Adversaries and Partners:
The Impact of the Cross-Strait Economic Relationship on the Development of the Taiwanese and Chinese Economies

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Introduction

This article assesses the impact of trade and investment across the Taiwan Straits on the economic development of Taiwan and China[1]. While there have been fears of hollowing out of manufacturing in Taiwan with the opening of trade with China following WTO accession, this article argues that Taiwan has adjusted remarkably well to the increasing trade with and investment in China. For the Taiwanese, even for some areas where one might expect severe economic dislocation and adjustment, such as manufacturing employment, the effects have been relatively minor. Similarly, viewing the situation from China's vantage point, there have been charges that foreign investors, including Taiwanese[2], have come to dominate China's economy, particularly its export sector, even as these foreign investors have brought little actual technology and knowledge to China (Huang 2003). For China, this article will provide evidence that Taiwan has in fact played a critical role in boosting China's technological development, despite the charges to the contrary. Nonetheless, the gains from integration are not the only story in the cross-strait economic relationship. There were also costs to this increasing integration and disappointments in areas where benefits were expected.

First, the article will present the historical development and general statistics of the cross-strait economic relationship. Then, it will examine the distinct economic impacts of integration on Taiwan and China. Finally, the conclusion will consider the sustainability of current trends.

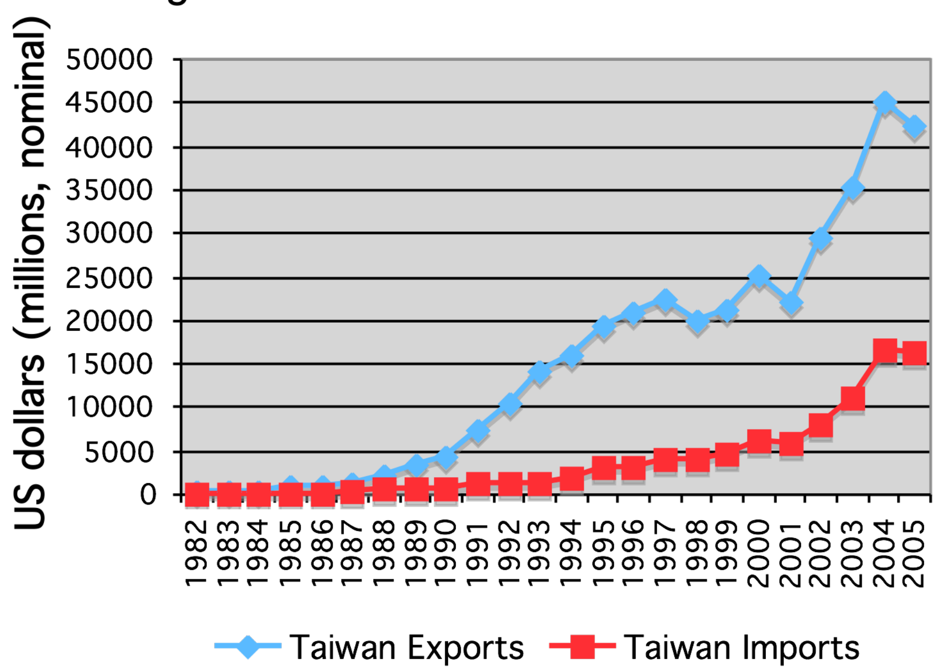
1. The Historical Development and Current Magnitude of Cross-strait Economic Ties

The initial reaction of Taiwan's government to the beginning of reforms in China was to ban completely imports from and exports (even indirect ones) to the People's Republic of China. Over the course of the 1980s, the Taiwanese government gradually loosened restrictions on investment and trade even as China continued to open up its economy to trade and investment. In 1985, indirect exports channeled through Hong Kong were legalized and unofficial Taiwanese tolerance of small-scale investments in mature industries emerged. With the lifting of martial law in 1987, Taiwanese were permitted to visit China for the first time since the end of the civil war in 1949. This new regulation combined with capital outflows in the context of the appreciation of the New Taiwan dollar following the 1985 Plaza Accords opened up significant investment and trade opportunities with China. As always, the legalization trailed the actual trade and investment flows so indirect trade, investment and technical cooperation were only permitted in 1989.

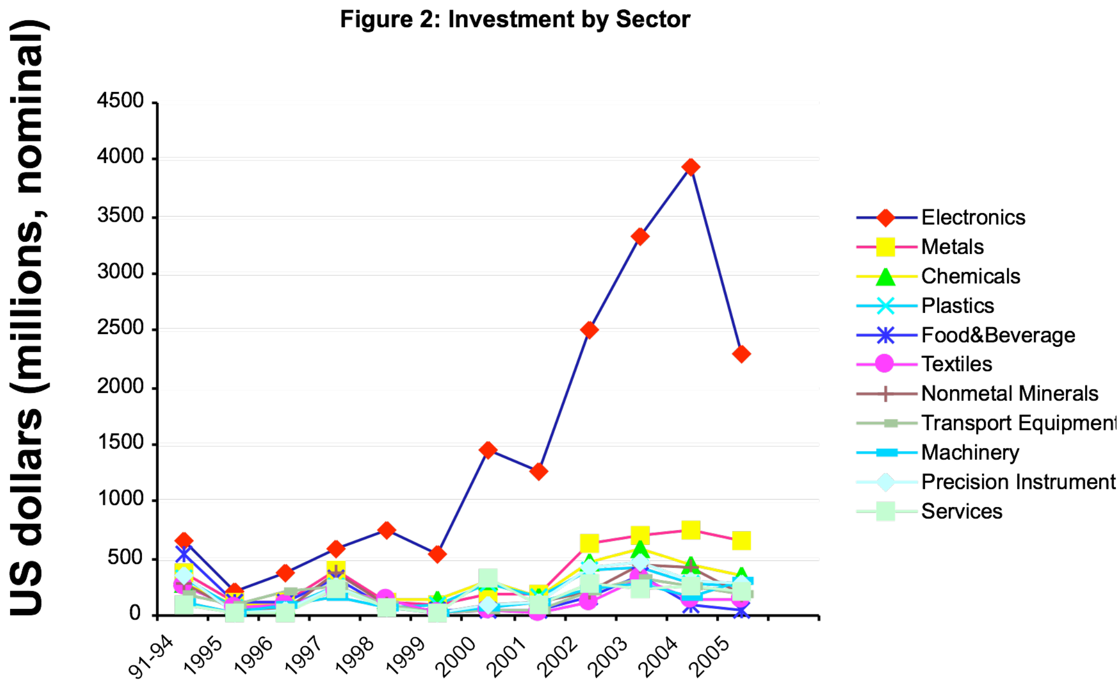
With growing investments in China, the Taiwanese government in 1990 decided to increase its supervision of flows of technology and capital to China by requiring all investments over one million US dollars to register with the Ministry of Economic Affairs' (MoEA) Investment Commission. Investors were prohibited from investing in certain "valued" industries and a list of prohibited lists was created. In 1996, in the face of continuing investments in China including investments from Taiwan's prized electronics sector, President Li Denghui in 1996 announced his *jieji yongren* ("no haste be patient") policy that introduced new regulatory hurdles for investment in China.

Investment was capped at 50 million US dollars and technology sector investments had to be approved on a case-by-case basis, which was simultaneously a liberalizing move (items were moved off the prohibited investments list) and a constraining one in that investments still had to be vetted by the Investment Commission. These regulations established a pattern that would be repeated time and again. In face of growing investment in China, the Taiwanese government would grow alarmed and then try to gain some control over China-bound investment, but due to demands from the business community, the regulations were never as strict enough to slow very significantly the cross-strait economic relationship.

Figure 1: China-Taiwan Bilateral Trade



Source: Mainland Affairs Council, ROC based on statistical data from the People's Republic of China.



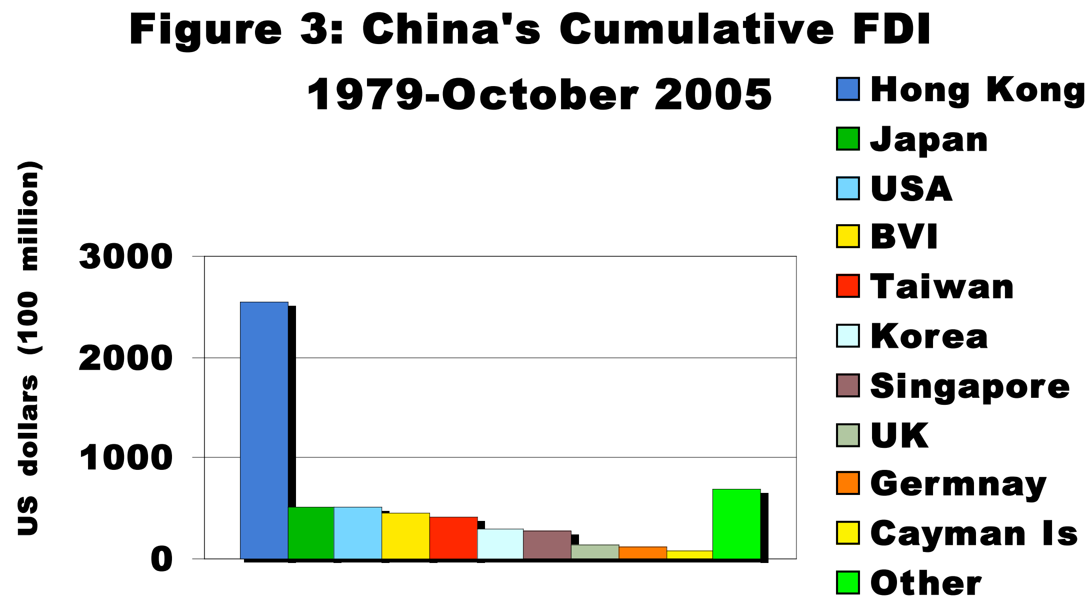
Source: Investment Commission, MoEA, ROC.

This cycle repeated itself once again when Chen Shuibian came to power precisely in 2000 because the sectoral shift of investment (Figure 2) worried the government. Whereas in the early years of legal investment a mix of sectors invested in China, in more recent times the electronics industry came to dominate the investment in China. More worrisome for the Taiwanese government was the increasing investment in higher value-added parts of the electronics industry from the late 1990s onward (Fuller 2005a). Even the notebook computer segment began to move production to China despite specific Investment Commission prohibitions against the manufacture of notebooks in China. While these prohibitions were still in force, this author visited a number of major Taiwanese manufacturers' plants in China where notebooks were being produced.[3]

The government was alarmed and yet the business community demanded greater access to investment in China because of competitive pressures. Chen after convening a conference with business leaders announced his *jiji kaifang, youxiao guanli* ("active opening, effective management") policy toward economic integration in China in August 2001. The liberalization measures announced were substantial: the 50 million USD investment cap was scrapped, direct investment was permitted, the bar to require investment approval was raised to 20 million USD, the investment cap was lifted to 40 percent of a firm's total worth and prohibited investments list was reduced. However, some of the measures took a year to implement and it was not clear which prohibited items would be legalized. These conflicts between government and business played out across several sub-sectors of electronics.[4] The end result was the same: partial liberalization with continued restrictions or clarifications of restrictions. This compromise gave the business community some of what it wanted while meeting the government's concerns to prevent hollowing out.

The cycle of increased integration followed by generally ineffective state attempts to manage the cross-strait economic relationship continued in President Chen's second term. At the beginning of 2006, President Chen announced a change in economic policy by scrambling the words of his previous policy. Now, the policy would be *youxiao kaifang, jiji guanli* ("effective opening, active management") signaling a tightening up of actual supervision of Taiwanese investment in China. And yet, when President Chen convened an economic summit between his administration and business leaders in Taiwan, no breakthroughs were made in terms of further regulation as hoped for by Taiwanese independence supporters or further liberalization as pushed for by Taiwanese businessmen. In short, the cross-strait economic policy debate had reached a stalemate (Ong 2006).

While the sheer volume of investments and trade demonstrate the increasing importance of China to Taiwan's economy, the investments from Taiwan also were a large part of China's increasingly large foreign direct investment (FDI) inflows. In nominal terms reported by China's government, Taiwan's direct investment made it the fifth largest source of FDI in China. However, this data seriously underestimates Taiwan's role for two reasons. First, much of Taiwan's investment flowed through Hong Kong, which helps to explain why Hong Kong's quite small economy contributed by far the largest amount of FDI. Second, as Taiwanese investors, especially those investing in items on the prohibited list, came under increasing scrutiny from the Taiwanese government, they began to flow their indirect investments through the discreet offshore banking locations in the Caribbean.[5] This movement of Taiwanese funds through the Caribbean also explains why such minor economic powers, such as the Cayman Islands and the British Virgin Islands, were among the top ten largest investors in China over the reform period (see Figure 3). When one accounts for the Taiwanese FDI to China coming through these other regions, it is likely that Taiwan is actually the second largest source of China's FDI after Hong Kong. Taiwan probably accounts for over ten percent of China's cumulative 610 billion US dollars in FDI and some estimates place Taiwan's contribution as high as 150 billion US dollars (Ong "Taipei Economic Forum Fails to Reach Consensus," Straits Times, July 29, 2006).



Source: Mainland Affairs Council, ROC based on People's Republic of China data.

2. The Impact of Economic Integration

Even with such large flows of trade and capital, the question remains what the impact these flows have on each economy. We now turn to address that question for Taiwan and China in turn.

2.1 The Impact on Taiwan: Triumphs of Adjustment

What is most striking about the Taiwanese case is how small the negative impact of integration with China on industrial employment (defined in Taiwanese statistics as manufacturing, mining and construction employment). For it is precisely in these areas where one would expect cheap low-skilled Chinese labor to displace less-educated Taiwanese workers through Chinese imports and Taiwanese investment in manufacturing capacity in China. In fact, Taiwanese industrial employment has actually risen slightly in absolute numbers comparing 1991 to 2005 and industry has only experienced a slight decline in overall share in the economy. Even with the increasing employment of guest workers in the industrial sector from 1992 onwards, there has been a less than one percent decline in the number of locals employed in industry between 1992 and 2005. Indeed, the only year where more locals were employed in industry than 2005 was 1992. All of this evidence suggests fears of hollowing out of Taiwan's industry and employment have been highly exaggerated.

Table 1: Employment In Taiwan, 1991-2005
Unit: Thousands of workers (unless otherwise noted)
Source: Council of Labor Affairs and Directorate-General of Budget, Accounting and Statistics, ROC.

Year	Total Employment	Foreign Total	Local Total	Industry	Industry %	Foreign Industry	Local Industry	Service Total	Service %
1991	8439	NA	NA	3370	39.93	NA	NA	3977	47.13
1992	8632	16	8616	3419	39.61	15.27	3403.73	4148	48.05
1993	8745	98	8647	3418	39.08	90.07	3327.93	4323	49.43
1994	8939	152	8787	3506	39.22	137.54	3368.46	4456	49.86
1995	9045	189	8856	3504	38.74	170.15	3333.85	4587	50.71
1996	9068	237	8831	3399	37.49	205.37	3193.63	4751	52.39
1997	9176	248	8928	3502	38.17	207.75	3294.25	4795	52.26
1998	9289	271	9018	3523	37.92	216.53	3306.47	4944	53.23
1999	9385	295	9090	3492	37.21	219.22	3272.78	5118	54.54
2000	9491	327	9164	3534	37.23	219.48	3314.52	5220	54.99
2001	9383	305	9078	3377	36	190.82	3186.18	5299	56.48
2002	9454	304	9150	3332	35.24	180.34	3151.66	5413	57.25
2003	9573	300	9273	3334	34.83	176.01	3157.99	5543	57.9
2004	9786	314	9472	3446	35.21	179.85	3266.15	5698	58.23
2005	9942	327	9615	3558	35.79	179.84	3378.16	5793	58.27

When one takes into account the twenty-fold increase in foreign guest workers between 1992 and 2005, the ability of Taiwan to employ almost one million more local workers in 2005 over 1992 (an almost twelve percent increase in numbers of Taiwanese employed) is impressive. Most of the employment increase was in the service sector, but that is to be expected in a maturing economy.

Integration has not been entirely painless for Taiwanese workers despite Taiwan's excellent employment performance. As should be expected when an economy with higher wages integrates with another with generally lower wages, Taiwan has experienced increasing wage inequality in recent years as it integrates more fully with China. As measured by the Gini index (a lower number in the Gini index signifies more equality in income distribution), Taiwan's inequality has increased from a low of 27.7 in 1980 to 33.8 in 2005. However, it must be noted that Taiwan's high point of inequality in recent years was in 2002 in the wake of the Internet bubble bursting when Taiwan's Gini index was 34.5. Thus, increasing trade with China is not the only culprit in terms of Taiwan's increasing inequality of income distribution. Moreover, Taiwan's Gini index places its inequality roughly in the middle of the advanced economies in recent years. Indeed, despite an incomplete welfare state, Taiwan's inequality is still lower than that of the major neoliberal Anglo-American economies.[6]

The fact that Taiwan has run a large and generally growing trade surplus with China (see Figure 1) helps to explain why Taiwan's industrial employment has not been declined in the face of increasing economic integration with China, but it still begs the question how Taiwan has accomplished this feat of exporting manufactured goods to the "workshop to the world," China. This feat is all the more impressive when one considers that the core of Taiwan's industry, the electronics industry (Fuller 2005a), has seen movement of factories to China. Manufacturing of personal computers (PCs), the heart of Taiwan's electronic end-products sector, has moved completely out of Taiwan except for pilot production (author interviews). How has it been possible for Taiwan to maintain employment and exports in the face of the evidence of a giant sucking sound from China?

Taiwan has avoided many of the adverse consequences of displaced low-skilled workers in the face of the virtual end of computer-related manufacturing in Taiwan because it has been able to create new competitive advantages in certain segments of electronics and maintain existing competitiveness in one of the key components, semiconductors. Even in less technology-intensive and more labor-intensive industries, such as auto parts and bicycles, Taiwan has been able to maintain its competitive edge. We will now turn to examine Taiwan's adjustments in these areas.

To understand Taiwan's ability to adjust in the key electronics sector, we will examine three industry segments and one new policy focus: semiconductors, active matrix liquid crystal displays (AMLCDs) or flat panel displays[7] as they are more commonly known, mobile devices and the policy of encouraging R&D activities. Through a mix of private and public initiatives, Taiwan's electronics sector has been able to shift to new competencies and maintain existing strengths despite the move of computer manufacturing offshore, principally to China.

Since 2000, when two groups of Taiwanese semiconductor engineers announced plans to create foundries (firms that fabricate but do not design their own semiconductor chips) in China, the Taiwanese government has been alarmed by the prospect of China threatening one of the most technology-intensive areas in which Taiwan has developed competitiveness. Indeed, Taiwan has for years dominated the international foundry industry, routinely representing over 70 percent of the global foundry market (Fuller 2005a).

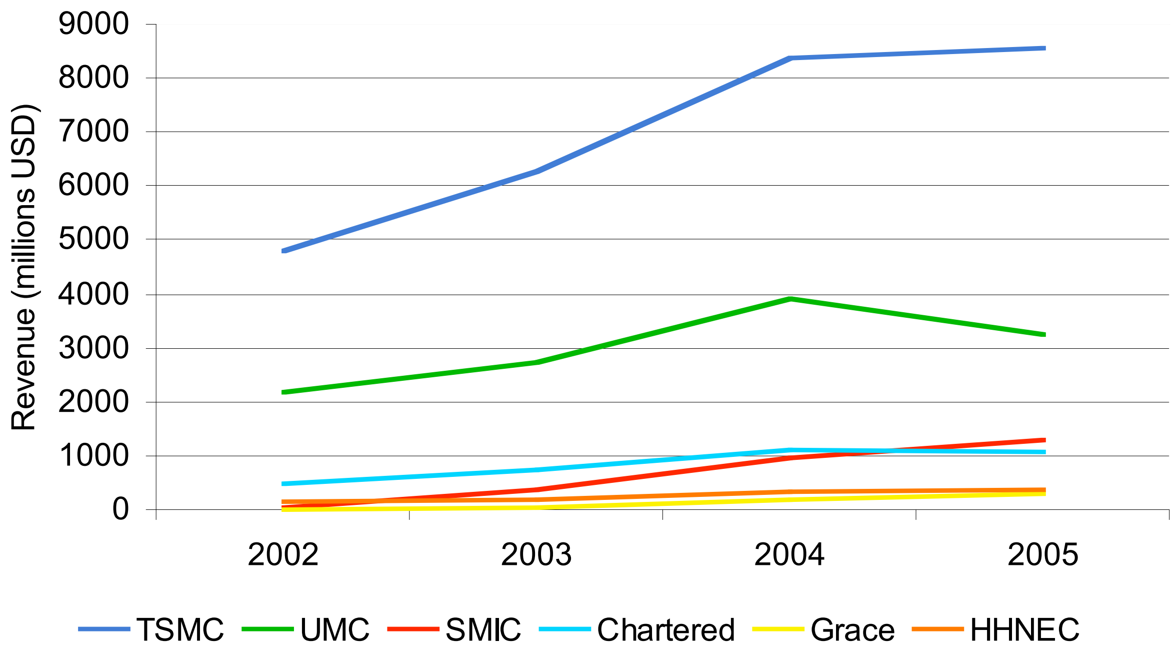
One of the two new foundry start-ups in China, Semiconductor Manufacturing International Corporation (SMIC), has been quite successful in ramping up production, increasing sales revenue and its market share since production started in 2002 (Hancock forthcoming; Fuller 2005a). However, there is little evidence that SMIC has been able to threaten the commanding position of Taiwan's foundry giants, Taiwan Semiconductor (TSMC) and United Microelectronics (UMC). These firms continue to increase their revenues and command imposingly large shares of the global foundry market (see Figure 4). Moreover, the global foundry market continues to grow as more and more semiconductor firms outsource their production to foundries. Thus, SMIC's gain has not been TSMC and UMC's loss. Instead, SMIC has displaced the perpetual and distant follower of UMC and TSMC, Singapore's Chartered, as the third largest foundry. Grace, the other Taiwanese-run, China-based foundry, and China's domestic champion, Huahong NEC (HHNEC), are still very small players in the global foundry market.

Given the skill-intensive demands of semiconductor fabrication and the developed competencies in Taiwan's large engineering community, there has not been much incentive to replicate the rapid shift overseas of Taiwan's computer manufacturing. SMIC appears to have developed a successful model of bringing skilled Taiwanese engineers to China to train locals (see Section 3), but the fact remains that TSMC and UMC each have only one fabrication facility in China. Indeed, when TSMC and UMC have set up fabrication plants overseas, most often they have gone to advanced industrial countries where skilled engineers are located. TSMC has its own plants or joint-ventures in Singapore and the US. UMC has its own plants or joint-ventures in Japan and Singapore. These facilities have more total capacity than these firms have in China. Furthermore, most of their production capacity remains in Taiwan.

The continued competitiveness of Taiwan's semiconductor fabrication had little to do with new initiative by government. Indeed, the one proposed government initiative in semiconductor fabrication technology was undermined and ultimately abandoned because of the refusal of TSMC and UMC to take part (Fuller 2005a; Fuller *et al* 2003). However, in moving into new segments of the electronics industry, Taiwan's government has continued to play a critical role.

In particular, the quasi-governmental research institute, Industrial Technology Research Institute (ITRI), has successfully continued to diffuse new technologies to

Figure 4: Foundry Revenue 2002-2005



Source: IC Insights.

industry, which then blossom commercially. This so-called ITRI model of technological upgrading has been well documented (Breznitz 2004: Fuller *et al* 2003; Fuller 2005a; Mathews 2002), but it has been an open question as to its continued effectiveness. Fortunately for Taiwan, the cases of AMLCDs and mobile technologies represent that the ITRI model is alive and well.

For AMLCDs, the ITRI was less of a major force than has been typical in the past. Most of the Taiwanese AMLCD firms received their technology directly from Japan rather than from ITRI. ITRI did however play an active role in training engineers in AMLCD manufacturing techniques.[8] In any event, from being a nonentity in the global display industry in 2000, Taiwan has emerged to become the largest producer of AMLCDs in the world today ("Taiwan Dogs Korea for LCD Share," *Business Week*, June 14, 2006).

What is interesting about the distribution of this relatively new Taiwanese industry is how quickly production has been moved to China. As early as 2001, Taiwanese producers were building back-end LCD module plants in China. However, this distribution of the industry has been to Taiwan's advantage. The back-end module assembly part of the process is the labor-intensive part of the process. The actual making of the liquid crystal display is capital- and skill- intensive and remains in Taiwan. From the perspective of creating high wage employment with the potential of creating technological spillovers, this type of cross-strait distribution of production is just what Taiwan should want.

In mobile technologies, ITRI has led the way in acquiring and transferring mobile technologies, such as cellular phone technology, to local firms by training local engineers in these technologies under its Computer and Communication Research Laboratories (CCL). In fact, many of the computer firms, such as Quanta, Acer and Compal, were able to benefit from ITRI's technology transfer to become major producers of mobile phones.

In contrast to ITRI's success in diffusing information technology (IT) knowledge to Taiwanese firms, the ITRI research units not connected to IT have been less successful in spurring local innovation (M. Hsieh 2005). Instead, those mature manufacturing industries that have managed to stay competitive in the face of cross-strait integration, such as bicycle and auto parts manufacturing, have done so with little effective state support.

While the bicycle industry has moved some production of mass-produced bicycles to China, the higher value-added custom bikes are kept in Taiwan. Production of these bicycles relies on a dense network of specialized suppliers co-located in central Taiwan. In essence, the bicycle industry follows the Italian industry district model based on a network of small and medium enterprises (SMEs) with focused competencies and this is much harder to replicate in China. Thus, it is not surprising that much of the industry remains in Taiwan.[9]

After-market auto parts, which are auto parts made as replacements, have been the driving force behind Taiwan's auto parts success story and have had virtually no government technological help or guidance. Moreover, in contrast to Taiwan's heavily protected and inefficient auto assembly industry, the after-market auto parts makers are focused on overseas markets. This focus has forced them to be efficient. Unlike auto assemblers, the barriers to achieving technological independence have not been high as these parts are often readily reverse engineered. On the other hand, Taiwanese manufacturers have been able to distinguish themselves from Southeast Asian and Chinese auto parts makers relying solely on cheap labor because they have developed skills in electronic data exchange with their key retailers, primarily in the US, to receive, process and track orders.[10] Despite the heavily reliance of Taiwan's domestic assemblers on imported parts and the falling protectionist barriers with Taiwan's 2002 entry into the WTO, Taiwan was still able to run a substantial trade surplus in parts because of its competitive after-market auto parts in 2005. Taiwan's surplus was over one billion US dollars despite having over two and half billion US dollars worth of imports.[11]

Taiwan's integration with China has not been without its setbacks. First and foremost, like many others, the Taiwanese have been gripped by the "China dream" of capturing a market of over one billion customers. And like most of those seized by this dream, the Taiwanese have often been disappointed.

Unlike many others, the Taiwanese are in some sense more dependent on and possess special advantages for realizing the China dream. Taiwan is more dependent on realizing this dream because Taiwan's home market is quite small. This small home market has inhibited the development of globally competitive Taiwanese brands (Fuller *et al* 2003). Thus, geographic and cultural proximity dictate that China is the logical "home" market of significant size for the Taiwanese to use to develop brands backed scale and scope. The same geographic and cultural proximity also may serve as Taiwan's competitive advantages in utilizing China as its home market. Having these potential advantages only make realizing the China dream more critical for the Taiwanese as alternative replacement home markets to China are less realistic.

Several Taiwanese brands have been very successful in China. Giant Bicycle is the largest bicycle brand in China. Taiwan's Kang Shifu and President Group dominate the large instant noodles market in China and have extended their reach into other food and beverage products, such as bottled tea. Kang Shifu's success is particularly impressive because this firm was a small-scale supplier of inputs for Taiwan's instant noodle firms before it set up its own instant noodle manufacturing operations in China. In contrast, President Group and Giant have simply extending their prevailing business operations to China.

The success of Taiwan's food and beverage firms in China illustrates the advantage that cultural proximity gives Taiwan in certain product areas. In media as well as food, cultural knowledge is key. Unfortunately, outside of the food and beverage business, Taiwan's success in culture-intensive industries has been limited because the People's Republic of China strictly prohibits majority ownership by non-domestic Chinese firms in its media sector. While Chinese audiences like Taiwanese pop stars, the Taiwanese media companies have little opportunity to take these cultural products and craft them into large media businesses given China's regulations.

The record of Taiwanese brands in China's electronics market is abysmal given the strengths of Taiwan's large electronics industry. While Taiwanese electronics manufacturers grew through manufacturing products for other bands, a number of these firms have had dreams of creating their own brands in the Chinese market. Acer, the one well-known Taiwanese computer brand, has tried to become a major player in China for almost a decade. For all its efforts, the firm still commands only a small slice of the Chinese market. Until 2005, regulations prevented foreign firms from setting up their own retail distribution networks in China[12], but that protectionist measure was only part of the problem. Major international brands, such as IBM, Hewlett Packard and Dell, were able to gain market share in China despite the retail restrictions. However, the position of these firms in the global industry has been quite different from Acer's. They offered higher-end models justified by their globally renowned brands whereas lesser-known Acer had to compete on price with local brands, such as Lenovo and Founder.

In mobile phones, the other IT end-product where Taiwanese have become major international players, the restrictions are more stifling. The Ministry of Information Industry of China restricted the number of foreign brands that could sell their mobile phones in China until 2005 when MII installed a more open system that allowed over thirty more firms to obtain rights to sell their own brand mobile phones in China. Originally, only one Taiwanese maker, Dbtel, was able to sell its own brand of phones in China. China's regulations clearly have not shown any favoritism to their Taiwanese compatriots as all the major international brands had licenses to sell in China while the Taiwanese were still kept out. Two Korean firms, LG and Samsung, had licenses under the restrictive regime compared to just one directly awarded to a Taiwanese firm.

Thus far, the dream of the China market has been somewhat of a disappointment for Taiwanese firms that hoped to build a global brand from a major branded presence in China. The future does not look very promising either. The restrictions in the media appear to remain in place and China's openness to foreign brands means there is not much space to develop Taiwanese ones.

Taiwan's plan to the future is outlined in its "Challenge 2008" Six-Year Development Plan covering from 2002 through 2007. This program was heavily influenced by Taiwan's economic bureaucracy in terms of planning as well as execution since the program spans presidential terms. Thus, even if Chen had lost the 2004 presidential election, the plan would have remained in place. The plan has continued support for the AMLCD and semiconductor industries in terms of tax breaks and has initiated a new aggressive push to recruit MNCs and local firms to establish R&D centers to Taiwan. As has already been discussed, the semiconductor and AMLCD sectors have continued to grow. As for the new turn to recruit MNC R&D, a number of MNCs, such as Intel, Microsoft and IBM, in addition to local firms have established R&D centers even while subsidies for these centers have been kept in check. These trends indicate this policy has been at least moderately successful thus far (Fuller 2005a).

2.2 True Compatriots: How China Benefits from Cross-strait Economic Integration

Given the relative size of their economies, China's public debates about the economy are far less concerned about Taiwan than Taiwanese debates are about China. Still, commentary on Taiwanese investment has often been critical. Huang's *Selling China* sees investment from the ethnic Chinese economies, a category including Taiwan, as bringing little technology or new knowledge to China. Taiwanese investors have often been accused of relatively egregious labor practices compared to other foreign investors in China (Anita Chan 2001). This section will weigh the evidence of the impact of integration with Taiwan and find that shows on balance Taiwan has made an overwhelming positive contribution to China's development, especially in the area of technological development.

Given that 34 percent of Taiwan's reported investment in China is in IT (Mainland Affairs Council website, www.mac.gov.tw) and the actual figure is likely to be higher because much of IT investment is officially restricted, examining the impact of Taiwan's IT investments in China is critical. Taiwan's investment has contributed dramatically to China's development because the investment has a significant technology component ignored by some of the critics of Taiwan's FDI, such as Yasheng Huang. This technology can be seen through two sets of data. First, the Taiwanese semiconductor industry is training significant numbers of engineers in China. Second, Taiwanese IT firms are beginning to produce many US patents from China.

Turning to the semiconductor industry, we will look at the design and fabrication parts of the industry as these segments are more technologically intensive than the assembly and packaging process. As more and more firms focus on design and outsource fabrication to foundries, such as TSMC and UMC, the design segment has blossomed. In fact, fabless design houses (i.e. design firms without their own fabrication facilities) in the last twenty years have gone from producing .3 percent of global semiconductor revenue to producing 14 percent (Fabless Semiconductor Association, www.fsa.org). The spectacular growth of Taiwanese fabless design firms has made Taiwan into the second largest center of fabless design after the US. Taiwan's share of global fabless revenue was 28 percent in 2004 and had doubled since 1996 (Shelton 2003).

With this strong competitive position in fabless design, one might think Taiwan would not need to expand to China, but the growing demand for design engineers forced Taiwanese fables firms to look abroad. Except for a few brave pioneers in the late 1990s, the first wave of Taiwanese design firms invested in China in 2000. 2000 was the critical year because Taiwan experienced an Internet boom that lured many engineers away from chip design. The shrinking supply of engineers available to design firms at a reasonable price forced them to explore sources of engineers abroad. In addition to geographic and cultural proximity, China has been producing large numbers of engineers (Fogel 2005) so the Taiwanese firms decided to explore this market.

Based on interviews with 58 design firms[13] in China employing approximately half of China's total design workforce[14], the Taiwanese design firms were extremely active in training local designers. Taiwanese firms trained one-third of the local designers who were trained in actual design skills rather than in reverse engineering. The Taiwanese firms generally reported that local engineering graduates to require more training than their Taiwanese peers, but they also found local engineers to have a good basic engineering education so they were highly trainable. At least seven of the top ten largest Taiwanese design firms have design centers in China. Two others may have centers in China, but Chinese subsidiaries of Taiwanese design firms are often hard to locate given the efforts Taiwanese design firms in China make to hide their identities from the Taiwanese authorities due to continued restrictions on investments in semiconductor design.[15]

Table 2: Taiwanese Design Centers in China

Revenue Rank among Taiwanese Design Firms	Name	China Design Team
1	Mediatek	Yes
2	VIA	Yes
3	Realtek	Yes
4	Sunplus	Yes
5	Novatek	No
6	ALI	Yes
7	Elan	?

8	Elite	?
9	Faraday	Yes
10	Holtek	Yes

In semiconductor fabrication, the established Taiwanese foundries have made only a moderate contribution to training China's engineers because they each have only one factory in China. Instead, experienced Taiwanese chip engineers left these firms to set up new foundries in China. The two most prominent, Grace and SMIC, were founded in 2000 and have become two of the largest semiconductor manufacturers in China. Indeed, SMIC is now the third largest foundry globally (see Figure 2). What SMIC and Grace really have contributed is workforce training because most of the engineers at these firms are local ones. From 2001 to 2003, SMIC trained 800 local engineers to complement the 400 engineers it brought from Taiwan and elsewhere.[16] In contrast, the largest domestic Chinese firm, Huahong NEC, remains reliant on Japanese engineering expertise (Fuller 2005b) although they have recently recruited their own Taiwanese expert, the former vice president of manufacturing for SMIC.

In research and development of IT products, the important contribution of Taiwanese firms is also evident. Out of the total of 939 corporate IT US utility patents originating from China, 689 are from Taiwanese firms, including Grace and SMIC.[17] More importantly, the Taiwanese firms show a much larger share of their patents coming from China than other foreign firms. Among non-Taiwanese foreign firms, only Microsoft can claim to have even one percent of its US utility patents originate in China. Five Taiwanese firms (Hon Hai, Inventec, UMC, Winbond and SMIC) are in the top ten

US IT utility patent holders from China and all have at least one percent of their patents from their Chinese operations.

Several Taiwanese companies have explicitly embraced using China as a major base of operations beyond manufacturing. Inventec, a major computer manufacture, calls its strategy the "Twin Towers" approach, with one tower in Taiwan and the other in China. Hon Hai, a major component and computer producer, has gone so far as to list its Chinese assets on the Hong Kong stock market in order to circumvent continued restrictions on total investment in China. Both Hon Hai and Inventec derive a large percentage of their US utility patents from China, 18 and 32 percent respectively. Hon Hai has a very large US patent portfolio of almost three thousand patents (comparable to the portfolio of mid-sized US technology company, Seagate) so this commitment to research in China is not trivial.

Taiwan's contribution is not limited to training local engineers and pursuing R&D activities in China. Taiwan's venture capitalists have also contributed to China's technological development. Major Taiwanese-backed venture firms, such as Acer Venture Capital, Investar, China Merchant & Fortune Venture and Sino-Century, have invested in numerous technology start-ups based in China.

Moreover from interviews with 8 local Chinese, 5 Taiwanese and 9 foreign venture capitalists, it is clear that the Taiwanese firms are making a qualitative difference in spurring technological development through their selection of investment targets. The local venture capitalists are primarily state-owned financial vehicles with little experience or competence in selecting promising start-ups or fostering their growth. To the extent that they have been able to contribute effectively to technology entrepreneurship in

China, they have done so by following the lead of foreign and Taiwanese investors. In other words, they allow foreigners and Taiwanese to select and help to manage the investment targets while they co-invest in the selected start-ups.

The foreign venture capitalists, which are primarily American venture firms, look at China and see a place bereft of technology because they inevitably compare it to Silicon Valley, the heart of the American technology venture capital business. The Taiwanese with their experience in building up technology enterprises in a relatively technology backward economy have not been daunted when confronted with a similar task in China. Consequently, while the American firms have been concentrating on technology-light but profitable services, such as Internet and wireless services, the Taiwanese have been primarily investing in firms attempting to create technology in semiconductor and wireless segments.

Where the Taiwanese have failed to contribute to Chinese development is in Taiwan's traditional area of strength, manufacturing. While Taiwanese firms have been helping China develop capabilities in the human capital-intensive manufacturing sector of semiconductors, the traditional Taiwanese assemblers of electronics and other products have not contributed much to China's development because of their closed manufacturing networks. When Taiwanese firms move to China, they tend to move the entire cluster of suppliers as well. Thus, they do not help to cultivate a supply base of local Chinese firms. Yang and Hsia's (2005) study of Taiwanese production networks in the Yangtze River Delta found that local Chinese supplier were limited to furnishing six percent of total production value to the Taiwanese electronics network located in that area. This paper's author's own interviews with seven electronics Taiwanese manufacturers in the

Pearl River Delta also uncovered that overwhelmingly these assemblers relied on foreign-invested (including Taiwanese-invested) firms. None of these firms reported procuring more than five percent of the value of their inputs from local Chinese firms. Five of these firms had been in China for more than five years at the time of interviews suggesting that even with time there had been little progress in developing local suppliers. The same pattern of closed supplier networks was found by Hsieh (2005) in her investigation of Taiwan's machinery industries production in China. The one positive note found in this article's author's interviews of manufacturing plants is in a large, decade-old complex where a significant number of plant executives were localized in contrast with the typical situation in which the management is almost entirely Taiwanese. Still, with Taiwan's other large contributions to China's technological development, the failure to build up Chinese manufacturers should count as a singular disappointment rather than a definitive feature of character of the impact of cross-strait economic integration on China.

3. Sustainability of Trends

Can Taiwan continue to integrate with China without sustaining high costs of adjustment with its lower wage neighbor? The good news is Taiwan's protected industrial sectors, such as auto assembly, are not a large part of its economy or employment so workers from these sectors should be easily absorbed by the rest of the economy as WTO-mandated reductions in tariff protection take effect. Indeed, further shifts of employment from manufacturing to service should be expected given that none of the high wage economies of North America, Europe or even Japan have such a large share of employment in industry as Taiwan has. There is also increasing evidence that the cost of manufacturing labor is rising in China (*min gong huang*) ["The labor shortage is a self-correction for the low labor cost model," (民工荒是对低成本模式的自我矫正) Wang Yue-sheng, Twenty-First Century Economic Herald, March 13, 2006] so China's labor cost advantage may be shrinking. Furthermore, the government's efforts to transform Taiwan from a manufacturing to knowledge-based economy appear to be working with the ever growing number of foreign R&D centers being set up in Taiwan.

The downside is that China's massive investments in education (Fogel 2005) could place significant downward pressure on Taiwanese white collar wages[18] in the future if several conditions apply. First, Taiwanese white-collar workers are unable to avoid direct competition with Chinese white-collar workers by occupying different sectors or niches. Second, the global demand for such workers as Taiwan and China produce does not increase faster than the global supply, a condition which in part depends on what sectors or niches exist in the global marketplace. Finally, all of this assumes that China can create equally productive white-collar workers controlling for cost. For example, one scenario fulfilling this condition would be that Chinese engineers become only half as productive as Taiwanese engineers but cost half of what Taiwanese engineers cost However, given Taiwan's reliance on overseas markets, the danger of downward pressure for Taiwanese educated workers exists even if Taiwan chose to avoid integration with China although without Taiwanese investments in the PRC the process of training China's human capital would likely take much longer. Indeed, Richard Freeman (2004) examines such a declining wage scenario for US engineers in the face of competition from engineers in China and India and argues that such a scenario is plausible. If Taiwan is still trying to compete in the US and other marketplaces, Taiwan will face Chinese competition regardless of Taiwan's level of direct economic integration with China.

One must keep in mind the legitimate warning advocates of free trade always have for those worried about the costs borne by workers in certain sectors. Free traders invariably point out that there are always new industries and niches we cannot anticipate. This observation suggests possibilities for new unanticipated sources of demand in the same sector for what would otherwise be displaced workers and entirely new fields of industrial activity that could absorb these workers. The trick of course is to encourage those activities to spring up in one's own economy and to ensure that one's own workforce is able to seize these opportunities. ITRI's track record in cultivating new activities, Taiwan's high level of entrepreneurship and sound educational system for technologists suggest Taiwan should be able to sidestep China's competition through developing new and/or niche activities that China does not possess. And this possibility is in addition to Taiwan's current ability to stay at least one step ahead of China in the similar areas of technology.

As for China, will Taiwan continue to be a major driver of China's technological progress? Taiwan will continue to contribute significant amounts of technological progress to China if three conditions hold. First, China continues to prove fertile ground for those areas where Taiwanese have strong competencies, most notably IT. Currently, the IT industry is a major industrial segment in China and this will likely continue.

Second, China does not resolve its maldistribution of finance. China's support for inefficient state-favored firms and neglect of small, private and entrepreneurial firms has been a drag on China's innovation. Thus, Taiwanese have played an outsized role in part due to the constraints on domestic innovation in China. Will finance continue to play such a role in China? With high rates of savings and quite small fiscal deficits, China is under little pressure to change its current system of subsidizing its inefficient banking system as it still prefers to control the commanding heights of the economy (Pearson 2005). The tentative moves toward inviting foreign ownership in banks are only designed to bring in better management and are not designed to lead to ceding control to international financial institutions. This direction is true even without the public outcry over the last year against too much foreign involvement in the Chinese economy. The problem is without control the foreigners cannot actually change the managerial behavior. The failure of foreign management to change Shenzhen Development Bank due to the political nature of lending in China suggests foreign managers in Chinese state banks will continue to find their hands tied.[19]

The third condition is that China's legal system does not have rapid improvement. Taiwanese technology firms have been accustomed to operating in environments with relative lax intellectual property enforcement. Thus, they are not deterred from operating in China whereas many MNCs are more cautious of placing valuable activities in China due to the opaque environment (Iris Quan 2005).[20] For example, in IC design, American MNCs have placed quite sophisticated activities in India where the English legal structure is relatively (for a developing country) sound and transparent as well as familiar to American firms whereas the same firms place on unsophisticated layout activities in China (Fuller 2005b). With MNCs scared off by China's lack of transparency, the Taiwanese have played a relatively outsized role in bringing technology to China.

China's legal structures are improving but most likely it will take a long time before they become transparent enough for the comfort of MNCs.

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[1] In this article, the Republic of China will be referred to as Taiwan and the People's Republic of China will be referred to as China for no other reason than these terms are convenient short-hand for these two economies.

[2] The investors from Taiwan, Hong Kong and Macao are treated as their own category of investors separate from both domestic and foreign investors in the Chinese government's statistical data, but for most important purposes, such as tax breaks and sectoral restrictions on investment, they are given treatment equivalent with foreign rather than domestic firms.

[3] Some firms tried to justify their production of notebooks through a loophole in Taiwanese law. The law defined Taiwanese notebook computer generations by the central processing unit (CPU) used e.g. Intel Pentium 2. Some firms claimed to manufacture notebooks without placing the CPUs in them in China. However, these author's observations in plants in China indicate that these CPU-less notebooks were not the only Taiwanese notebooks produced in China.

[4] See Yang and Hung (2003) for the semiconductor case.

[5]Witness for example the case of Semiconductor Manufacturing International Corporation (SMIC). This Taiwanese-invested firm built a 200mm wafer fabrication facility (a plant for manufacturing semiconductor chips) in China when it was still illegal to do so under Taiwanese law. The firm registered in the Caribbean to beyond the reach of Taiwanese authorities. The Taiwanese government has since threatened the founder, Richard Chang, with arrest if he enters Taiwan.

[6] The comparison of Taiwan and other advanced countries is based on data from John Weeks, "Inequality Trends in Some Developed OECD Countries," Department of Economics and Social Affairs (DESA) Working Paper, No. 6, October 2005.

[7] Technically, AMLCDs are only one type of flat panel displays, but the media often use flat panel displays to refer specifically to AMLCDs.

[8] This brief synopsis of the development of Taiwan's AMLCD industry relies heavily on the account in Fuller *et al* 2003.

[9]This section is based on Michelle Hsieh, Ph.D. Dissertation. (Department of Sociology, McGill University, 2005).

[10] This section is based on Cunningham, Lynch and Thun "A Tale of Two Sectors: Diverging Paths in Taiwan's Automotive Industry," In Berger and Lester (ed) *Global Taiwan*.

[11] This data was provided by Mr. Chih-yen Tai of Industrial Economics and Knowledge Center (IEK), a unit of ITRI.

[12] China was supposed to open distribution in December 2004 according to its WTO commitments. Instead, China opened them only in 2005 according to the US-China Business Council (www.uschina.org).

[13] One of these firms has sold its design operation in China and several other firms are technically integrated device manufacturers (IDMs), firms that both design and fabricate their products. The IDMs included in the 58 interviewed firms all had design operations in China.

[14] This estimate is based on an I-Suppli estimate of total Chinese designers and the numbers of engineers employed as reported by each firm during interviews.

[15] For example, many Taiwanese firms use different names for their Chinese subsidiaries. Design investments are no longer banned, but they have restrictions sophistication of design (measured in terms of the lithography width of fabrication process) done in China. Furthermore, many of the firms set up shop in China before it was legal to do so and therefore face legal problems if they report their activities to the Taiwanese Investment Commission now.

[16] This figure is based upon interviews and an internal report from China's Ministry of Science and Technology.

[17] The US Patent Office awards utility and design patents. Design patents are for the exterior appearance of a product are not technology-intensive so they were excluded. Most patents are invented and held by individuals. Corporate means those patents funded and owned by corporations. The patent data was accessed on May 9, 2006 at US Patent Office's database website, patft1.uspto.gov/netahtml/PTO/search-bool.html.

[18] Here we define white-collar workers as university-educated workers.

[19] The author interviewed an interlocutor close to the former foreign managers at Shenzhen Development Bank.

[20] Quan argues that MNCs have placed R&D activities in China primarily because they have been able to segment the R&D value chain so control of valuable knowledge is kept in the home base of the MNC.

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