China vs. Mexico in the Global EPZ Industry: Maquiladoras, FDI Quality and Plant Mortality

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The International Labor Organization (ILO) estimates that in 1997 93 countries had set up export processing zones (EPZs) and zone firms employed 22.5 million people (ILO, 1998). A second ILO study found that only five years later these numbers had increased to 116 countries and 43 million employees (ILO, 2003). The reasons for this growth are well understood. From a host country standpoint, EPZs are relatively easy to establish; participating firms are allowed to import raw and intermediate components duty free, process those inputs, and then export the final product paying few if any export duties. Once up and running EPZs help host countries increase exports, create jobs, generate foreign exchange, and achieve other development goals. China, the Philippines, Malaysia, Pakistan, Mexico, Costa Rica, Honduras, and Madagascar are just a few of the developing countries with what are generally regarded as successful EPZ programs. From the producer standpoint, the advantages represented by EPZs are also clear and compelling. Zones allow multinational companies (MNCs) easy access to large numbers of low wage employees.

MNC lead EPZ programs have clearly contributed to economic development in many developing countries. Nonetheless, EPZs have their weaknesses. MNCs tend to retain knowledge intensive manufacturing and service activities in the industrialized world and outsource to developing country EPZs low value added, labor intensive fragments of the value chain (cf. Fernández-Kelly, 1993; Steinfield, 2004). This international division of labor does not represent the straight jacket it once was for a select group of rapidly developing countries (WIR 2005). However, low value added assembly remains the dominant characteristic of industrial activity in newly created zones as well as in EPZs in countries making slow, uncertain progress down the path leading to advanced industrialization. Early zone entrants frequently employ young, unskilled, predominately female employees and compete in price sensitive, hyper-

competitive global industries such as apparel, footwear, and electronics assembly (cf. Jayanthakumaran & Weiss, 1997, Romero, 1998; Schrank, 2003). Many EPZs never evolve beyond this initial stage (Kaplinsky, 1993, Willmore, 1995; Cling, Razafindrakoto, & Roubaud, 2005).

The pervasiveness of low value added assembly work and stagnant wage rates for lower level employees in many EPZs has prompted scholars to question whether zones represent a wealth creation or simply a poverty alleviation program for the developing world. There are clearly steps host country governments can take to increase the probability of positive development outcomes such as rapid industrial upgrading occurring in a particular zone. However, external factors, ranging from the incentive packages offered by other countries competing for the same investment, changes in technology, under or overvalued exchange rates, international trade agreements, geography, and the whims of MNC decision makers may be more important than a country's own internal efforts in determining the success of EPZ upgrading efforts (cf. Bair & Dussel Peters, 2006).

In the study described in this paper we examine how an external shock, specifically China's new role as the primary supplier of EPZ type goods to the North American market, is shaping the industrial structure and the rate of industrial upgrading in the largest EPZ in the Americas. Mexico's maquiladora industry, commonly referred to as maquiladoras or simply maquilas, is a well researched example of a largely successful, mature EPZ where widespread industrial upgrading has taken place. Maquila outputs include not only apparel but also electronics, electrical equipment, auto parts, medical products, household appliances, and even items for the aerospace and defense industries. It has become common practice to classify maquilas into three generations to reflect variations in the complexity of maquila production

systems; 1) first generation plants perform simple, highly repetitive assembly tasks, 2) second generation maquilas perform more sophisticated manufacturing operations, 3) third generation maquilas utilize technologically intensive systems to perform complex manufacturing and assembly operations (Wilson, 1992; Carrillo & Hualde, 1998). On-site design engineering and/or research and development (R&D) is another characteristic of third generation plants. Second and especially third generation maquilas are commonly regarded as high quality forms of foreign direct investment (FDI) (Wilson, 1992).

China's emergence as the world's dominant EPZ has had a profound effect on Mexico's maquiladoras. Traditionally 90 percent or more of all maquila exports have gone to the United States (US) (Dussel Peters, 2005). Since the late 1990s there has been a dramatic increase of US imports from China. Research consistently finds considerable similarity in the composition of US imports from Chinese and Mexican EPZ producers (Lall & Weiss, 2005; Dussel Peters, 2005; Hanson & Robertson, 2006; Freund & Ozden, 2006). China has gained and Mexico has lost import share in many of these shared segments. There is general agreement Chinese competition represents one if not the most important factor contributing to the first major contraction in the history of the maquiladora program (GAO, 2003; Hanson & Robertson, 2006). In October, 2000, 3,655 maquiladoras employed 1,347,803 people. By December, 2003, the number of plants and employees had fallen to 2,802 and 1,050,201 respectively (a net loss of 853 maquilas and 297,602 jobs) (INEGI, 2006). As of September, 2006 maquila employment is still 134,000 lower than in 2000 (Table One).

At the start of the contraction the general sentiment with Mexican policy makers and in the popular press was that China's primary competitive advantage as an EPZ producer was very low cost labor. Compensation rates in China are typically estimated at one third to one half the

rates common in Mexico. Therefore, it would seem likely maquiladoras especially dependent on low cost labor would be the group most likely to close facilities and move to a lower cost location. It would also seem probable that of the three maquila generations the category most dependent for its survival on lowest cost labor are first generation, low-tech assemblers. If maquila job losses have been concentration in first generation plants, Chinese competition will have served to eliminate a considerable portion of the least attractive maquila segment. However, China is also pursuing a strategy of rapid industrial upgrading. If the Asian giant now enjoys both low cost and technology advantages over Mexico, it would seem probable maquila losses would be spread across all three generations and Chinese competition may have no impact or even a negative impact on FDI quality in Mexico.

In this paper we utilize a unique data set to test which of these two scenarios appears to be the more accurate portrayal of recent maquiladora evolution. Starting in 1993 we began collecting data through top management interviews and plant tours at Mexican EPZ plants in Cd. Juárez (1993), Cd. Chihuahua (1993), Guadalajara (1995), Monterrey (1995-1996), and Reynosa (1998-2000). The combined sample from these efforts total 101 plants employing over 87,000 people. With 72 of these sample firms we measured the use of the following; 1) advanced manufacturing technology (AMT), 2) just-in-time (JIT) inventory systems, and 3) total quality management (TQM) practices. In 57 of the 72 maquilas we also collected measures of the use of human resource management (HR) policies that are closely associated with skill development. In 2006 we revisited each of the study locations to identify sample firms still in operation. We found 30 of the 101 EPZ plants were no longer present in their respective cities. We test to determine the plant level characteristics that differentiate non-surviving from surviving maquilas. If the contraction has been concentrated in first generation plants, there should be a positive

relationship between AMT, JIT, TQM, HR policies linked with skill development, and maquila survival.

We believe longitudinal studies utilizing sound sampling techniques may be an especially important tool to more fully understand how China's success is shaping opportunities for exporters in other countries. Most recent EPZ research has relied upon macro-economic data, cross sectional studies, and/or research examining the practices of leading MNC subsidiaries. The pervasiveness of these methodologies may have resulted in an unfocused view of how MNCs operating in EPZs contribute to host country development. For example, much of the literature suggests maquilas have evolved in very positive ways over the last two decades. In one of the few longitudinal tests utilizing firm level data of this assertion, Fouquet and Moreno (2006) surveyed the population of Monterrey based maquiladoras in 1994 and again in 2004. In 1994 they found a significant number of Mexican companies were participating in the maquila program, sample firms were active in a broad range of industries, and a number of sample plants relied upon Mexican suppliers for their raw and intermediate inputs. In 2004, the percentage of firms controlled by foreign capital had increased from 55 to 70 percent, Monterrey maquilas were increasing concentrated in the auto parts, electronics, and electrical equipment sectors, and there was a decrease in the use of local inputs.

Only 37 percent of the 67 maquilas surveyed in 1994 were still operating in 2004. Only 27 percent of the plants owned by Mexican nationals survived versus 46 percent of the MNC subsidiaries. Relatively few maquilas producing apparel (23 percent), furniture (zero percent), or leather (zero percent) were still active while 60 percent of the electronics and 68 percent of the auto part producers remained. In the maquilas surveyed in both 1994 and 2004, the average age of the operators had not changed (predominately between 16 and 25), the percentage of women

employees had increased slightly (from 46 to 48 percent), and the percentage of operators to administrators and technicians had also increased slightly. Fouquet and Moreno (2006) conclude Monterrey maquilas have undergone a process of *maquiladorización*; i.e. increasingly taking on the characteristics of EPZ firms located in zones with less industrial experience. This study serves as an important example both of the power of firm level longitudinal research and that there is no guarantee EPZ producers in a medium cost country such as Mexico will remain viable over time much less evolve towards a more attractive development model.

This paper continues as follows. In Section Two we review literature examining how China's emergence as the world's preferred EPZ has shaped the development of zones in other countries. Section Three is divided into four subsection where we present findings from each round of data collection and for the combined sample. In Section Four we summarize our results as well as discuss how China's continued expansion may impact host country development opportunities in middle income countries which incorporate MNC lead EPZs as a key component of their economic development strategy.

2. China's EPZ Success and the Maquiladora Contraction

China took over the role of the global economy's premier location for EPZ activity during the 1990s (Graham, 2004; Lemoine & Unal-Kesenci, 2004; Dussel Peters, 2005). In 1997 an estimated 18 million people worked in Chinese EPZ firms (ILO, 1998). In December, 2000 China gained full membership in the World Trade Organization (WTO) and the country's improved access to international markets added to China's EPZ dominance. By 2002, EPZ employment in China had increased to 30 million (ILO, 2003). Lemoine and Ünal-Kesenci (2004) estimate EPZ firms are responsible for over half of all Chinese exports and 70 percent of

Chinese exports to the US (Chinese exports grew from $266.1 billion in 2001 to $762.0 billion in 2005). Bergsten et al. (2006) provide roughly comparable estimates with goods assembled from imported parts and components responsible for 55 percent of China's total exports and 65 percent of the country's exports to the US.

As a general rule the increase in Chinese exports has not come at the expense of higher income countries in East Asia. A largely complementary import/export model appears to have emerged in parts of Asia (Lall & Albaladejo, 2004; Zhou & Lall, 2004). Higher wage countries such as Japan, Taiwan, and South Korea are specializing in the production of capital and skill intensive intermediate components which are then exported to China for final assembly. This complementary relationship may change as Chinese industry increasingly produces intermediate inputs within its own borders.

Research is just beginning to discover what China's expansion means for Latin America. Studies sponsored by the Inter-American Development Bank (Devlin, Estevadeordal, & Rodríguez-Clare, 2006) and the World Bank (Lederman, Olarreaga, & Perry, 2006) find economic growth in China is creating strong demand and higher prices for agricultural, mining, and energy exports from South American Cone countries. In addition, exporters of manufactured goods in South America rarely directly compete against Chinese products in third country markets. In contrast, these studies found considerable export similarity between China, Mexico, and Caribbean Basin countries specializing in EPZ apparel exports. A review of US import data suggests EPZ firms in China and Mexico are competing for US import share in several industries and that China is consistently improving its position in these overlapping segments. US imports from China increased from $99.6 billion in 2000 to $242.6 billion in 2005 (USITC, 2006). Mexican exports to the US were essentially unchanged from 2000 ($134.7

billion) to 2003 ($137.2 billion). US imports from Mexico did increase in 2004 ($154.9 billion) and 2005 ($169.2 billion) but the percentage increase was less than the average increase in total US imports during these years.

The shift in sourcing preferences has been particularly acute in two of the three primary maquila sectors. The dollar value of US imports of electrical machinery and equipment from Mexico remained more or less constant from 2000 ($44.4 billion) to 2005 ($46.7 billion) and fell in apparel (from $8.6 billion to $6.2 billion) (USITC, 2006). US imports from China during this time period increased from $29.4 billion to $96.7 billion in the electrical machinery and equipment segment and from $6.2 billion to $16.8 billion in apparel. These shifts in trade are reflected in changes in maquila employment. From October, 2000 to December, 2005, maquila job losses have been concentrated in electronics/electrical equipment (89,447) and apparel (123,350) (see Table One).

At first glance, rising US apparel imports from China would appear to be directly responsible for the struggles experienced by Mexico's apparel exporters. A historical perspective suggests provisions of the North American Free Trade Agreement (NAFTA) also played a major role. Since 1994 Mexican apparel firms using North American fabric have enjoyed duty and quota free access to the US market. With these benefits maquila employment in the apparel sector grew from 126,061 in January, 1994 to 293,576 in October, 2000 (Table One). Gruben (2006) argues much of this grow was due to trade diversion; i.e. efficient producers from outside the NAFTA block closing facilities and moving to Mexico to take advantage of regional trade liberalization. Mexico's unique advantages as an apparel exporter have been undermined by two major trade agreements (Rodriguez-Archila, 2000; Tafoya & Watkins, 2005). In 2000 the Caribbean Basin Trade Partnership Act gave producers in Central

America and the Caribbean a weak form of NAFTA parity. In 2005 the Multi-Fiber Arrangement ended and exporters in WTO member countries gained quota free access to the US market. This shift from protected to relatively open markets may have resulted in considerable job losses in Mexico's apparel sector even without China's ascension to full WTO membership.

China's success has forced decision makers in the Mexican government to develop new strategies to recapture US import share. Authors such as Farrell, Puron, and Remes (2005) argue Mexico as well as other medium cost countries should not try to win back low wage assembly jobs but instead focus on developing higher value added, more technology intensive industries. Mexican policy makers have embraced this perspective and frequently state exporters have little choice but to upgrade and compete on the basis of advanced technology (*Secretaría de Economía*, 2004) . These same officials also propose many maquiladoras have already made this transition. At the 2005 national maquiladora convention Mexico's Sub-Secretary for Industry and Commerce argued maquiladora production systems have become more technology intensive and a significant number of firms have reached third generation status (Rocio-Ruiz, 2005) (Figure One). Rather than commodity manufacturing, the Rocio-Ruiz (2005) proposes maquiladoras now compete on the basis of speed to market, flexibility, supply chain efficiency, short delivery times, product diversification, and through the ability to design, innovate, and create knowledge.

There are reasons to doubt this portrayal of maquiladora evolution accurately reflects how China's success is shaping Mexico's export industry. China is aggressively upgrading its manufacturing base and moving towards higher valued added, technology intensive manufacturing and service sectors. The empirical evidence suggests it is making this transition much faster than Latin American countries such as Mexico and Brazil. For example, as of the

end of 2004 700 foreign affiliated R&D centers representing an investment of four billion dollars were operating in China (WIR, 2005). From 1994 to 2002 R&D spending by US MNCs in China increased from $7 million to $646 million. A study by the OECD (2006) estimates total R&D expenditures in China will be greater than any only other country except the US in 2006. US companies have increased R&D activities in Mexico (from $183 million in 1994 to $284 million in 2002). However, Mexico's total share of US subsidiary R&D expenditures dropped from 1.5 to 1.3 percent over this eight year period (WIR, 2005).

Research focusing on trade shifts cast further doubt that Chinese competition will uniformly force Mexican exporters to compete on the basis of advanced technology. In a study supported by the World Bank, Freund and Ozden (2006) report:

> Using bilateral trade data at the 4 digit SITC level from 1985 to 2004, we find that China's export expansion has had a significant negative effect on Latin American exports. The effect is concentrated primarily in industrial exports from Mexico to North America since 1995. We find some evidence of quality upgrading in response to China's emergence, but there is significant evidence that China has put downward pressure on LAC (Latin American and Caribbean countries) export prices. In addition, China is displacing LAC in relatively high-wage export sectors. Thus, China's export surge has limited LAC's ability to move up the export ladder.

Mexico does have one clear advantage over other low wage countries in the battle for US import share. The North American neighbors share a close to 2,000 mile long land border. In a series of studies Sargent and Matthews (2004, 2006) propose increased international competition is forcing surviving maquiladoras as well as new entrants into Mexico's EPZ program to increasingly rely on geography based, proximity dependent business models. These authors first collected information through top management interviews and visits at 55 EPZ plants in Reynosa and Guadalajara during 2002 and 2003. Maquila managers responded to questions such as the role played by the plant in the parent's sourcing strategy and how this role had changed as a result of Chinese competition. Sargent and Matthews (2004) conclude market characteristics,

rather than the ability to efficiently utilize advanced manufacturing technology, is the primary reason MNCs continue to produce in Mexico. They divided sample firms into three categories;:

1. Maquilas competing in global markets - Defined as markets where maquilas face direct competition in the US from producers located in lower cost countries. These plants tend to produce highly standardized, high volume items and to compete on the basis of price. Firms in this category were on average struggling.
2. Maquilas competing in mixed global/regional markets - Defined as markets where maquilas have conceded the production of high volume, standardized, low-cost goods sold in North America to producers in lower cost countries. Maquilas in this category focus on the production of low volume items, customized products, and compete in segments with uncertain consumer demand. Firms adopting these strategies appeared to be very successful.
3. Maquilas competing in regional markets - Defined as markets where maquilas do not face direct competition in the US from producers in lower cost countries. Successful business models in this category include remanufacturing centers and JIT, zero defect, and low value to weight producers. Firms competing in regional markets also appeared to be very successful.

In a follow up study Sargent and Matthews (2006) collected information through top management interviews and plant tours from 2004 to 2006 at 36 startup, rapidly expanding, and premier EPZ producers in Reynosa, Guadalajara, and Monterrey. They found MNCs making new investments in EPZ plants in Mexico uniformly pursue proximity dependent strategies. The capital intensity, technology intensity, and skill development activities of proximity dependent maquilas varied from low to very high.

Sargent and Matthews (2004, 2006) focused on how established maquiladoras were adjusting to competitive forces in 2002 and 2003 as well as the characteristics of new and expanding maquilas in 2004 through early 2006. Their research does not support the position that technology intensive, third generation maquilas are the group most likely to succeed in a post China/WTO world. However, these two studies did not examine the characteristics of MNC subsidiaries that remain in Mexico versus those that chose to leave during a time period when Chinese producers were making strong US import share gains. The current study directly addresses this gap in the literature.

3. Results

3.1 Study One: Cd. Juárez and Cd. Chihuahua

In 1993 we conducted top management interviews and plant visits at 30 maquiladoras (23 in Cd. Juárez and 7 in Cd. Chihuahua). Located across from El Paso, Texas, Cd. Juárez is the Mexican city with the largest number of maquila employees. Cd. Chihuahua is 230 miles south of Cd. Juárez and has traditionally been the city in the Mexican interior with the largest maquila concentration. The goal of this first study was to determine if in the maquiladora industry there is a positive relationship between the technology intensity of production systems and the use of JIT, TQM, and HR practices associated with above average skill development. We utilized a deliberate sampling for heterogeneity sampling method for this study (Cook & Campbell, 1979). In Cd. Juárez we contacted a diverse mix of small, medium, and large producers. Once we gained an understanding of industry practice through the initial interviews, producers that might be different than the average maquila were targeted. Towards the end of the data collection period we primarily focused on employers that had developed a reputation as best practice

plants. In Cd. Juárez we contacted managers at 54 maquiladoras in order to obtain the 23 plant sample. In Cd. Chihuahua an individual who was very familiar with the maquila community in the area identified and helped obtain interviews at best practice plants in the city's main industrial parks.

We patterned the questions used in the semi-structured interviews after the survey developed by Wilson (1992). Maquila managers were asked to assess utilizing Likert type scales whether their plant performed primarily assembly or manufacturing tasks, the degree of utilization of computer controlled machinery, and the degree of automation on the factory floor. Managers also responded to questions regarding the use of JIT and TQM practices. Responses were scored a one if they had implemented a specific practice such as statistical process control and a zero if they had not. Finally, interviewees responded to questions about HR practices at the operator level (the use of formal ability/literacy tests in the selection process, the days of initial training provided, if the maquila had formal continuing, technical, and/or quality training programs, if the plant had adopted an incentive based compensation system, if operators were subject to a formal performance appraisal, and if a formal career ladder was in place where operators could obtain specialized training and eventually be promoted to technician positions).

We followed a three step procedure to determine if maquiladoras continue to operate in 2006. First, we consulted a directory listing all maquiladora operators maintained by Mexico's *Secretaría de Economía*. Second, in September, 2006 we visited factory locations in Cd. Juárez and Cd. Chihuahua. Third, if a maquila was not listed in the directory or at the original plant site we reviewed company websites and other information sources to determine if the parent company maintained a presence in the respective study city. Companies that had moved from the original site but continued to produce the same types of products in the same city were scored

as survivors. Producers that had been acquired by another company but again continued to produce the same types of products in the same city were also scored as survivors.

In Table Two we summarize the firm level characteristics of non-surviving and surviving maquiladoras. For the 30 plant sample, 7 maquilas were no longer operating. On average non-survivors and survivors both began operations in 1983. The largest maquila in our Cd. Juárez sample was no longer present which resulted in the average number of employees in non-surviving (1,035) and surviving maquilas (965) to be similar. However, the median number of employees at non-surviving plants (205) was much small than at surviving plants (659). Non-survivors were concentrated in the electronics/electrical equipment and "other" industrial segments and suffered from higher turnover than did surviving plants. We tested to determine if there were significant differences between non-surviving and surviving maquiladoras utilizing the non-parametric Mann-Whitney test. There is significant differences between the two groups on the measure of monthly turnover ($z = 1.91$, $p < .10$). There were no significant differences between the two groups on the measures of AMT, JIT, TQM, and HR intensity.

3.2. Study Two: Guadalajara and Monterrey

In 1995 and 1996 we collected information at MNC subsidiaries in Guadalajara (7 plants) and Monterrey (20 plants). The country's second largest city, Guadalajara is often refereed to as Mexico's Silicon Valley due to the cluster of electronics firms in the area. IBM, HP, Hitachi, Solectron, Jabil Circuit, Flextronics, and Sanmina-SCI all have large facilities in Guadalajara. Monterrey is Mexico's third largest city and a center for heavy industry. Several large MNCs, including Caterpillar, John Deere, Johnson Controls, Denso, LG Electronics, and Cemex have major plants in Monterrey. The purpose of this second study was to test the relationship between AMT, JIT, TQM, and HR practices linked to skill development using measures more suitable for

multivariate testing. A secondary goal was to compare and contrast maquilas with a sample of "normal" MNCs (NMNCs). NMNCs are MNC subsidiaries not registered as maquiladoras and selling a significant percentage of their output in the Mexican market. NMNCs still fit the definition of EPZ producers; they all exported and qualified for duty free import and export benefits as a result of non-maquila export promotion programs.

To identify firms for this second study we first reviewed the Dun and Bradsteet Key Business Directory of Latin America. To be considered at this stage a MNC had to be located in the Guadalajara or Monterrey metropolitan area, employ at least 100 people, manufacture or assemble a product, and belong to an industrial category where it was reasonable to assume some form of AMT was being used. In addition, we contacted the US Consulate in Guadalajara and obtained a listing of all US MNCs with manufacturing operations in the area. We also visited the major industrial parks to identify non-US MNCs and firms not listed in the Dun and Bradstreet directory. In Monterrey we obtained a business guide (*Guía de Negocios 1994*) published by the Monterrey Chamber of Commerce as well as another directory *(¿Quién es Quién en Calidad? 1995*) published by the American Chamber of Commerce: Northeastern Region. We also visited the major industrial parks in Monterey to identify producers our review of published materials might have missed. We identified 58 MNC subsidiaries in the two cities that met our sample criteria. Managers at 33 plants agreed to an on-site interview and 27 completed our survey. Of this group, 15 were NMNCs and 12 were maquiladoras. Seven of the plants were joint ventures between US and Mexican firms while the others were subsidiaries of US (16), Japanese (1), Canadian (1), and European (2) MNCs. There were no statistically significant differences between maquiladoras and NMNCs on the use of AMT, JIT, TQM, or HR practices except on the external pay equity measure.

The AMT, JIT, TQM, and HR scales used for this study were taken from Snell and Dean (1992). AMT was measured using a 10 item scale focusing on the use of such production technologies as computer controlled machinery, robotics, and automated materials handling systems. The JIT scale included five items measuring efforts to reduce work in process, the number of suppliers, and the size of deliveries. The TQM scale include nine questions measuring the use of continuous improvement practices, statistical process control, and doing things right the first time. The HR scales measured the use of what Snell and Dean (1992) refer to as selective staffing (seven questions), comprehensive training (eight items), developmental performance appraisal (eight items), and external and internal compensation (seven items). As in Cd. Juárez and Cd. Chihuahua, in the summer of 2006 we reviewed the maquiladora directory prepared by the *Secretaría de Economía*, visited plant locations in Guadalajara and Monterrey, and reviewed company websites and other secondary sources to determine which sample plants continue to operate.

Table Three profiles the 9 non-surviving and 18 surviving plants in the Guadalajara-Monterrey sample. Survivors were older than non-survivors. Similar to Study One, plant size as measured by the average number of plant employees was nearly identical but the median number of employees was much lower in the non-surviving plants. In Guadalajara 29 percent (2 of 7) and in Monterrey 35 percent (7 of 20) of sample firms were no longer operating. Only half of the producers registered as maquiladoras (6 of 12) remained while 80 percent of the NMNC qualified as survivors. Electronics/electrical equipment plants were much more likely to fail (55 percent) than either auto part (0 percent) or "other" (25 percent) producers. We carried out two tailed T-tests to determine if there were statistically significant differences between non-surviving and surviving maquiladoras. We also utilized logistic regression to determine if the

measures of AMT, JIT, TQM, and HR practices serve as predictors of firm survival. Neither of these tests revealed statistically significant differences between survivors and non-survivors.

3.3. Study Three: Reynosa

We collected data through managerial interviews and plant visits in Reynosa from 1998 to 2000. Reynosa is a particularly interesting location for this study. Located across from McAllen, Texas, Reynosa is the only major center for Mexican EPZ activity that experienced growth in total maquila employment during the 2000 – 2003 contraction. In October, 2000, Reynosa maquila employment stood at 67,275. This number grew to 72,492 in December, 2003 and 93,180 by December, 2005. We conducted two rounds of data collection in Reynosa. Study Three-A examined the use of expatriates in maquilas with US parent companies, expatriate cross-cultural and Spanish language skills, and the existence of cross-cultural conflict. In addition, we collected information on the use of AMT, JIT, and TQM. The AMT and TQM measures are identical to those used in Study Two. The eight item scale developed by Kaynak (1997) was used to measure JIT intensity. For Study Three-A we contacted all the maquiladoras located in four of the five major industrial parks that were controlled by a US parent and employed at least 100 people. Managers at 15 of the 29 possible maquilas participated in the study.

In the summer of 1999 and continuing into early 2000 we conducted a second round of data collection in Reynosa. The primary purpose of Study Three-B was to determine how specific NAFTA provisions were affecting maquiladora strategy. For this round of data collection we contacted all of the maquiladoras in the five major Reynosa industry parks that employed 100 or more people (69 total plants). We interviewed top managers at 29 maquilas and re-interviewed managers at 13 of the Study Three-A firms. For Study Three-B we did not

measure the use of AMT, JIT, TQM, and HR practices. We did collect information, such as the date the plant began operating, industry sector, and number of employees that is useful for the present study. We followed the same procedure used in Study One and Study Two to identify survivors and non-survivors.

In Table Five we present information on the Reynosa samples. In Study Three-A 33 percent (5 of 15) of the sample firms fall in the non-surviving category. Survivors were larger (measured by the mean and median number of employees) and older than the non-survivors. Plant losses were again concentrated in the electronic and "other" industrial segments. We conducted two tailed T-tests comparing non-surviving and surviving maquiladoras on our measures of AMT, JIT, and TQM intensity. There were no statistically significant differences between the two groups. For Study Three-B 31 percent (9 of 29) of the sample firms fell in the non-survivor category. Similar to Study Three-A survivors were again larger (on by the mean and the median measures) and older than non-survivors. As in the other rounds of data collection non-survivors were concentrated in the electronics and "other" industrial sectors.

3.4. Combined Sample

The small sample sizes in each round of data collection constrain the power of our statistical tests. To address this limitation we constructed a series of indexes for the measures of AMT, JIT, TQM, and HR intensity. For Study One, to form our AMT index we combined the computer controlled equipment and automation measures after these items were rescaled to a common metric. The JIT index consists of the JIT and Kanban measures. The TQM index was constructed through adding the statistical process control, quality circle, and job rotation measures. For the HR intensity index we first assigned a zero to plants that scored below the average number of days of initial training and a one to those scoring above average. We than

summed the eight HR measures shown in Table Two. For Studies Two and Three-A the indexes consist of the AMT, JIT, and TQM measures. For Study Two we combined the measures of selective staffing, comprehensive training, developmental performance appraisal, and compensation to form an overall HR intensity index. The raw index scores for each of the studies was standardized to create common units of measure across the three studies.

Table Six contains a correlation table for the combined sample measures. There is a significant positive relationship between plant survival, size (measured by the natural log of the number of maquila employees), the auto parts sector, TQM intensity, and HR intensity. The relationship between survival and plant size is consistent with prior studies. Research has often found lower mortality rates for larger as well as older firms (cf. Jovanovic, 1982; Caves, 1998; Shane & Foo, 1999; Yamawaki, 2004). In addition, firm size has been linked with a number of formal firm level practices such as AMT, TQM, and the use of formal training programs (Snell and Dean, 1992). These relationships are clearly important given our research question. However, if the external shock caused by Chinese competition is forcing maquiladoras to adopt a technology intensive strategy these effects should be evident in our data after controlling for size and industry. We utilized logistic regression to test the relationship between survival, plant size, industry sector, and the three index measures. Logistic regression is particularly appropriate for this study in that it allows one to predict a discrete outcome from a set of variables that may be continuous, discrete, dichotomous, or a mix of any of these variable types. After entering our control variables, the measures of AMT, JIT, TQM, and HR intensity are not significant predictors of maquila survival.

There are two additional findings in our data that deserve special attention. There are nine plants that employed more than 1,000 employees within the non-survivor category. On

average these maquilas scored very high on our measures of AMT, TQM, and attractive HR practices. The failure of several of these facilities can be directly traced to Chinese competition. The largest non-survivor was split off from its parent and sold to a European-Chinese joint venture before being closed. There were four producers of telecommunications equipment within the very large non-survivor category. One MNC controlled three of these maquilas with facilities in Reynosa, Monterrey, and Guadalajara. The parent sold the division responsible for the Reynosa and Guadalajara operations to a Chinese company that subsequently shut down the plants. In Study Three-B it was not entirely clear whether a computer equipment repair facility should be scored a non-survivor or as a survivor. The plant began in the late 1990s as a dedicated repair facility. Although company officials would never openly acknowledge plans to move manufacturing to Mexico, they sent engineers from Reynosa to train at production plants in Malaysia. Complaining the facility was too big, the parent sold the Reynosa plant in 2002 to an electronic contract manufacture and eventually moved repair of the bulk of its computer components to China. The new tenant was able to attract repair work from several new clients and continues to operate the Reynosa facility. Since the original MNC withdrew from Mexico and the contract manufacturer no longer repairs the same class of electronic components, we scored this as a non-survivor. A producer of disposable medical products, a manufacturer of power supplies, and an electronics contract manufacturer make up the other large non-survivors. With the exception of the medical products producer, these maquiladoras all competed in segments vulnerable to Chinese competition.

Another notable finding is only 2 of the 22 auto parts maquilas fall in the non-survivor category. One of these plants was a 70 person operation that assembled wiring harnesses for use in US military transportation vehicles. The parent no longer performs this activity but it is not

clear if this assembly operation has been spun off to another location in Mexico. The second auto parts non-survivor assembled wiring harnesses for use in very expensive German made vehicles. This company expanded into the production of leather interior components but found high turnover and a shortage of workers were creating operational challenges. The parent transferred the border operation to central Mexico in order to gain access to a larger and more stable workforce. For the Reynosa labor market and given our research protocol, this plant qualifies as a non-survivor. For Mexico, this MNC subsidiary is clearly a survivor.

To summarize our findings, we surveyed 86 maquiladoras and 15 NMNCs employing over 87,000 people during the 1990s and early 2000 in five major Mexican industrial cities. There were statistical differences between maquiladoras and NMNCs in Study Two on only one of the HR sub dimensions and to avoid redundancy we refer to the full sample as maquiladoras. Best practice plants were overrepresented in the Study One sample. In Studies Two and Three we obtained representative samples of EPZ plants employing 100 or more people in three large Mexican cities. In the summer of 2006 we reviewed a directory maintained by the Mexican government, visited the original plant locations, and conducted web searches. We found 30 of the 101 sample plants were no longer operating. At the time of our interviews these non-survivors employed 21,961 individuals. The median, but not the mean, number of employees is much greater at surviving maquilas compared to non-survivors in all three studies. Survivors were also older than non-survivors in two of the three rounds of data collection. Auto part producers (91 percent; 20 of 22 plants) were much more likely to survive than maquilas in the electronics/electrical equipment (64 percent; 29 of 45 maquilas) or "other" (65 percent; 22 of 34 maquilas) industrial sectors. Surviving EPZ producers utilized TQM and HR practices associated with skill development to a greater degree than non-survivors while there were no

statistically significant differences between the two groups on the index measures of AMT and JIT intensity. After controlling for size and industry sector, the measures of AMT, JIT, TQM, and HR intensity are not significant predictors of maquila survival.

4. Discussion and Conclusion

In this study we examine how China's success as a EPZ supplier to the US is altering the types of tasks retained by and taken away from Mexico's maquiladoras. Chinese competition is clearly only one factor influencing maquila performance. However, the rapid increase in Chinese exports to the US, the stagnation and/or fall in Mexican exports to the US in several of these same sectors, the loss of close to 300,000 maquila jobs from late 2000 to December, 2003, reports of widespread enterprise migration from Mexico to China, and a growing number of studies from agencies such as the World Bank and the Inter-American Development Bank provide clear evidence China represents a direct threat to Mexico and its EPZ industry.

Mexican policy makers argue maquiladoras are responding to higher levels of Chinese exports in their traditional market by shifting from labor intensive, first generation production systems to a higher value added, more technology intensive business model (see Figure One). This argument has some face validity given the increasing numbers of second and third generation maquilas present in Mexico over the last two decades. However, the external shock caused by China's success may not be creating clear incentives resulting in rapid industrial upgrading in Mexico's EPZ industry. After examining the export performance of China and Latin America from 1990 to 2002, Lall and Weiss (2005; p. 22) conclude "The real competitive threat from China is that its industrial advance will force Latin American countries further down the technology scale." The Freund and Ozden (2006) finding that China is displacing Mexico in

relatively high income export sectors is additional evidence contradicting the position taken by the Mexican government. At the firm level, the *maquiladorazación* of Monterrey's EPZ sector documented by Fouquet and Moreno (2006) is another important example showing that over the last 10 plus years the quality of Mexican EPZ investment has not always improved.

The results of our study should not be oversimplified. The relationship between Chinese competition and higher quality FDI in Mexico is complex. From late 2000 to the end of 2005 employment in maquilas producing auto parts has increased slightly while the apparel sector lost over 120,000 jobs. This study serves to reinforce prior findings that auto parts represents the most attractive of the major maquila segments. We also found a positive correlation between the use of TQM, attractive HR practices, and maquila survival. After controlling for size and industry sector, however, the measures of AMT, JIT, TQM, and HR intensity are not significant predictors of maquila survival. These results are counterintuitive and at odds with accepted managerial theory and practice. They are also consistent with focused studies examining how China's success is shaping Mexico's maquiladoras. Utilizing plant level information from 2002 and 2003, Sargent and Matthews (2004) found established maquiladoras were reacting to China's success by adopting proximity dependent strategies. Low, medium, and high-tech maquilas competing in market segments where geographic proximity is not particularly important were struggling. A follow up study found that new maquiladora investment from 2004 to early 2006 into Mexico's EPZ industry is the result of MNCs transferring proximity dependent operations from the US to Mexico (Sargent & Matthews, 2006). The technology intensity of these post China/WTO maquiladoras ranged from low to very high. The present study provides further evidence the adoption of a technology intensive business model does not represent an effective way for Mexican EPZ firms to shield themselves from low cost Chinese competition.

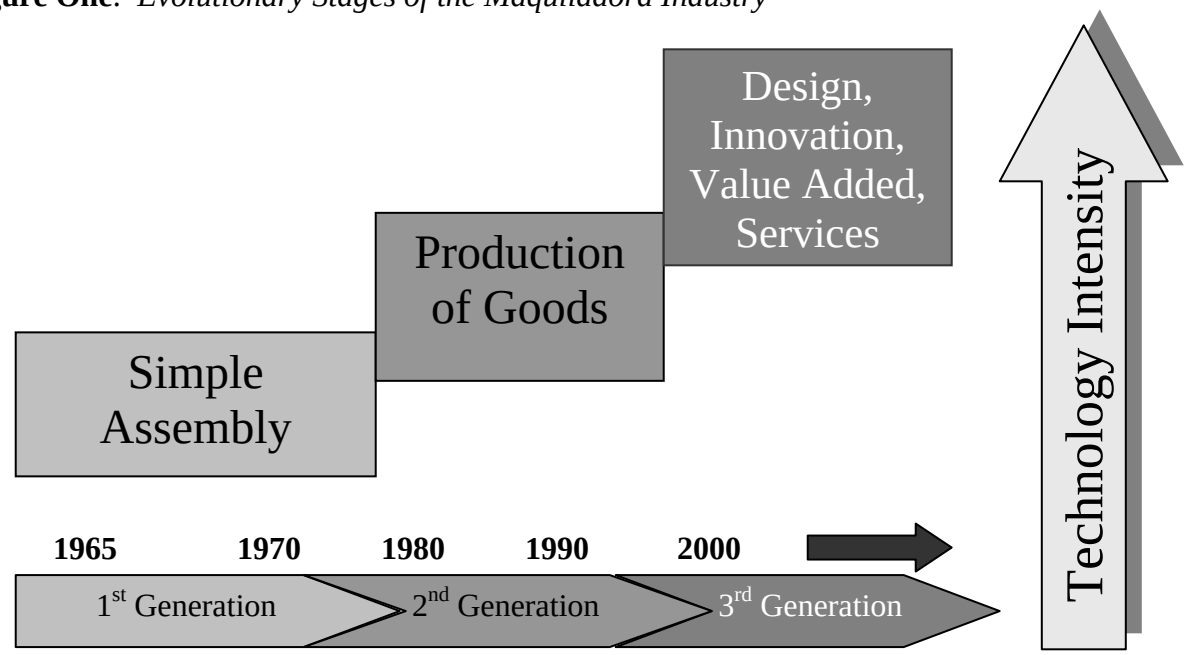
The low mortality rate in the maquila auto part sector provides further evidence of the relationship between proximity dependent business models and maquila survival. The Toyota production system with its emphasis on regional rather than global supply networks is clearly the dominant paradigm adopted by the major North American auto assemblers. Sargent and Matthews (2004) found Mexico's auto parts producers did not face Chinese competition in North America due to the preferences of final assemblers to maintain regional supply networks. Consistent with these findings in our combined sample there is a significant positive correlation between the auto parts sector and JIT intensity. It would clearly be challenging to efficiently supply North American auto assembly facilities on a JIT basis from China. In the medium term distance may not always represent such an effective shield. Dussel Peters (2005) reports the Chinese government has targeted auto parts as a strategic sector and Chinese auto parts exports to the US while small are rapidly increasing.

This study has clear strengths and weaknesses. The information collected through plant level interviews at 101 maquiladoras in five major industrial cities provides a perspective that may not be available through other sources. The sampling methodologies used in the three rounds of data collection is another strength. In Study One our data set includes a limited number of small, somewhat marginal firms as well as a several best practice plants. In Studies Two and Three a primary goal was to collect information at all EPZ firms in Guadalajara, Monterrey, and Reynosa that employed 100 or more people. The sampling methods used in the five cities contributes to the credibility of our findings and increases the possibility our results may generalize to other EPZ centers. On the not so positive side, we cannot determine whether sample plants failed due to Chinese competition in the US market or as a result of other factors. In addition, the measures used were not identical across the three rounds of data collection.

There is also a span of seven years from the first interview in Cd. Juárez to the last interview in Reynosa. The time difference prevent us from controlling for the age in the combined sample. Sample plants may also have made significant changes in the use of hard and soft technologies after our visit. Additional research is clearly needed to further our understanding of how China's success is shaping economic activity in EPZs around the world.

The ILO (2003) found 116 countries have adopted EPZ programs as part of their national development strategy. Our results are not particularly encouraging for other middle income countries with ambitious development goals that face Chinese competition in third country markets. The lessons emerging from the restructuring of Mexico's EPZ industry is that China is an extremely competitive offshore production location for not only labor intensive, low-tech items but also high complexity, high-tech EPZ exports. As mentioned EPZ firms in many zones have not been able to evolved beyond low value added, labor intensive assembly activities. China's success in labor intensive segments such as apparel and footwear clearly threatens these existing activities. China's attractiveness as a production location for high complexity, high value added EPZ products is also limiting the opportunities for middle income countries to attractive this type of work to their own EPZs. The lesson emerging from the Mexican experience is that MNC lead EPZ programs can be successful if zone firms identify market segments where they do not directly face Chinese competition. Unless they can identify similar opportunities, host country governments with MNC lead EPZ programs should expect their zones to under-perform until China's cost structure shifts upward.

Figure One: *Evolutionary Stages of the Maquiladora Industry*



Source - Presentation made by María de Rocio Ruiz Chávez, Subsecretaria de Industria y Comercio, Secretaría de Economía, entitled *Visión Global de la Industria Manufacturera de Exportación* at the National Maquiladora Convention, October 27th, 2005.

Table One: *Changes in Maquila Employment*

	01/1994	10/2000	12/2003	12/2005	09/2006
City					
Cd. Juárez	129,991	264,241	196,933	227,255	240,591
Tijuana	80,506	199,428	141,938	162,437	176,273
Reynosa	34,874	67,275	72,492	93,180	97,956
Matamoros	39,126	69,989	52,201	56,287	55,442
Mexicali	19,495	65,494	49,373	53,388	54,017
Cd. Chihuahua	28,336	53,319	45,485	43,065	43,732
State					
Nuevo Leon	22,581	72,566	54,208	67,139	75,774
Jalisco	9,165	27,332	27,968	47,391	48,576
Sector					
Electronic	190,940	467,508	330,378	378,061	394,449
Apparel	126,061	293,576	195,577	170,226	170,497
Auto Parts	67,269	250,635	238,577	267,626	269,280
Industry Total	546,433	1,347,803	1,050,210	1,163,362	1,213,439

Source: INEGI, *Banco de Información Económico, Industria Maquiladora de Exportación*

Table Two: *Profile of Maquiladora Non-Survivors and Survivors: Cd. Juárez and Cd. Chihuahua*

	Non-Survivors (n = 7)	**Survivors (n = 23)**
Plant Characteristics		
Date established	1983	1983
Employees per plant		
Mean	1,035	965
Median	205	659
Industry		
Electronic	3	9
Auto parts	1	10
Other[1]	3	4
Monthly turnover	15.1	6.1
AMT		
Assembly/Manufacturing[2]	2.14	2.91
Computer controlled machinery[3]	3.29	3.87
Use of automation[4]	2.00	2.35
Quality Management Practices[5]		
Just-in-time	.43	.64
Kanban	.14	.35
Statistical process control	.71	.91
Quality circles	.29	.57
Job rotation	.43	.57
HR Practices		
Ability/literacy testing	.29	.57
Days of initial training	1.57	2.96
Continuing training	.14	.39
Technical training	.29	.43
Quality training	.43	.57
Incentive compensation	.29	.18
Formal performance appraisal	.00	.26
In-house technician development	.29	.35

1. Non-surviving maquilas include a producer of medical products, a shelter operator, and a plastic injection molder. Surviving plants include producers of latex gloves, industrial valves, plastic lens, and a contract assembler..
2. Response to the question "Is this maquila primarily an assembly or a manufacturing plant?" (1 = assembly, 4 = manufacturing to a low degree, 7 = manufacturing to a high degree)
3. Response to the question "In this plant do you use computer controlled machinery?" (1 = No, and we do not plan to introduce it, 4 = Yes, to a low degree, 7 = Yes, to a high degree)
4. Response to the question "In your judgment what is the degree of automation in this plant?" (1 = Not automated, 4 = Highly automated)
5. With the exception of the days of initial training measure, in these two sections plants were scored a one if these practices were being used and a zero if they were not.

Table Three: *Profile of Maquiladora Survivors and Non-Survivors: Guadalajara and Monterrey*

	Non-Survivors (n = 9)	**Survivors (n = 18)**
General Plant Characteristics		
Date established	1981	1974
Employees per plant		
Mean	655	667
Median	170	546
Guadalajara	2	5
Monterrey	7	13
NMNCs	3	12
Maquiladoras	6	6
Industry		
Electronic	6	5
Auto parts	0	3
Other[1]	3	9
AMT Intensity[2]	3.20	3.03
JIT Intensity	3.68	3.85
TQM Intensity	5.21	5.71
HR Intensity		
Selection	4.40	4.81
Training	5.08	5.58
Performance appraisal	4.37	4.34
Compensation	4.20	4.46

1. Non-surviving maquilas produce medical equipment, large steel items, and plastic goods. Survivors include producers of film, industrial valves, rubber tubing, steel boilers, bathroom accessories, farm equipment, welding supplies, filters, and construction equipment.
2. AMT, JIT, TQM, and HR intensity were measured using seven point Likert type scales with higher numbers indicating a more intense use of the various practices.

Table Four: *Profile of Maquiladora Survivors and Non-Survivors: Reynosa*

Study Three-A

	Non-Survivors (n = 5)	**Survivors (n = 10)**
General Plant Characteristics		
Date established	1992	1989
Employees per plant		
Mean	599	750
Median	420	767
Industry		
Electronic	3	5
Auto parts	0	2
Other[1]	2	3
AMT Intensity	2.36	2.71
JIT Intensity	4.05	4.57
TQM Intensity	4.44	5.03

1. Non-survivors include producers of decorative items and bags used to transport agricultural products. Survivors include a contract manufacturer, a foundry, and an apparel producer.

Study Three-B

	Non-Survivors (n = 9)	**Survivors (n = 20)**
General Plant Characteristics		
Date established	1994	1989
Employees per plant		
Mean	603	1,225
Median	500	820
Industry		
Electronic	4	9
Auto parts	1	5
Other[1]	4	6

1. Non-survivors include producers of sports equipment, apparel, bingo cards, and a shelter maquila. Survivors include producers of apparel, medical products, a printer, medical equipment, industrial abrasives, and steel doors.

Table Six: ***Correlation Table***

	1	2	3	4	5	6	7	8
1. Survivor								
2. Size	.205							
3. Electronics	-.115	.158						
4. Auto Parts	.238**	.103	-.473***					
5. Other	-.087	-.256**	-.256*	-.376***				
6. AMT	-.054	.096	.065	-.012	-.058			
7. JIT	.159	.279**	.016	.273**	-.223*	.107		
8. TQM	.252**	.435***	.074	.170	-.227*	.251**	.296**	
9. HR	.230*	.496***	-.158	.309**	-.117	.172	.344***	.616***

* = significant at the .10 level
** = significant at the .05 level
*** = significant at the .01 level

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