their investments.

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[14] The income tax rate to which the investor is subject is not relevant, as long as the effective percentage rate does not change in relation to the level of received profits (dividends or capital gains).

Figure 4

Summary of Effects of Chinese Policies on Net Profit

Note: These numbers are illustrative only, based on a reasonable hypothetical.

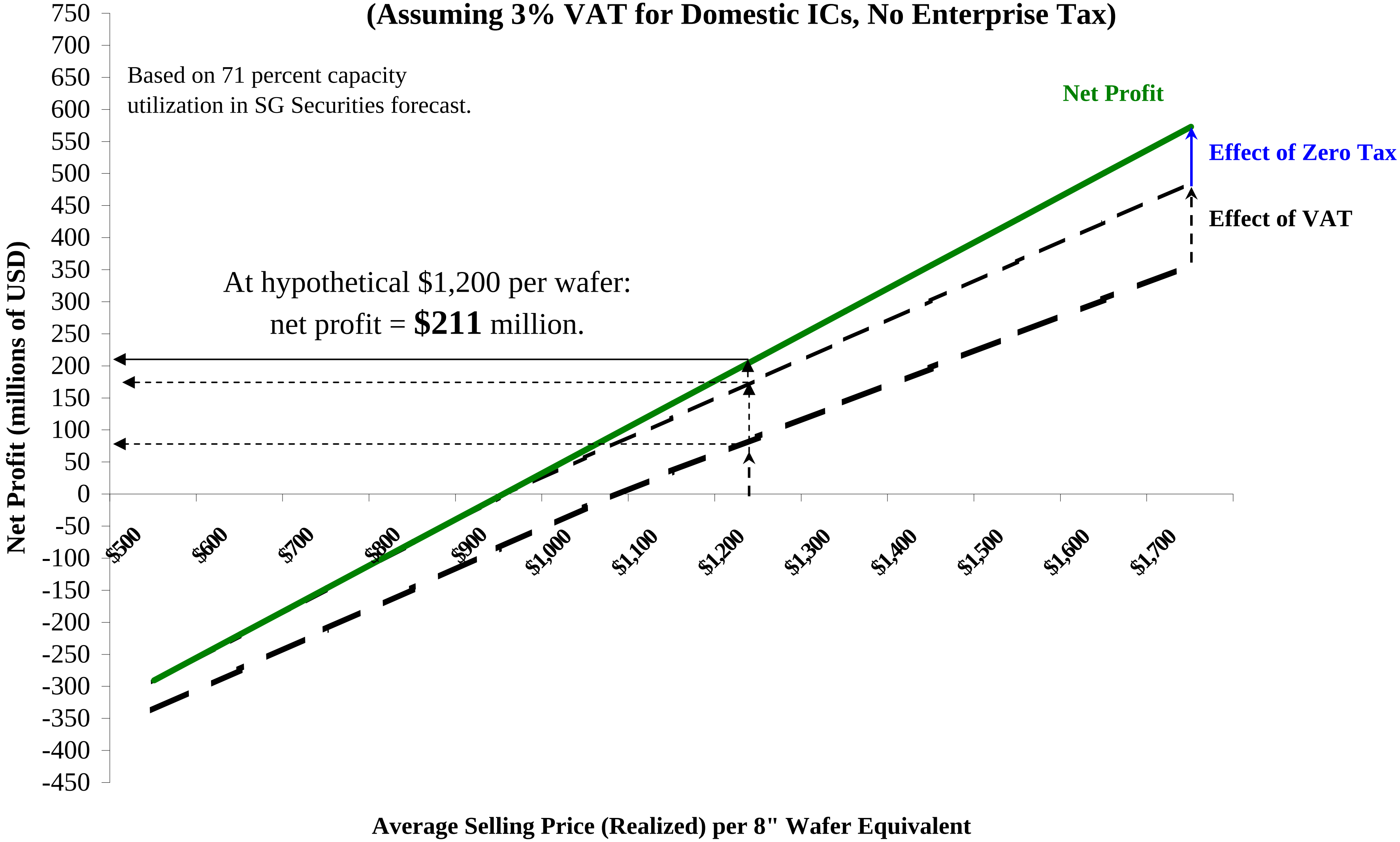
Chinese Semiconductor Preferences					
VAT Preference[1]	Tax Holiday[2]	Soft Debt[3]	Description	Net Profit (millions USDs)	Ratio to Base Case
None	None (15% tax)	None	Base case, assuming no preferences	**89**	**1.0**
3%*	None (15% tax)	None	VAT preference: ***price effect only**	**179**	**2.0**
3%**	None (15% tax)	None	VAT preference: **price **and volume** effect	**375**	**4.2**
3%	**Tax Free**	None	VAT preference price effect, with zero enterprise tax	**211**	**2.4**
3%	**Tax Free**	**3pp preference**	VAT preference price effect, with zero enterprise tax, soft debt	**225**	**2.5**
3%**	**Tax Free**	**3pp preference**	All effects	**456**	**5.1**

Notes:

1. "3% VAT preference" indicates domestic ICs pay a net (post-refund) VAT of 3% rather than 17% normal (and imported IC) VAT.
2. Tax holiday assumes that the enterprise pays zero tax. All other scenarios assumes enterprise pays current rate normally applied to FIEs.
3. Assumes SMIC received $480 million in government loans (as suggested by evidence) at 3 percentage-points below market (pure assumption for illustrative purposes)

Figure 5

Profit Model: 2004 Profit: Effect of VAT and Enterprise Tax Preferences (Assuming 3% VAT for Domestic ICs, No Enterprise Tax)



In the case of recent fab investments in China, large government loans may have played a key role as "seed money" around which private capital could rally. Indeed, given the sheer magnitude of the Chinese government loans to SMIC -- in excess of $480 million, mostly in hard currency, during a severe electronics recession -- it could be argued that SMIC would not have gone forward without such a government loan. The favorable terms of the loan also appear to have extended beyond the interest rate charged. Although the exact interest rates on the loans are not known, there have been statements made that the repayment terms are highly flexible,[15] which further reduces the *perceived* risk from the viewpoint of the investor.

Considering the effect on the income statement in isolation, however, semiconductors' benefits from such loans is not great when compared to the VAT benefits and the tax benefits. Figure 6 percents the effect on the profit model, assuming that the enterprise is being relieved of 3 percentage points of interest per year[16] on a $480 million loan (approximately the amount of SMIC's government loans). The net result is a small increase in net profitability (to $225 million) from the level assuming only the price effects of the VAT and the zero-tax policy ($211 million).

D. Conclusion

Figure 4 or 5 presents the total change in profit caused by the price- and volume-effects of the VAT, the zero-enterprise-tax environment, and the assumed interesting savings on the government loans to the semiconductor enterprise. For the example in which the starting-point wafer ASP is $1,200 and capacity utilization is 71 percent, the combined effect of these three policies alone is to increase expected net profits -- and therefore expected rates of return to investors -- by more than 400 percent, or from $89 million to $456 million.

At all profit levels, the VAT is the overwhelming source of the increased net profits, and this is the one policy which China can maintain but Taiwan cannot. Roughly speaking, all other Chinese and Taiwanese policies merely put each country closer to being on a level playing field with the other. Yet, from a global perspective, these policies have a powerful effect on pulling semiconductor manufacturing investment to the region.

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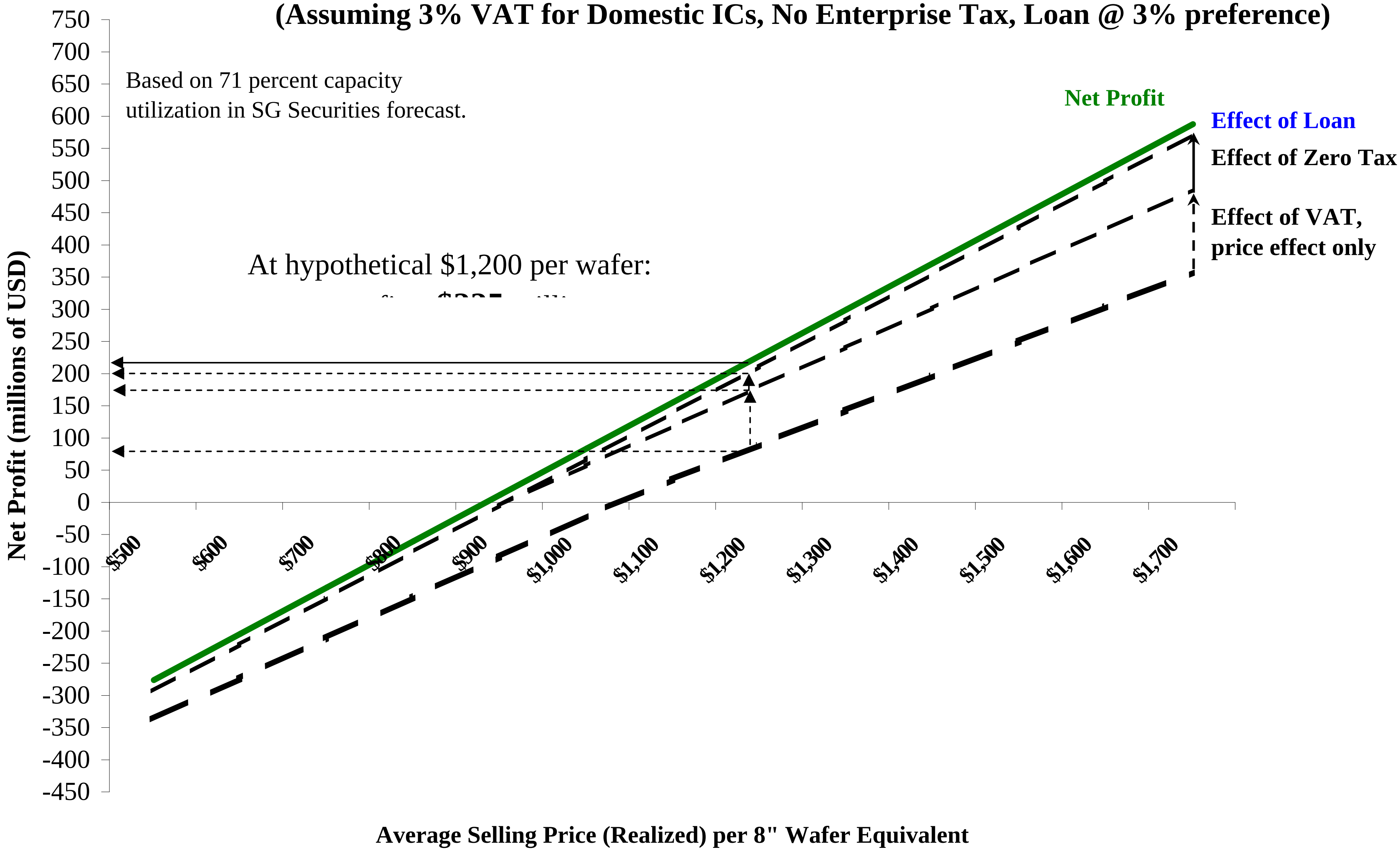
15 See China section, above.

16 There are likely three components to the interest-rate subsidy on these loans: (1) most Chinese government loans have a subsidy element because rates are regulated in the presence of capital shortages; (2) SMIC may have received a special rate even when compared to other borrowers from government banks, particularly when the reportedly "flexible" terms are taken into account ; (3) local governments have programs to pay some portion of eligible semiconductor enterprises' interest costs, albeit these seem to be limited to RMB-denominated loans. See Section II, above.

Figure 6

Profit Model: 2004 Profit: Effect of VAT and Enterprise Tax Preferences

(Assuming 3% VAT for Domestic ICs, No Enterprise Tax, Loan @ 3% preference)



APPENDIX 4

THE EROSION OF EXPORT CONTROLS ON SEMICONDUCTOR TECHNOLOGY FOR CHINA

For decades the U.S. and its allies have maintained restrictions on the export of advanced semiconductor technology to China, effectively ensuring that Chinese semiconductor producers could not achieve technological parity with the global leaders. These restrictions have eroded to the point that they represent more of an impediment than an outright barrier to Chinese development. China's semiconductor industry has made rapid technological strides in the past five years which is attributable, in substantial part, to the acquisition of foreign process technology and manufacturing equipment. U.S. export controls on semiconductor technology to China, while more restrictive than those of its allies, but still permit most proposed exports of semiconductor manufacturing equipment (SME) to China. U.S. allies do not categorize China as a security threat and do not restrict export of most types of semiconductor technology and equipment to China. While Japan, in particular, has balked at licensing certain SME exports -- specifically Nikon steppers with 0.18 micron capability -- Chinese producers have generally succeeded in obtaining most of the equipment they seek from non-U.S. sources.[1]

A recent report by the U.S. General Accounting Office found that the current multilateral regime has "not effectively slowed China's ability to obtain billions of dollars worth of advanced semiconductor equipment as part of its national strategy to modernize its semiconductor industry." [2] The 2002 GAO study concluded that China had narrowed the technological gap in semiconductor manufacturing with the U.S. from 7 to 10 years behind to 2 years or less behind (e.g., one generation).[3] While that specific conclusion with respect to current Chinese competency levels is debatable, there is no question that China has succeeded in acquiring advanced Western semiconductor manufacturing technology and equipment and that the leading-edge Chinese firms are gaining ground with respect to the global technological state of the art:

- At present it is relatively easy to obtain export clearances for all of the new and used equipment needed to establish 8-inch fabs using 0.25 micron design rules. Lithography equipment capable of producing line widths of 0.18 microns is difficult to get, but is currently obtainable, particularly from European sources.As of September 2002 equipment needed to establish 12-inch wafer fabrication lines was "impossible" for Chinese manufacturers to obtain from any source, but a universal expectation existed that this situation would change in the not-distant future.

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1 Interview with SMIC's Tsuyoshi Kawanishi, *Nikkei Sangyo Shimbun* (March 28, 2002).

2 General Accounting Office, *Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review* (April 2002) GAO-02-620.

3 GAO, *Export Controls*, op. cit. (2002) p. 2.

1. U.S. export controls on SME. U.S. controls on exports of semiconductor technology and equipment are more rigid than those of other supplying countries, and some recent examples exist which indicate that U.S. controls are a continuing impediment to Chinese semiconductor producers.[4] However, U.S. controls are now more of a hindrance to Chinese development than an outright barrier because Chinese manufacturers are increasingly able to obtain comparable SME from non-U.S. sources. In addition, U.S. authorities have allowed the export of some advanced U.S. equipment from the U.S. to China:

> *The U.S. government restricts mainly lithography equipment to no better than 0.25 Mum, but deep UV steppers are being shipped, giving capability at 0.18 Mum.*[5]

The United States regulates the export of dual use technologies which are regarded as "sensitive," e.g. posing a defense or foreign policy concern, including advanced semiconductor manufacturing equipment, materials and devices.[6] U.S. export regulations are not explicit with respect to any overall criteria for limiting China's access to advanced semiconductor technology, and the GAO cited numerous sources to the effect that a "two-generations-behind" policy is pursued in the government at the working level, but also presented evidence that to the extent "two-generations-behind" still serves

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4 In 2001 SMIC, which was pushing forward with a 1.5 billion fab investment in Shanghai, encountered a delay because of an unexpected decision by the Bush Administration to freeze an export license granted under the Clinton Administration for the export of two electronic beam systems that had been ordered for the new facility. Six months later an interagency group had been formed to review the decision, but by then SMIC had turned to alternative foreign suppliers. Interview with SMIC executives (Shanghai, September 2002); Zheng Li, "U.S. Attempt to Restrict Technology Exports Will not Work," *Renmin Ribao* (August 26, 2002). "The process of obtaining export licenses [for SME destined to China] is more complicated" for China than other countries. Mary Puma, President of Axcelis Technologies, commenting an capital equipment purchasing for semiconductor operations in China. Executives Discuss Promise and Pitfalls of Doing Business in China," *Semiconductor International* (September 2002).

5 "Executives Discuss Promise and Pitfalls of Doing Business in China," *Semiconductor International* (September 2002).

6 U.S. controls are administered pursuant to the Export Administration Act of 1979. This Act was terminated in 1994 but its provisions have been extended by successive Executive Orders. See Executive Order 13222, Aug. 17, 2001 (66 Fed. Reg. 44025). In order to export equipment or technology designated as sensitive, exporters are required to secure licenses from the Department of Commerce authorizing specific export transactions. A number of agencies review license applications, including the State Department and the Department of Defense. Restricted SME items include stored program controlled machines for epitaxial growth, ion implementation, plasma dry etching, chemical wafer deposition, automated wafer handling, and testing.[6] Optical and x-ray wafer steppers capable of producing minimum feature sizes of 0.5 microns or less as possessing a light source wavelength shorter than 350 nanometers are categorized as sensitive. U.S. Department of Commerce Dual Use List, Category 3 (Electronics), Part (3) (b) (1) (a)-(e) and Category 3, Part (3)(B)(1)(f).

as a regulatory benchmark, it is ineffective.[7] The GAO report observed that the U.S. Export Administration "approves most licenses for exports of semiconductor manufacturing equipment and materials to China".[8]

2. Erosion of multilateral controls. During the Cold War, the export of dual-use technology to Warsaw Pact countries, China, and certain other countries was regulated by the U.S. and its allies in the Coordinating Committee for Multilateral Export Controls (CoCom), pursuant to which all member countries agreed not to export certain designated dual-use products and technology to the Warsaw Pact countries and China, and to secure unanimous pre-approval for export of nonprohibited items.[9] CoCom was replaced by the so-called Wassenaar Arrangement in 1996, a voluntary system for coordinating and sharing information with respect to national controls on conventional weapons and dual use technologies.[10]

The Wassenaar regime differs from CoCom in a number of significant respects: Unlike CoCom , which was explicitly directed against the Warsaw Pact and China, Wassenaar's' controls are not directed at any particular country and merely commit signatories to vaguely defined self-restraint -- e.g. not to export technologies in a manner which, in the view of the exporting country, would result in the development or enhancement of military capabilities which undermine regional and international security.[11] The GAO concluded in 2002 that "the United States is the only [Wassenaar]

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7 U.S. Secretary of Commerce Donald Evans stated in a January 2002 letter to GAO that "the U.S. Government does not seek to use the export licensing process to keep China at least two generations behind global state-of-the-art manufacturing capabilities." Letter from Commerce Secretary Donald L. Evans to GAO Director Joseph A. Christoff, January 16, 2002. Officials from the Commerce, Defense, and State Departments also stated that "two-generations-behind" is not U.S. policy when they commented on the draft GAO study. The GAO responded that "in its detailed comments [on the draft] the Commerce Department contradicted this assertion and stated that certain exports to China are limited to two generations behind state-of-the-art levels." Semiconductor Industry officials confirmed to the GAO that "two-generations-behind" was U.S. government policy.

8 While the licenses themselves contain conditions stipulating how the equipment can be used, GAO found that the Commerce had not conducted any 'end use' checks on the equipment during the preceding five years. GAO, *Export Controls*, op. cit., p. 27.

9 CoCom consisted of the Nato allies (except Iceland), plus Japan and Australia.

10 The Wassenaar countries include not only the NATO allies, Japan and Australia, but former Soviet bloc countries including Russia and Ukraine. With respect to dual use technologies, members have agreed to guidelines on information exchange with respect to licensing of exports of technologies classified as "basic" (Tier 1), "sensitive" (Tier 2), and "very sensitive" (a subset of Tier 2). A Wassenaar signatories agree to (a) exchange information on all denials of export licenses for Tier 1 technologies; (b) notify denials of licenses for Tier 2 items within 60 days; (c) to provide biannual information with respect to issuance of licenses for export of Tier 2 items to nonmembers; and (d) to inform other members within 60 days of approval of any license that has been denied by another member within the preceding three years.

11 An informal understanding exists that exports are to be controlled to North Korea, Iraq, Iran, and Libya, but not all members regard all of these four as targets of controls.

member concerned about China, a conclusion that has been reached by other studies as well."[12] European countries "have explicitly rejected a new (technology) embargo on China."[13] GAO found that neither the Europeans nor the Japanese authorities regard China's acquisition of advance semiconductor manufacturing equipment as a threat to regional or international stability.[14] A spokesman for the Defense Science Board commented in 2001 that

> *In the wake of CoCom's dissolution, a chasm has developed between the U.S. and many of its Western allies, who no longer view China as a threat and have relaxed or lifted their dual use export restrictions to China accordingly. This, in turn, has rendered many U.S. controls on exports to China essentially unilateral, thus neutralizing their utility as constraints on Chinese acquisition of dual use technology.*[15]

Wassenaar members have no power to veto any other member's decision to export any piece of equipment or technology to any country. Thus, a recent technology-sharing arrangement between Europe's foremost design center, IMEC of Belgium, and SMIC in Shanghai, required only the approval of export licenses by Belgian authorities.[16]

The Wassenaar Agreement relies entirely upon transparency -- the exchange of information and views -- between the U.S. and its allies -- to achieve the goal of limiting technology exports to states which constitute a security concern. The GAO found, however, that little information is shared between the Wassenaar signatories with respect to the export of most types of semiconductor manufacturing equipment. Only one category of SME, chemical vapor deposition equipment, is subject to reporting requirements, and even with respect to this equipment, the information exchanged "lacks

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[12] GAO, *Export Controls*, (2002), op. cit., p. 17. "Wassenaar members will not embargo civil technology to countries like India and China. Consensus between the United States and its allies on potential threats and on technology transfer has eroded . . . There is no multilateral support for Cold War-style economic warfare or embargo," CSIS, *Computer Exports and National Security in a Global Era,* op. cit., p. xvi.

[13] Center for Strategic International Studies (CSIS), *Computer Exports and National Security: New Rules for a New Century* (June 2001), p. 25.

[14] One Taiwan-invested foundry on the mainland indicates with respect to the acquisition of semiconductor manufacturing equipment that, "we had no problem with imports from the EU; Japan was slower than the EU, but faster than the US; and in the U.S. we faced case-by-case decisions and major delays." Interview with senior manager at a Taiwan-invested foundry (Shanghai, September 2002).

[15] Testimony of Donald Hicks, representing the Defense Science Board Task Force on Globalization and Security before the Senate Committee on Banking, Housing, and Urban Affairs (February 14, 2001).

[16] "IMEC to Cooperate with SMIC, China in Accordance with International Regulations" (May 31, 2002), http://www.imec.be/wwwinter/mediacenter/en/SMIC2002.shtml.

enough detail to shed much light on its capabilities or end use and is of little practical use" in determining the capabilities of the recipient countries.[17]

The U.S. government "generally takes a harder look at export licenses for products going to China than do other Wassenaar countries." [18] In general, a "climate of very limited multilateral cooperation" characterizes the Wassenaar Arrangement, and U.S. allies suspect that U.S. insistence on controls has an ulterior commercial motive.[19] While the effect of protests by the United States cannot be dismissed altogether, in a number of cases other Wassenaar countries have licensed export of SME to China notwithstanding U.S. objections.[20]

> *The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies has not affected China's ability to obtain semiconductor manufacturing equipment primarily because the United States is the only member of the Wassenaar Arrangement that considers China's acquisition of semiconductor manufacturing equipment a cause for concern.*[21]

Given the nature of the Wassenaar regime, as a practical matter, even in instances in which one country denies an export license for a category of SME to China, Chinese buyers are often able to obtain comparable equipment from another western source.[22] Widespread reports indicate that such incidents are indicative of a general trend, and that advanced SME not available from U.S. sources is being supplied to China by the Japanese and the Europeans:

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17 GAO, *Export Controls*, op. cit., p. 18.

18 Jennifer Connell-Dowling, Semiconductor Equipment and Materials International, in "Industry Lobbies U.S. to Allow Access for Tools for 0.18 Micron Design Rules -- China's Fabs Eye on Rule Change," *Electronic Engineering Times* (August 27, 2001).

19 CIS, *Computer Exports and National Security,* op. cit. 2001, pp. 24-25.

20 In 1997, for example, Japan granted licenses over U.S. protests for the export of 0.35 micron technology to Hua Hong-NEC's fab in Shanghai. "Industry Lobbies U.S. to Allow Access for Tools for 0.18 Micron Design Rules -- China's Fabs Eye on Rule Change," *Electronic Engineering Times* (August 27, 2001).

21 GAO, *Export Controls*, (2002), op. cit., p. 17.

22 In May 1998 the United States denied an export license for the sale of an advanced metal organic chemical vapor deposition machine to China's Hebei Semiconductor Research Institute. Hebei simply bought equivalent equipment from a German SME maker, Aixtron GmbH. The United States formally protested this sale to the German government. GAO, *Export Controls*, op. cit., p. 19. The United States has denied export licenses for the sale of arsine and phosphine gases, used in semiconductor manufacturing, to the Institute of Semiconductors in Beijing. According to an official of that Institute, the organization has been able to obtain these gases from European and Japanese sources. In 2001, a U.S.-based SME manufacturer encountered delays in securing an export license for the sale of a mask pattern generating machine to China's SMIC. SMIC cancelled the order and obtained comparable equipment from Micronic, based in Sweden. Ibid.

'If the US won't sell us a piece of equipment, we can get it elsewhere,' said Joseph Xie, an American-educated native of Shanghai who returned to China last year to work for Semiconductor Manufacturing International…[SMIC]. 'We love to do business with the US, but we can't wait forever," Xie said. "Europe and Japan are getting the business.[23]

[23] Startup in China gears for foundry battle (Semiconductor Manufacturing International will launch chip production using 0.25- to 0.35-micron fabrication process; may reach capacity of 42,000 eight-inch wafers/month) *Electronic Engineering Times*, p 38 February 19, 2001.

Appendix 5

Summary of Costs for Chinese Investment Zones

Name	Province	Electricity Rate (yuan/kwh)	Water Rate (yuan)	Land Rate (yuan, unless spec.)	Average Salary (yuan)	Notes
Beijing Economic-Technological Development Area	Beijing	0.401	2.90 / ton	600-800 / m^2	n/a	Electricity rate for peak hours; land rate for industrial use
Shanghai Minhang Economic and Technological Development Zone	Shanghai	0.548	1.10 / m^3	$5.50 / m^2	12,060	Electricity rate for industry under duplex system, and does not include capacity charges; water does not include sewage charge; land rate is for site development, and does not include land use fee; salary is for median Shanghai income
Wuhu Economic and Technological Development Area	Anhui	0.482	0.95 / m^3	120-180 / m^2	At least 12,000	Capacity costs for electricity and water are exempted
Xiamen Haicang Taiwanese Investment Zone	Fujian	0.532	1.60 / ton	n/a	15,276	Minimum salary is 5,040 per year
Fuzhou Economic and Technological Development Zone	Fujian	51 Fen / kwh	1.05 / ton	250-300 / m^2	9,600-13,200	Salary rate is for a technician
Jiaomei Industrial Comprehensive Development Zone	Fujian	0.230	1.5 / ton	900 / m^2	9,600-12,000	Electricity and water do not include capacity fees; land does not include rent; salary is for management personnel
Xiamen Torch Hi-Tech Industrial Development Zone	Fujian	0.532-0.625	1.60 / ton	500 / m^2 (island); 150-300 / m^2 (off island)	37,000	Salary is for executive and managerial officers
Nanning National Economic and Technological Development Area	Guangxi Zhuang	0.439-0.577	1.13 / m^3	n/a	3,600-6,000	
Qinhuangdao Economic and Technological Development Zone (East)	Hebei	0.35-0.60	2.023?	90-120 / m^2	n/a	Electricity does not include capacity charges; water rate (for enterprises) does not state quantity units; land rate does not include rent
Qinhuangdao Economic and Technological Development Zone (West)	Hebei	0.50-0.65	2.023?	270-300 / m^2	n/a	See above
Harbin Development Zone	Heilongjiang	0.413	2.60 / ton	116 / m^2	n/a	Electric and water do not include capacity charges; land rate is for "transfer of the land use right," and does not include charge for infrastruction contrusction or heating fund
Wuhan Economic and Technological Development Zone	Hubei	0.410	0.88 / m^3	135-165 / m^2	9,600-14,400	Electricity and water do not include capacity fees; land does not include rent, and is for 50 years; salary is for technical workers
SIP Loufeng New and Hi-Tech Development Zone	Jiangsu	0.458	1.40 / m^3	n/a	n/a	Electricity and water do not include capacity fees
Yinchuan National Economic Technological Development Zone	Ningxia Hui	0.424	1.70 / ton	n/a	n/a	

Name	Province	Electricity Rate (yuan/kwh)	Water Rate (yuan)	Land Rate (yuan, unless spec.)	Average Salary (yuan)	Notes
Xi'an Economic and Technological Development Zone	Shaanxi	0.467	1.86 / ton	345-375 / m^2	n/a	Electricity does not include capacity charge
Kunming National Economic and Technological Development Zone	Yunnan	0.414	1.60 / ton	n/a	20,000-30,000	Electricity and water do not include capacity/startup fees; 4% of total investment required for labor insurance fund; labor rate is for technicians
Xiaoshan Economic and Technological Development Zone	Zhejiang	0.611	1.70 / m^3	450-550 / m^2	9,600-14,400	Electricity does not include capacity charges, and is for peak hours; land rate is construction rate for steel structure; average salary is for college graduate
Hangzhou Economic and Technological Development Zone	Zhejiang	0.510	1.75 / ton	10-15 / mu	7,200-8,400	Electricity and water do not include capacity/installation fees; land rate is for lease only; salary is for "normal workers"

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