The De-industrialization of Taiwan: A Spatial Perspective

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Over the period 1986 to 2001 some 235,000 manufacturing jobs were lost in Taiwan. As such the Taiwanese economy met the classical definition of de-industrialization. However, when data derived from the successive Industrial and Commercial Census mapped for all 318 cities and townships (hsiang and chen) a more varied and positive view of the structural changes in manufacturing in Taiwan emerges. For example, 18.24 percent of the areal units had experienced no declines in manufacturing employment as late as 1996; similarly, 14.46 percent of all units reported net gains in employment through 1996. In addition, 81.33 percent of all areal units experienced increases in both average salaries in manufacturing and in value added. It appears then that industrial restructuring rather then de-industrialization is a better perspective through which Taiwan's most recent economic changes should be viewed. This evaluation is corroborated by changing patterns of Taiwanese exports. Future research on changing patterns of regional specialization in Taiwan manufacturing sector will further our understanding of the restructuring process.

Keywords: *de-industrialization, Taiwan, direct foreign investment*

INTRODUCTION

Since the late 1980s it has been fashionable to lament the fact that the economy of Taiwan had apparently undergone a process of de-industrialization (Dreyer, 1991; Tung, 1997). The evidence that such a major structural change in Taiwan's economy had in fact occurred was seemingly easy to identify: the number of workers employed in manufacturing had fallen annually since 1986 (Table 1). In the period 1986 to 2001, the number of those employed in manufacturing declined from 2.8 million to 2.5 million, a loss of some 234,000 workers or 8.29 percent; there was some recovery in employment, so that by 2005 the total had increased to 2.7 million, still well below peak employment. The decline in manufacturing in employment in the Taiwan economy and the increases in service employment were interpreted to

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mean that Taiwan was best understood as a service economy (Fare, Grosskoft, and Lee, 1995; Selya, 1994). The main concerns expressed over the fate of the Taiwanese economy that would result from the decline in manufacturing employment focused on unemployment and its economic and social consequences.

Table 1: Taiwan Industrial Indicators

Year	Employment in Manufacturing (1000s of persons)	Number of Factories	Average Monthly Industrial Earnings(NT$)	Value of Manufactured Exports (US$Million)
1952	272	9966		9.5
1953	271	12175		10.7
1954	289	14392		9.9
1955	296	16154		12.8
1956	298	17852		20.1
1957	323	18774		18.7
1958	345	12289		21.9
1959	362	16893		37.1
1960	377	18788		53.1
1961	387	20646		79.8
1962	404	22373		110.1
1963	424	24837		136.3
1964	439	27540		183.9
1965	449	24603		206.9
1966	477	27437		295.2
1967	439	29861		394.8
1968	510	33057		539.7
1969	577	35146		776.4
1970	596	15031		1164.7
1971	758	20247		1666.9
1972	917	24906		2489.1
1973	1139	32318	2525	3794.1
1974	1160	37345	3389	4766.2
1975	1248	40982	4029	4440.6
1976	1450	43809	4734	7154.1
1977	1529	47704	5461	8188.6
1978	1916	52849	6341	11309.5
1979	2083	59499	6554	14580.8
1980	2152	55421	8043	17989.7
1981	2162	60277	9564	20989.1
1982	2168	59223	10467	20619.3

(cont.)

Year	Employment in Manufacturing (1000s of persons)	Number of Factories	Average Monthly Industrial Earnings(NT$)	Value of Manufactured Exports (US$Million)
1983	2282	63220	11136	23422.1
1984	2497	61008	12173	28624.8
1985	2501	68145	12697	28847.1
1986	2635	76886	13983	37284.1
1987	2821	86546	15356	50430.1
1988	2802	89965	17012	57347.1
1989	2796	93295	19461	63246.9
1990	2653	92978	22048	64204.2
1991	2598	95327	24469	72608.2
1992	2585	94673	26986	77986.8
1993	2483	96579	28869	81606.8
1994	2485	95581	30797	89240.5
1995	2449	97016	32545	107375.3
1996	2422	96756	33900	111858.3
1997	2570	99844	35456	119529.2
1998	2611	98836	36436	108626.5
1999	2603	100682	37686	119637.7
2000	2655	98860	68792	146215.1
2001	2587	97172	38277	120906.1
2002	2563	98195	38208	128548.1
2003	2590	98865	39583	142031.9
2004	2671	90751	40611	171552.2
2005	2762	89883	41751	186924.3

Source: Taiwan Statistical Data Book. Taipei: Council for Economic Planning and Development, various years.

Alarm over what appeared to be de-industrialization generated a debate as to its causes. No fewer than thirty-three "causes" of de-industrialization in Taiwan have been identified. Listed by frequency of mention, these include:

- The high cost of labor and /or the shortage of skilled labor (Chen, 1994; Chen, 2000; Chou,2002; Clark, 1994; Courtenay, 1999; Domes, 1992; Dreyer, 1990, *Free China Journal*, 18 Oct., 1996; Lin, 2001; Smith, 1998; *Taipei Journal*, 25 Aug., 2000; Tung, 1997);
- Environmental concerns and protests (Chen, 1994; Cheng, 1998b; Cheng and Liao, 1998; Courtenay, 1999; *Far Eastern Economic Review*, 2 April, 1998; Shen, 1993; *Taipei Journal*, 25 Aug. 2000; Wu, 1995; Yu, 1995);
- Competition from manufacturers in the People's Republic of China (Biers, 2001; *Economist*, 2003b; Her, 1997b; Landler, 2001; Smith, 1998; Wu and

Cheng, 2002);
- Republic of China "Go South" Overseas Investment Policy (Chang, 1993; Chang, 1999; Li, 2002a, b; Sheng, 1998);
- High price of land and/or difficulty in acquiring land (Chen, 1994; Cheng and Liao, 1998; *Taipei Journal*, 25 Aug., 2000; Wu, 1995; Yu, 1995);
- World Cyclical Demand (Courtenay, 1999; *Economist*, 15 Sept., 2001; Her, 1997a; Lin, 2001; Wu and Cheng, 2002);
- Appreciation of the NT Dollar (*Free China Journal*, 24 Jan., 1994; Liang, 1993; Smith, 1998);
- Companies' desire to increase market share elsewhere (Cheng, 1998a; *Free China Journal*, 1996);
- Shifts in the domestic economy of Taiwan (Clark, 1994; Lin, 2001, Rowthorn and Ramaswamy, 1997);
- Weak Investor Sentiment (Hwang, 2002; Tung, 1997);
- Crime (Domes, 1992);
- Decrease in willingness to work (Chang, 1988; Her, 1996);
- Desire to locate closer to upstream suppliers (*Free China Journal*, 18 Oct., 1996);
- Failure of domestic manufacturers to up-grade technology (Her, 1997a);
- Fragile industrial infrastructure (Tung,1997);
- General restructuring of the Taiwan economy (Chiu, 2001);
- Improvements in quality of Mainland Chinese products (*Free China Journal*, 1996);
- Increase in self-employment (Chang, 1988; Cheng, 1998d);
- Increases in labor disputes (Her, 1997a);
- Lack of direct transportation links with the People's Republic of China (Cheng, 1997);
- Lack of local raw materials (*Taipei Journal*, 25 Aug., 2000);
- Local opposition (Baum, 1998);
- Loss of government subsidies (Chou, 2002);
- Obstacles to export expansion (Wu, 1995);
- Over-reliance on small and medium sized enterprises (Clark, 1994);
- Poor water quality (Shen, 1993);
- Power shortages (Wu, 1995);
- Privatization of state-owned firms (Shen, 1999a,b);
- Red tape involved in permit application process (Baum, 1998);
- Social unrest (Domes, 1992);
- Part of world-wide process (Economist, 2003b);
- Work in manufacturing no longer attractive (Chou, 2002);
- World bans on export of certain chemical products (Shen, 1993).

As a set of explanations not only is this list quite long, but many of the items on it have been cited repeatedly as either bottlenecks to further development of manufac-

turing, or as explanations for the strength of the service sector. For example, water quality issues, including shortages, have been cited as a limiting factor in industrial expansion since the 1960s (Lin, 1965; Selya, 1974). Similarly, land related problems have long plagued Taiwan, and government programs to build industrial zones were designed to ease this bottleneck (Fuchs and Street, 1982; Tsai, 1984). Changes in attitudes towards work have been identified as a basis for the preference of employment in the service sector (Cheng, 1998e; *Free China Journal*, 1991; Gold, 1991; Selya, 1994). Other items appear to be related to short term economic and financial crises in either Asia, such as the East Asian Financial Crisis of 1997, or more general world economic cycles

In this research both the perception that de-industrialization took place to the detriment of the Taiwan economy and the explanations for de-industrialization are subject to analysis using spatial methods. Data for this study were taken from the successive *Industrial and Commercial Census of Taiwan.* There are two advantages to using this source. First, a similar methodology of data collection was used for all censuses so that the data are highly comparable. Second, the census reports contain tables measuring manufacturing in various ways at the enumeration level of city and township (*hsiang* and *chen*). The only exception to the second advantage is the 2001 *Census.* No detailed tables showing data at the *hsiang* and *chen* level were published. Hence the spatial analysis of de-industrialization uses the end point of the 1996 *Census.* For readers unfamiliar with Taiwan, Figure 1 provides a basic place name orientation. For additional information readers should consult Chang (1972).

DE-INDUSTRIALIZATION: DEFINITIONS, MEASURES, ISSUES

In focusing on the decline in employment in manufacturing, those concerned with de-industrialization in Taiwan have used the most simplistic and contentious measure of economic change possible (Cairncross, 1979; Dicken, 1986). While calculating the absolute and relative decline in employment in manufacturing is relatively direct and easy, it also can lead to confusion. The main cause of confusion involves the difficulty in differentiating a shrinking workforce in manufacturing due to periodic recessions as part of normal cyclical changes in an economy, and de-industrialization. In addition, it is not clear whether or not changes in employment reflect changes in industrial output, the importance of manufacturing in the GDP of a country, or the role of manufacturing in the size of a country's export base. Finally, shifts in manufacturing employment do not provide a basis for deciding whether the manufacturing sector of an area is unable to compete internationally in the production and export of manufactured goods, thus depriving a country of the means to import manufactured goods (Dicken, 1986, 1992). A more complete set of measures is needed then to establish whether an area is under going de-industrialization. At a minimum, changes in employment patterns must be cross-checked

to see whether or not there have been productivity increases in output per worker (Doyle, 2002; Thirwall, 1982). It is also necessary to see whether or not changes in real wages have led to deterioration in competitiveness (Lin, 1993).

Figure 1: Taiwan orientation map.

Another seeming error in the discussion of the de-industrialization of Taiwan has been to assume that de-industrialization is a negative process. In contrast, there is a large literature that argues that a decline in manufacturing can be seen as an indication of economic success, featuring shifts in consumer preferences towards services (Cairncross, 1979; Brown and Sheriff, 1979), increases in living standards and technological progress (Rowthorn and Ramaswamy, 1997), and economic efficiency within the context of globalization (*The Economist*, 2003a).

EVIDENCE OF DE-INDSUTRIALIZATION

Based on the above considerations, it is possible to begin analyzing the changes in manufacturing in Taiwan. For all variables, the peak year was compared with the initial and/or last year of our data set, a method used elsewhere with good results (Thirwall, 1982).

Maps of employment in manufacturing provide some unexpected insights in the nature of the de-industrialization process. First the timing of job losses is not uniform across the island (Figure 2). While it is true that four out of the five major cities experienced declines from their maximum employment in manufacturing by 1986, the only other places with early job losses are relatively remote. Significantly some of the suburbs of the major cities experienced very late declines, while other suburbs, some 18.24 percent of all townships, experienced their maximum manufacturing employment in the last year of census data, 1996, i.e., in essence they had not experienced de-industrialization. Second, some 21.2 percent of townships actually experienced job increases (Figure 3). These townships are widespread, but include a broad tier of administrative units to the south and west of Taipei City, clusters of units around Tainan and Kaohsiung Cities, and one area to the southeast of Taichung City. The areas that experienced the highest decline in manufacturing employment are very clustered: there is a broad band running through Taipei and Ilan *hsien*; a similar band extends through eastern Taoyuan, Hsinchu, and Miaoli *hsien*. Similar clusters appear in Nantou, Chiayi, Tainan, and Tainan *hsien*. The areas experiencing the severest losses appear to be a band running north south along the southeastern coast of Taiwan, including parts of Ilan, Hualian, Taitung, and Pingtung *hsien*. Of the major cities only Taipei city experienced a loss below the average, while the remaining cities were well above the average loss.

Finally, losses are not necessarily permanent (Figure 4). A small minority of the administrative areas of Taiwan, thirty-two townships and Taipei City, actually experienced some recovery of lost manufacturing jobs. In no case did the number of new positions completely compensate for previous losses. Nevertheless, it is telling that remote areas with early losses and Taipei City with all its constraints to manufacturing, were by 1996 able to recoup some of their previous losses. The implication is that future employment gain in manufacturing could be possible virtually anywhere. In fact, a significant recovery of manufacturing jobs has been reported (Bradsher, 2004). This recovery can be traced to two sources. First, a general recovery of the economy starting in 2001. Second, Taiwan entrepreneurs did not totally abandon Taiwan as a manufacturing center. They did move off shore those products that depended on cheap labor, while retaining in Taiwan the production higher value products. Similarly they kept upstream functions such as developing new products in Taiwan, while sending downstream manufacturing jobs abroad. In so doing they followed what has been termed a "keeping the roots planted in Taiwan while letting the branches and leaves expand abroad" strategy (Chen, 2005).

Figure 2: Peak period of manufacturing employment.

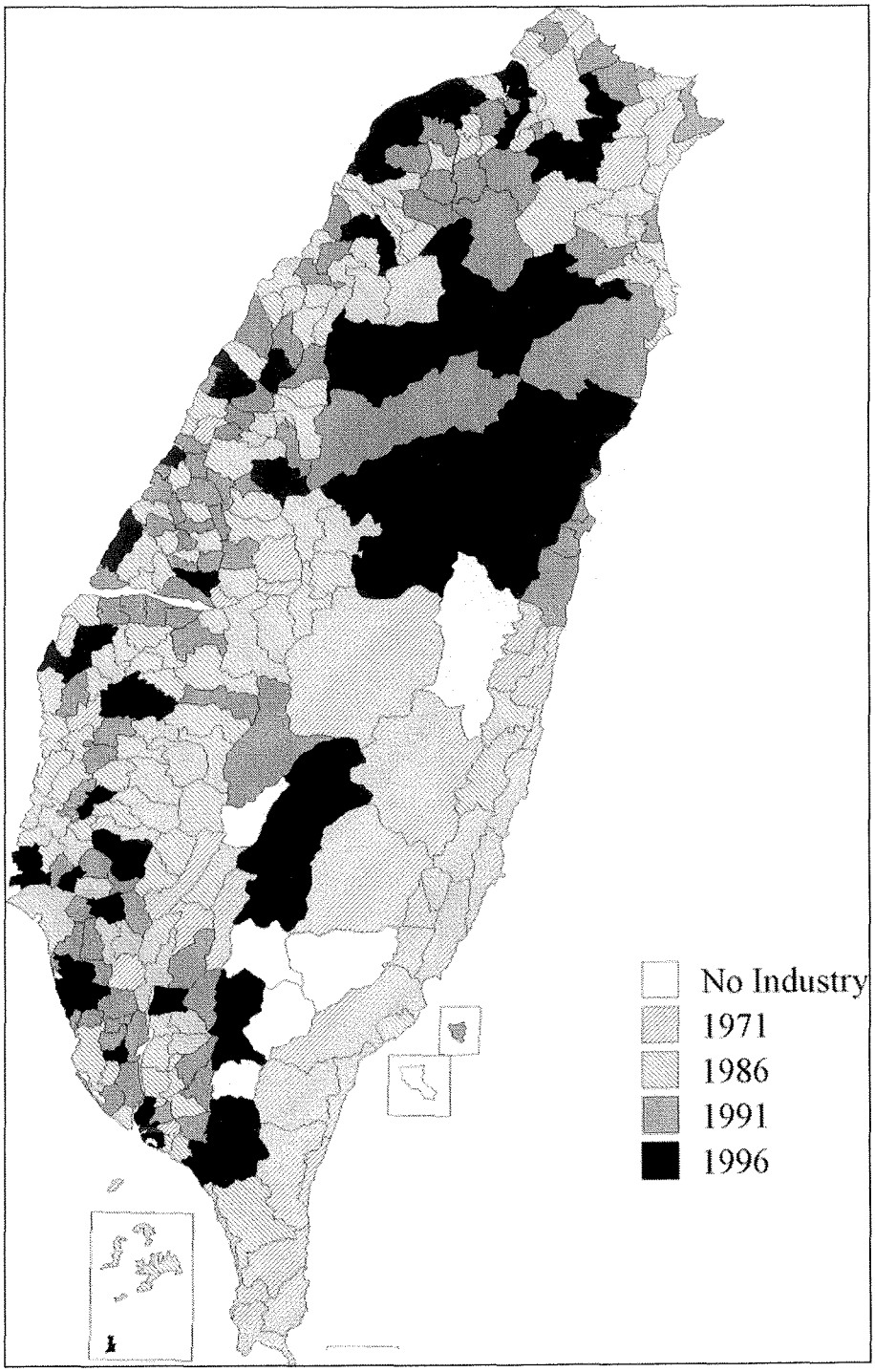


Figure 3: Percent decline in employment from peak period.

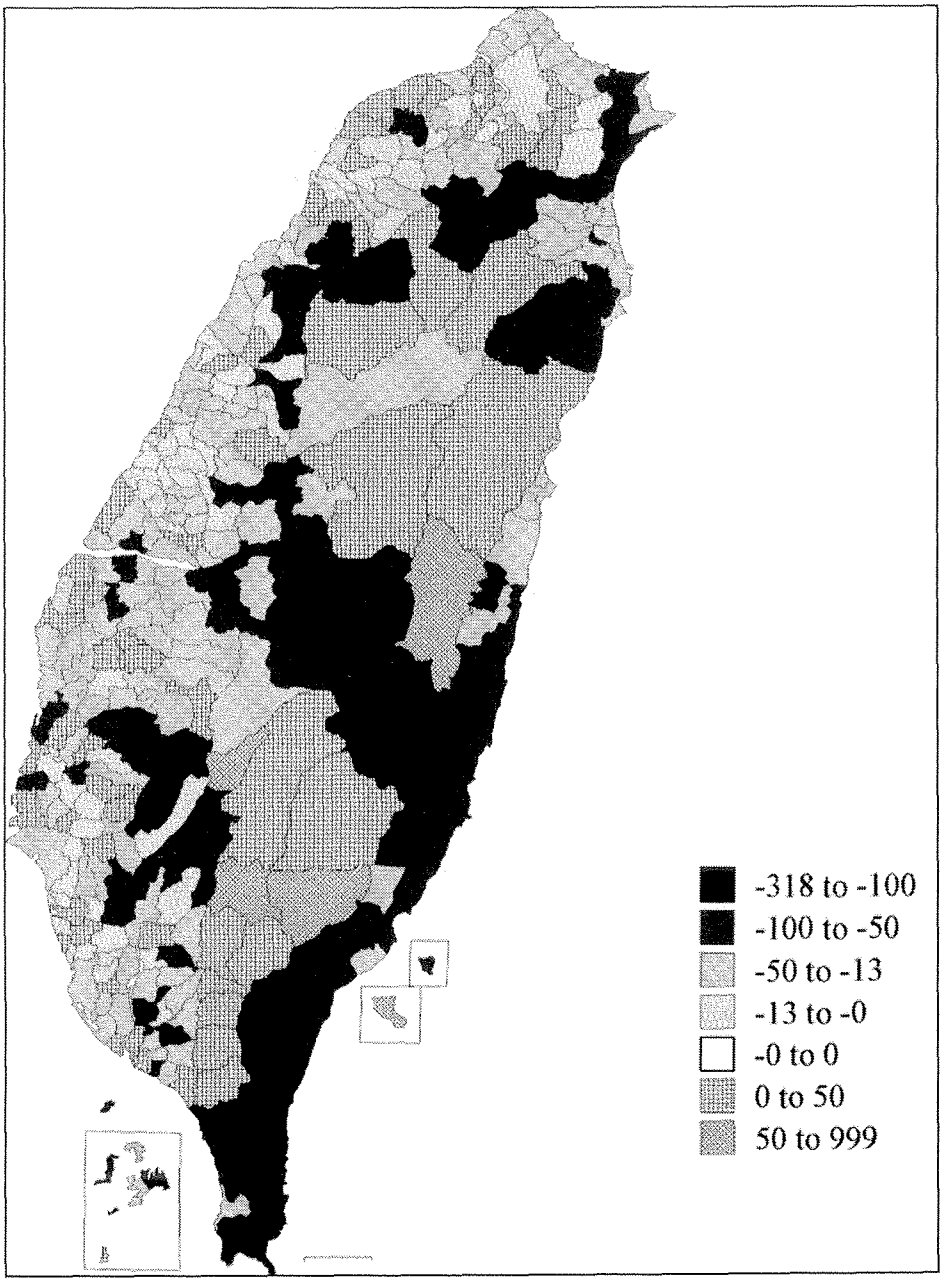
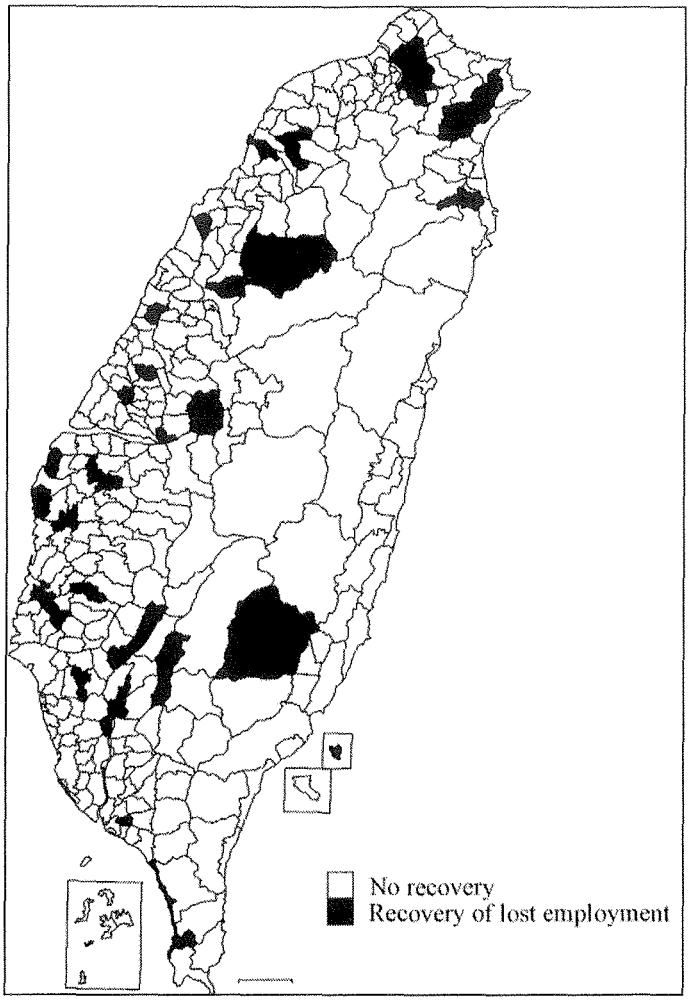


Figure 4. Recovery of employment in manufacturing.



ALTERNATIVE MEASURES OF MANUFACTURING

It is a well recognized principle in economic geography that alternative measures of manufacturing display different spatial patterns (Morrison, et al., 1967; Selya, 1982), especially when, as is the case for Taiwan, the measures are not highly correlated (Table 2). Two examples are offered to demonstrate that an argument can be made that rather than suffering from chronic de-industrialization, the manufacturing sector of Taiwan is strong and growing, albeit with problems that need addressing.

Table 2: Product moment correlation matrix: Alternative measures of manufacturing in Taiwan.

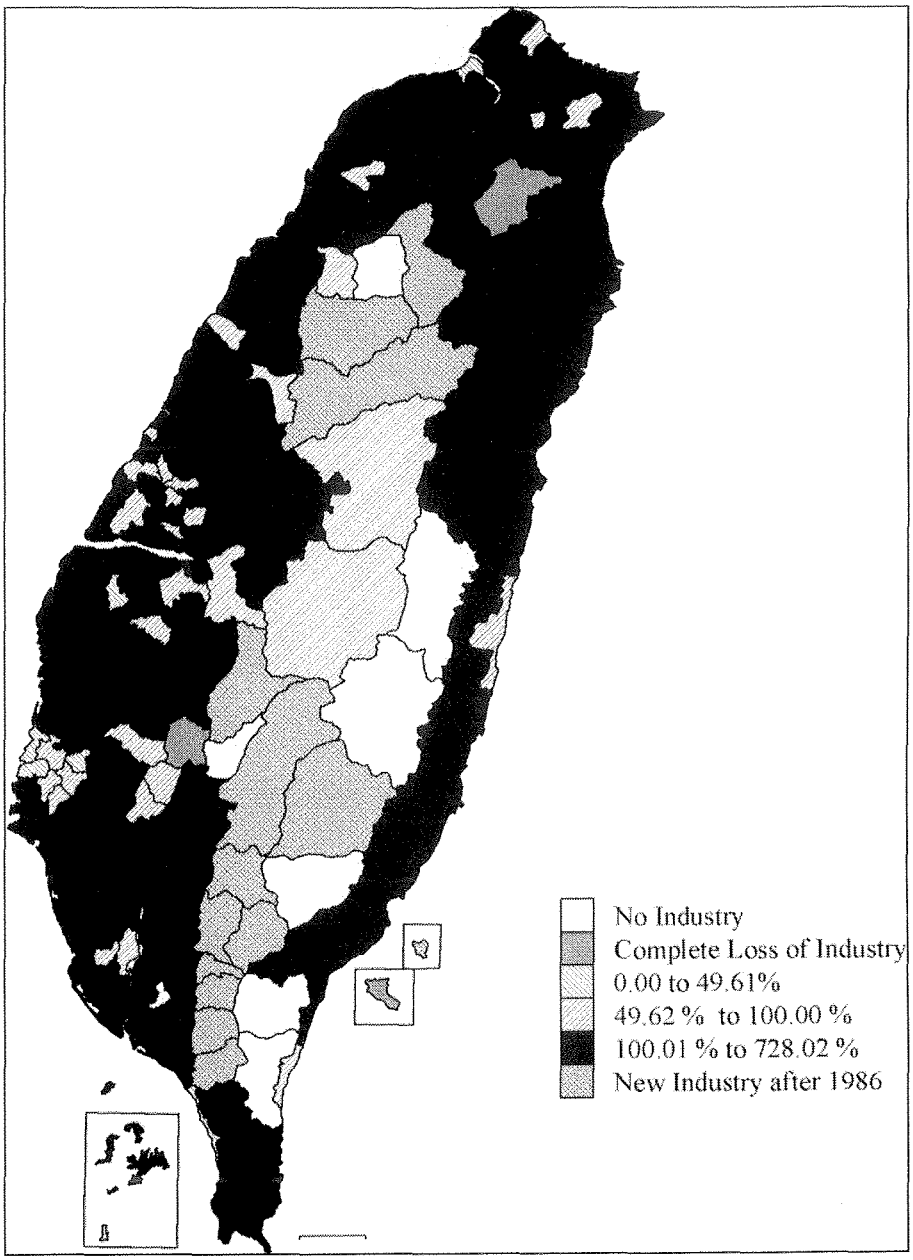
1986			
	Employment	Value Added	Average Salaries
Employment	1.00	0.541	0.228
Value Added	0.541	1.00	0.077
Average Salaries	0.228	0.77	1.00
1996			
Employment	1.00	0. 908	0.088
Value Added	0.908	1.00	0.170
Average Salaries	0.088	0.170	1.00
Changes in Measures			
Employment	1.00	-0.356	0.040
Value Added	-0.356	1.00	0.522
Average Salaries	0.040	0.522	1.00

Source: Calculated by author from data in Industrial and Commercial Census of Taiwan, various years. Taipei: Directorate-General of Budgeting, Accounting, and Statistics, Executive Yuan.

Between 1986 and 1996 the *average salary increase* for all employees in manufacturing was 49.61 percent. The statistical distribution of increases however is most telling: 2.05 percent of all places had an increase up to the average, while 10.92 percent had increases above the average and as high as double (100 percent) the 1986 figure, and 87.03 percent had increases from 100 to 728 percent. All told then, if the townships that developed new industry after 1986 are included, 96.5 percent of all townships experienced increases. What is striking about the spatial distribution of salary increases is how widespread the highest increases are (Figure 5). Rather than describe where these major increases occurred we are better off noting that the central mountain core in its northern and southern extremes attracted new industry, while the middle section had either no industry to start with or townships with increases in the second highest category. The only real cluster of townships with very low salary increases are found scattered in west -central Tainan *hsien* or randomly distributed in Chiayi and Taipei *hsien*.

In contrast, the data for *changes in the value added in manufacturing* are more varied (Figure 6): only 78.8 percent of townships experienced increases in value added, with roughly half of these have increases up to 107 percent, while the other half had increases ranging up to 25,540 percent. Clusters of high gain townships are widespread: in and around Taipei City, on the east coast south of Hualien *hsien*, in a rough east-west band across central Taiwan, in a north-south cluster aligned along the Kao-ping river in the south, at the tip of the island, along the Taoyuan-Miaoli-

Figure 5: Changes in salaries in manufacturing.



Ilan *hsien* border, and in Taoyuan *hsien* along the coast. Those places with negative changes or very low positive changes present a checkerboard pattern along the east coast, and in the areas with very high changes. Although the group with negative change constitute but some 15.51 percent of all townships, many of the places with such losses had also experienced very high gains in salaries. These contrasting patterns are consistent with the mixed correlation coefficients shown in Table 2. But they also suggest that manufacturing is not as vibrant as the spatial distribution of salary gains might suggest.

Given the contrasting observations that have been made regarding the spatial distribution of three measures of manufacturing, what can be concluded about the current health and prospects for manufacturing in Taiwan? Since we are lacking data on regional specialization in manufacturing, this question must be answered in a more aspatial, macro context. As might be expected there are reasons to be either optimistic or pessimistic.

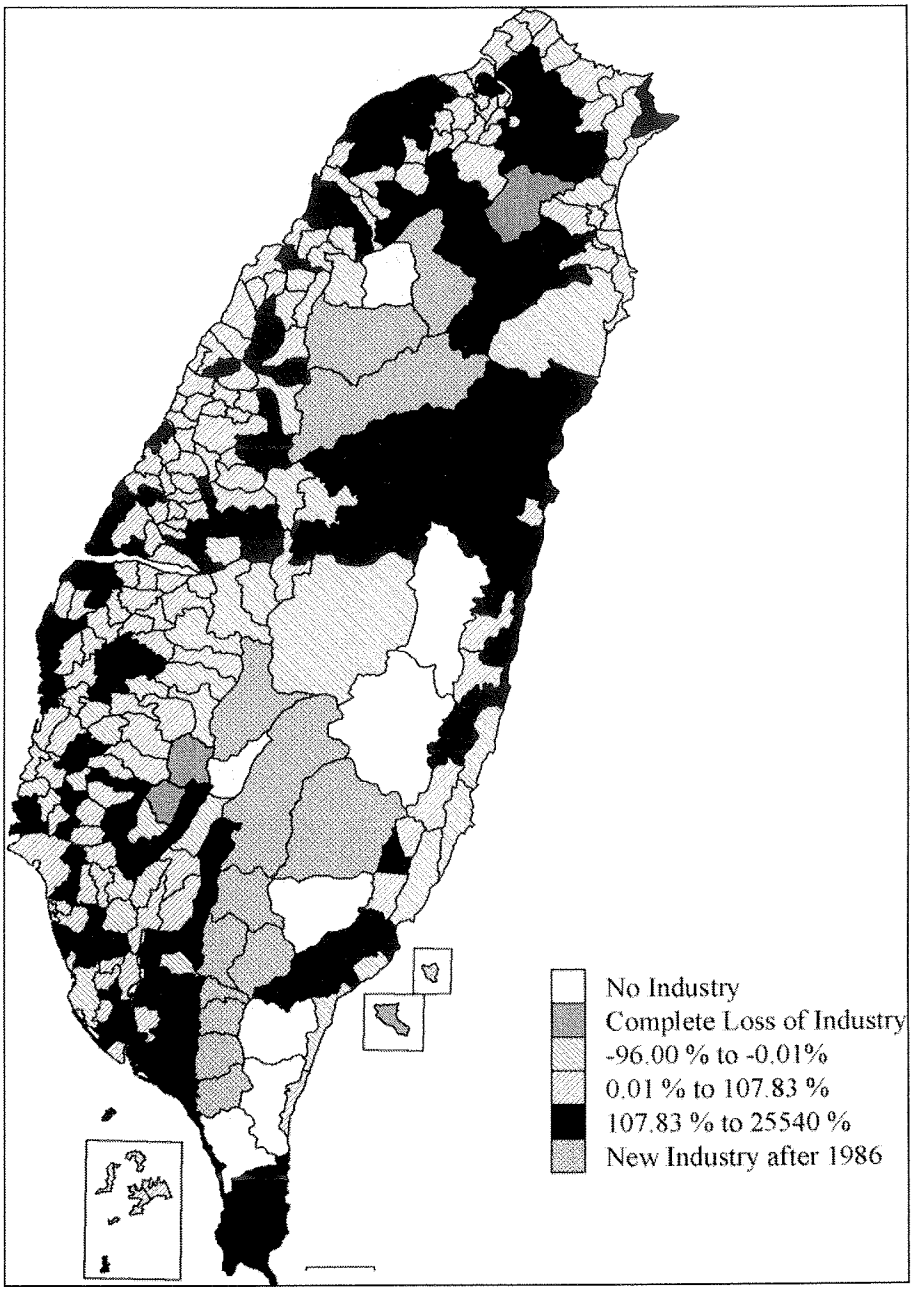
REASONS FOR ANTICIPATING A BRIGHT FUTURE FOR TAIWAN MANUFACTURING

An optimistic future for manufacturing in Taiwan can be derived from clusters of data dealing with six economic measures: foreign trade, direct foreign investment, competitiveness, employment trends, standards of living and industrial restructuring.

In terms of *foreign trade*, Taiwan has had strong growth in the value of manufactured exports and a positive balance of trade since the government adopted an export orientation in the 1960s (Table 1). Some slowdowns or reversals in growth and balance of trade did occur during world or local recessions, but as conditions improved exports rebounded. Another perspective on the strength of Taiwan's exports is derived from Taiwan's ranking as a world trading power (*Pocket World in Figures*, various years; *Direction of Trade Yearbook*, various years): she has ranked as high as 12th and as low as 15th in the period 1986 to 2001. Similarly, the percent of world exports generated by Taiwan has been on average some 1.73 of the total, varying on a year-to-year basis with a narrow range of 0.56 percentage points. It is important to note that growth occurred, and rank maintained, even as competition from other Asian Tigers and the People's Republic of China intensified

Although Taiwanese entrepreneurs have gone overseas, foreign entrepreneurs continue to find Taiwan an attractive place to invest (Dreyer, 1990), despite the perception that it is a high wage country (Diesenhouse, 2003). Taiwan then has been able to continually attract significant *direct foreign investment in manufacturing*. For the period 1952 to 2005 some $ 64.7 billion was invested in manufacturing (Table 3). This investment occurred across the entire spectrum of goods, including such low order products as food and beverage, processing, textiles, and garments. However,

Figure 6: Change in value-added in manufacturing.



investment in electronic and electric appliances has been a major area of investment. Since 1993 major direct foreign investments have been made in plastics, precision instruments, and transportation. Taiwan remains an attractive place for investors due to the high quality of goods produced (Cheng, 1998c), its strategic location (Cheng, 1997; 1998c); its experienced workforce (Shen, 1996a); its sound economic structure (Cheng, 1997; Wu and Cheng, 2002); its excellent, low-risk, credit rating (Shen, 1996b); government incentives and plans to turn Taiwan into an Asia Pacific manufacturing center (Shen, 1996a; Wu and Cheng, 2002); and the possibility to establish strategic alliances with other Taiwan-based firms (Li, 2003a).

In terms of de-industrialization, the data clearly show that fully some 92 percent of the total direct foreign investment in manufacturing occurred after 1986 (Table 3). On an annual basis, all years after 1986 show that the percent of total direct foreign investment devoted to manufacturing is well above the 1962-2002 average of 50.8 percent. Furthermore, on a sector-by-sector basis only one out of fourteen categories of manufacturing, non-metallic materials, had less than 73 percent of the investment occurring after de-industrialization was said to have set in. A favorable investment climate is also evident in the high rankings afforded Taiwan by such organizations as Business Environment Risk Intelligence, Economist Intelligence Unit, Heritage Foundation, Money Matters Institute, and World Economic Forum (Li, 2003b,c). Taiwan's attractiveness has even transcended political and military threats from the People's Republic of China (Baum, 1995).

As for *competitiveness*, Taiwan has clearly been able to maintain its rankings (Courtenay, 2003; Li, 2003b,c,d; Shen, 1997). Regardless of which institution or foundation ranks Taiwan, and regardless of the ranking measure used, Taiwan has either maintained or improved its competitiveness rankings over the years. One factor in Taiwan's ability to remain competitive is the fact that increases in labor productivity in manufacturing have been strong from the mid 1980s through 2002, averaging some 5.9 percent per year.

Regarding *employment trends*, it is true that the historically low rates of unemployment enjoyed by the Taiwan population have increased from an average of 1.5 percent during the 1970s, 1980s, and 1990s, to 5.2 percent in 2002. This increase has led to a call for additional government action and programs (Chiu, 2000a,b), in addition to the provision of labor insurance begun in 1985 (Kuo, 1985). Concern over unemployment rates however must be balanced by three significant facts. First, Taiwan workers have been enjoying a decrease in the average work week (Harmsen, 1995; *Far Eastern Economic Review*, 1997). Second, the Council of Labor Affairs has continuously allowed the import for foreign workers for placement in the Three D—dirty, dangerous, and disgusting—industries, albeit in the context of changing labor needs, unemployment rates, and the state of diplomatic affairs (Gao, 2001; Lee, 2002). Third, compared with unemployment rates in first world countries, Taiwan's rates are not high.

By all measures, despite a decline in the number of employees in manufacturing, *standards of living* have improved since 1986. Per capita income has continued to increase, although the US dollar value of that income has fallen somewhat as the value of the dollar itself has weakened during 2001-2. Nevertheless purchasing power parity has kept well ahead of fluctuations in currency rates. Ownership of common household appliances is near or at saturation levels.

Finally, Taiwan's manufacturing has gained due to *industrial restructuring*. Two examples, textiles and high technology, demonstrate how industrial restructuring has strengthened Taiwan's manufacturing.

Textiles is often seen as an archetypical sunset industry. And the data for Taiwan at first glance support such a view. Employment has declined by some 180,820 positions, or 53.3 percent, since its peak of some 339,498 in 1976 (as a percent of the workforce in manufacturing textile employment peaked in 1971, with 25.9 percent; by 1996 some 6.41 percent of manufacturing employment was in textiles). By 2002 some 23.7 percent of the textile manufacturing establishments have closed their doors since the 1986 peak of 8437 factories. Some 147 Taiwanese entrepreneurs have responded to what they saw as deteriorating economic conditions by investing some US$917 million in textiles factories offshore in the period 1952 to 2005 (All data taken from *Taiwan Statistical Data Book*, various years.).

Yet the value of textile exports continued to climb up until 1997, when some $14.2 million worth of textiles, representing some 11.6 percent of all exports, were shipped overseas. Although the value and percent of textile exports have declined, in 2005 some US$10.8 million were exported, presenting 5.74 percent of all exports. Similarly, labor productivity has increased every year in this industry, albeit sometimes at rates lower than overall manufacturing. And foreign investors found Taiwan textiles a good investment: 88.1 percent of all textile investment have occurred after 1976. The US$585 million invested ranks textiles as the seventh most popular sector for attracting direct foreign investment. This investment in essence represents a return of some 84 percent of the investment made by Taiwan entrepreneurs in textiles overseas!

Despite the loss of jobs in textiles, Taiwan has been able to maintain a viable textile industry. This has been done by a number of strategies (Her, 2002; Mehta, 2006). First, the textile industry has paid more attention to niche needs in both upstream and downstream production of speciality, high-value, man-made fibers known as "functional fabrics" and processed silk, rather than relying on staple fabrics (Lu, 2002). As such it has made major changes in the product lines it produces. In so doing it has worked to acquire a reputation for high quality products. Second, it has upgraded the technology it uses to include high technology machinery. Part of this upgraded has been made possible by the new cadre of college graduates that are being produced by modernized programs in fashion design and textile engineering. In turn, manufacturers of textile machinery have begun providing a range of automated machines, implemented strict quality control systems, established a strong

Table 3: Direct foreign investment (US $1000).

Year	Food	Textiles	Garments	Leather	Lumber	Chemicals	Paper	Rubber	Plastics	Non-Metallic	Basic Metals	Machinery	Electronics	Transport	Precision Instruments	Total	% Manufacturing
1952	0	961	0	0	0	8	0	0	0	0	98	0	0	0	0	1067	100.0
1953	671	347	91	0	0	2	0	0	0	312	0	17	0	0	0	3695	38.97158322
1954	2045	0	0	0	0	14	0	0	0	0	0	50	0	0	0	2220	95.0
1955	0	0	30	0	0	4423	0	0	0	141	0	0	0	0	0	4599	99.89128071
1956	507	1115	0	52	0	961	360	100	0	96	0	0	0	0	0	3493	91.35413685
1957	100	0	0	22	86	417	0	0	0	335	0	0	0	0	0	1622	59.18618989
1958	0	149	0	3	0	0	379	0	0	337	0	0	1043	0	0	2518	75.89356632
1959	100	333	0	0	0	0	0	0	0	82	0	0	0	0	0	965	53.36787565
1960	0	2316	0	0	0	12452	0	0	0	0	0	294	0	0	0	15473	97.3437601
1961	170	384	98	32	0	4608	0	0	0	172	323	0	1156	0	0	14304	48.53887025
1962	95	440	0	0	0	2408	78	75	0	0	411	0	851	0	0	5203	83.75936959
1963	6000	54	0	0	38	8613	0	383	0	207	328	354	625	0	0	18050	91.97783934
1964	3760	513	572	22	403	1250	25	0	0	120	691	1706	771	0	0	19897	49.41951048
1965	753	503	1706	461	254	10061	13	463	0	195	344	0	21377	0	0	41610	86.83008892
1966	533	1832	58	272	618	585	237	178	0	626	1061	387	15381	0	0	29281	74.3417233
1967	2039	1541	6040	146	282	6595	1143	2078	0	2958	5873	4642	14559	0	0	57006	84.01922605
1968	2144	3133	5250	104	1000	14434	775	3980	0	3330	2727	1650	26993	0	0	89894	72.88584333
1969	1913	4353	1536	224	125	3490	593	3288	0	717	2004	3349	64766	0	0	109437	78.91115436
1970	222	4177	2529	817	250	10638	254	1891	0	5920	3516	3090	73832	0	0	138896	77.13397074
1971	145	6752	2258	771	223	11903	620	7442	0	317	67500	1592	32970	0	0	162954	81.30699461
1972	726	2898	1853	108	1314	3883	597	4982	0	156	3327	40058	19720	0	0	126656	62.86476756
1973	1652	16026	4537	2962	3289	28864	1814	6995	0	24557	11029	43818	75748	0	0	248854	88.92402774
1974	3796	10720	1100	798	2265	12633	5382	2557	0	36210	6587	8174	69652	0	0	189376	84.4214684
1975	1763	7329	1641	2508	21	30568	1310	2201	0	1802	3816	5661	24701	0	0	118175	70.5064523
1976	3259	3972	1526	487	2743	12433	25	1594	0	12330	5108	8177	72395	0	0	141519	87.65536783
1977	1663	1493	814	339	915	14010	940	2719	0	4151	6991	7627	52801	0	0	163909	57.63136863
1978	673	5557	910	213	629	35170	94	9806	0	3246	8593	9417	63495	0	0	212929	64.71781674
1979	8701	5262	3410	72	4480	22866	955	6246	0	44045	16936	8887	110408	0	0	328835	70.63360044
1980	14004	8201	1928	0	3865	57258	587	9965	0	186740	29325	14519	108602	0	0	465964	93.35356379
1981	18367	6582	2172	0	1554	42982	82	18700	0	5729	44099	39462	83948	0	0	395757	66.62598514

(cont.)

Year	Food	Textiles	Garments	Leather	Lumber	Chemicals	Paper	Rubber	Plastics	Non-Metallic	Basic Metals	Machinery	Electronics	Transport	Precision Instruments	Total	% Manufacturing
1982	20375	4130	4062	0	614	35994	7252	5395	0	6922	46383	30727	70797	0	0	380006	61.22298069
1983	10773	1426	913	0	1375	36934	3826	12418	0	10435	13922	141642	107267	0	0	404468	84.2912171
1984	9275	3533	1993	2023	1525	132507	479	23430	0	895	17412	41739	267652	0	0	558741	89.92771248
1985	21058	7749	2006	2782	1565	214259	555	6927	0	6644	51425	86471	139304	0	0	702459	76.97886994
1986	9442	5725	3028	1026	1356	139896	2658	21662	0	11566	45637	110565	231741	0	0	770380	75.84594616
1987	77073	16218	4541	2431	7823	171625	9806	72427	0	47776	121163	75946	377375	0	0	1418796	69.36895791
1988	56916	25778	3805	885	3587	104237	13017	56701	0	34737	68419	137098	237329	0	0	1182538	62.78944102
1989	219206	52400	5296	772	11934	519996	33157	83079	0	32667	175561	102885	391042	0	0	2418299	67.31983928
1990	100179	31403	3287	2543	22977	506678	8786	33176	0	33089	187232	128384	377039	0	0	2301772	62.33341095
1991	38410	46631	13332	478	13320	200963	1245	18409	0	30797	132960	175049	570099	0	0	1778419	69.82004803
1992	55014	15218	1392	1767	8613	106517	12355	70088	0	10490	40192	97529	323308	0	0	1461374	50.80718557
1993	55354	9279	13437	2899	5801	107682	1008	364	22158	44386	72897	36923	226651	65197	8873	1213476	55.45301267
1994	93118	53595	16407	10248	1897	189567	3419	4015	8608	14953	42935	45882	296088	115607	22272	1630717	56.33172402
1995	43187	39935	3448	7476	1681	374874	5704	460	6798	13572	22578	51772	1241040	146220	16984	2925334	67.5385785
1996	108285	30200	1251	17898	3502	64526	10571	1991	19014	7247	63696	45422	443147	49645	23795	2460836	36.17429199
1997	47718	46959	33969	34296	1844	188689	6604	953	11173	8972	763444	62595	952463	99335	50888	4266629	54.13880607
1998	59752	54763	4439	41094	1566	171008	4900	334	29618	25815	67634	46576	1205776	93401	47473	3738758	49.59264547
1999	17728	21795	1749	13190	2441	163015	7377	954	44387	13019	62661	57733	1034058	68687	34546	4231404	36.47347311
2000	81501	4907	16050	16906	2832	146122	46798	609	10644	83117	59027	87078	1092871	26451	62960	7607739	22.84348872
2001	75838	5072	18326	6712	1714	136062	3365	397	20622	47636	118938	102380	1055614	48496	129284	5128529	34.52171178
2002	52796	11440	2175	11721	3687	98750	3971	2403	20309	32018	63993	40491	662994	169874	57700	3271747	37.72669464
2003	26098	15146	2185	10478	219	161843	10092	3464	19021	22403	30261	72147	894369	37736	89275	3575656	39.00646483
2004	43378	7417	27968	12239	47658	146365	8699	30128	17505	34511	76205	118879	1263682	43745	54460	3952788	48.8981195
2005	40337	23213	#	13020	3660	112881	5154	16	23702	42910	61206	84509	783756	39368	92143	4228068	31.35888543
Total	1438612	630875	225118	223297	177545	4584519	227061	535443	253559	951408	2626468	2183353	15181256	1003762	690653	64723091	47.79272517
%86-05	90.46	81.96	78.22	93.18	83.42	83.13	87.50	75.01	100.00	62.19	86.68	76.94	89.98	100.00	100.00		

Textiles and Garments combined since January, 2005.

Sources: Statistics on Overseas Chinese & Foreign Investment. Technical Cooperation. Indirect Mainland Investment. Guide of Mainland Industry Technology Republic of China. December 31, 1999. Table 3. Taipei: Investment Commission Ministry of Economic Affairs.

Statistics on Overseas Chinese & Foreign Investment, Outward Investment, Mainland Investment. The Republic of China.April, 2006. Table 5. Taipei: Investment Commission, Ministry of Economic Affairs.

distribution network, and offered both sales and service of equipment (Li, 2001;Lu, 2002). Further improvements have been made in packing, inventory control, price, and timely delivery (Lu, 2002).

The evolution of the *electronics industry* stands in stark contrast to that of textiles. Early in the 1960s United States and European electronics firms began manufacturing in Taiwan. Manufacture of radios and telephone sets began in earnest in1962; of televisions sets in 1965 and of integrated circuits in 1968 (Liu et al., 1990). But the main force driving the growth of both electronics and high technology came in the form of a government policy that aimed at identifying key growth industries for incubating new, as well as up-grading existing, industries (Chi and Tsai, 1990; Chiu, 2000c; Hwang, 2002). In particular this policy sought to deepen Taiwan's indigenous science and technology based industries (Courtenay, 1993; Sun, 1999; Wang, 2003). The center piece of the government's plans for this sector was the establishment of the Hsinchu Science-based Industrial Park in 1980. Hsinchu was selected as the site of the park for situation reasons: two universities—National Tsing Hua and National Chiao Tung—were located in the town, as was the Industrial Technology Research Institute; in addition the town had good transportation links to Taipei city and the Chiang Kai-shek International airport. As a result, the Park has in essence evolved into a Science City (Zi, 1991). By the end of 2000 some 314 high-tech firms has located in the Park.

The success of this approach to developing critical economic sectors can be measured in several ways. The value of electronic, information, and communications products has increased some 1050 percent from US$ 3.4 billion in 1986 to $39.2 billion in 2001. The value of such goods from the Park alone reached US$29.8 billion in 2000 (Wang, 2003). For the period 1986 to 1996 employment in these high-tech sectors is up about 13.6 percent, and the value of salaries paid has increased some 218 percent. The prospects for continued growth in high-tech/ knowledge-based industries is bright, since the success of the original Hsinchu Park has led both the government and private entrepreneurs to develop three additional parks. The Tainan Science-Based Industrial Park began operations in 1996. By 2006 there were 203 factories producing some US$ 11.8 billion in exports; A twin park, Central Taiwan Science Park, opened in 2004 with a precision machinery and aerospace focus in Taichung *hsien* and a precision machinery, aerospace, biotechnology, communications, and opto-electronics focus in Yunlin *hsien.* The Formosa Plastics Group privately developed the Hwa Ya Technology Park in Taoyuan (Cheng, 1998c). This park was opened in 1999. Additional parks are being planned for including the Tingpu Science and Technology near Tucheng, Taipei *hsien*, with additional sites in Shulin, Ankeng, and Sanying under consideration (Li, 2003e). A software park is being developed in the eastern, Nankang, district of Taipei City. As has been the case with all types of planned industrial zones (Selya, 1974), not all high-tech zones that were planned have actually been built (Cheng, 1998b). As the electronics industry matures, entrepreneurs are themselves creating unique products and establishing

brand loyalty (Dean, 2003). In addition, biotechnology parks have been opened in Changhwa, Kaohsiung, Pingtung, Tainan, Taitung, and Yilan *hsien* (Smaglik, 2007).

The success of the electronics and high technology industry in turn was a major factor in the growth of a more knowledge based economy, especially in terms of knowledge-based manufacturing industries (Shen and Liu, 2002; Shen and Liu, 2003). The long-term goal is to expand knowledge based economic activities to include services as well so that Taiwan can be considered a "Green Silicon Island."

REASONS FOR PESSIMISM OVER THE FUTURE OF TAIWAN MANUFACTURING

In contrast to the basically empirical foundations for optimism over the future of manufacturing in Taiwan, when it comes to pessimism the basis is fundamentally psychological. There are three issues, two political and one economic, in particular that generate concern. First is the perennial issue of Mainland China relations. The People's Republic of China sees the island province as a renegade province and is committed to its reunification with the motherland. Considerable upgrading of the military capabilities of the PRC has occurred in recent year. Such improvements could permit the PRC to either impose an embargo on the island or attempt an outright invasion. In addition, deployment of missiles alone the China coast represents a real and growing threat to the island. Tensions are easily increased as was the case in November and December 2003, when in the run-up to the 2004 presidential elections in Taiwan, politicians there debated name changes and a referendum over the future of the island (Lawrence and Dean, 2003).

The second political concern relates to the commitment of the United States to defend Taiwan against an invasion from the PRC. The fear is that with the United States preoccupied with a war on terrorism, it will be unwilling or unable to come to Taiwan's defense.

The main economic concern relates to the degree to which the economies of Taiwan and PRC will become more intertwined as investment by Taiwan entrepreneurs in mainland facilities proceeds. There may be a dipping point in investment where any additional investment will blur the lines between the two economies and as a result the economy of Taiwan could lose its identity and independence. Conversely, it may be the case that Taiwan will become increasingly dependent on the PRC as a market and thus loose any ability to independently make economic or political decisions. It is true that these economic concerns can be empirically described. For example, according to the Investment Commission, Ministry of Economic Affairs, Republic of China, between 1994 and 2001 indirect investment totaling some US$16.2 billion had been approved for the PRC. In contrast, data from the PRC indicate that some $21.6 billion had been invested by Taiwan entrepreneurs. The disparity between the

two numbers is mostly attributable to the fact that some Taiwan direct foreign investment is channeled through Hong Kong. Similarly, there is concern that without trade between Taiwan and the PRC and between Taiwan and Hong Kong, Taiwan's balance of trade in many years would be negative. However, it is the interpretation of the data that leads government officials and entrepreneurs on Taiwan to be pessimistic about the future of manufacturing in Taiwan.

One additional economic concern focuses on the impact of overseas investment by Taiwan entrepreneurs on the structural problems of manufacturing. Despite high hopes overseas relocation for the most part has neither solved nor improved long-standing impediments to industrial upgrading in Taiwan such as the dependency on small and medium sized businesses (Hsueh, 1990; Hu and Schive, 1996; Pun, 1994; Tseng, 1988), research and development capacity, upgrading management or marketing techniques, product design, or antiquated banking and financial strategies (Tung, 1997).

CONCLUSIONS

It appears that concern about the possible de-industrialization of Taiwan is as much methodological as factual. By using a definition and measure of changes in manufacturing that focus on employment, government officials and economists have concluded that Taiwan is in fact undergoing de-industrialization. However by international standards, Taiwan's decline in the number of manufacturing employees is at the low end of any scale. For example, from their respective peak years, the United States (1979) through 2002 has lost some 30.5 percent of manufacturing jobs, while Japan (1996) has lost some 20.1 percent. By these standards Taiwan's loss of some 8.29 percent of its manufacturing workforce while worrisome, is not unmanageable. There are already indications that the employment situation in Taiwan manufacturing is improving after a decade of economic competition from the People's Republic of China (Bradsher, 2004). In addition it is most telling that the standard of living in Taiwan has not declined during the period of alleged de-industrialization. Furthermore, alternative definitions and measures clearly demonstrate that the manufacturing sector of Taiwan is competitive, healthy, and robust In addition, both government policies and private initiatives have proven to be successful in generating a high degree of specialization in manufacturing that will insure a prosperous future for manufacturing. While textiles and high-technology products are two outstanding examples of the power of specialization, other industries, such as automobile parts (Li, 2004) and paper mills (Lu, 2004), also have begun to show rejuvenation and attractiveness to foreign investors (Li, 2004). Careful attention to producing well-designed, high quality goods has also helped Taiwan maintain its export performance (Mehta, 2004). The strategies used by both government and entrepreneurs in Taiwan are not unlike those used successfully by the Japanese to

overcome the apparent loss of comparative advantages resulting from higher labor costs (*Economist*, 2004). A full test of the success of the government and entrepreneurs in maintaining Taiwan as strong manufacturing center must wait for the availability of data detailing specialization in manufacturing at the cities and townships level for Taiwan.

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