Please Pass the Catch-up: The Relative Performance of Chinese and Foreign Firms in Chinese Exports, 1997-2005

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Abstract: Foreign-invested enterprises (FIEs) account for well over half of all Chinese exports and this share continues to grow. While the substantial presence of FIEs has contributed greatly to the recent export-led growth of China, an important objective of the Chinese government is to ultimately obtain foreign technologies and develop their own technological capabilities domestically. This chapter uses detailed data on Chinese exports by sector and type of enterprise to examine the extent to which domestic enterprises are "keeping up" or even "catching up" to FIEs in the volume, composition and quality of their exports. We also use a newly-created dataset on Chinese policies encouraging or restricting FIEs across sectors to examine the extent to which such policies can affect the evolving composition of Chinese exports.

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1. Introduction

The phenomenal growth in Chinese trade with the rest of the world since the opening of its markets in the 1980s is well documented. Recent attention has begun to examine the sources of such growth, particularly the concomitant growth of foreign firm presence in China and their use of China as a low-cost export platform. Whalley and Xin (2006) document that the foreign-invested enterprise (FIE) share of Chinese exports has risen from around 10% in 1990 to almost 60% in 2004 (Figure 4, p. 5). The Chinese experience in this regard is unique in that a substantial portion of the foreign-invested enterprises (FIE) presence is by investors from Hong Kong, Macau, and Taiwan – regions which are considered politically separate to some degree, but are populated with ethnic Chinese who have strong connections to mainland China. However, the share of FIE from other countries is significant and growing over time.

More broadly, the Chinese situation is also unique in its mixture of markets and state-controlled portions of the economy. Openness to market forces has been allowed in a stepwise fashion by the government since 1980, with successive new policy announcements, presumably informed by prior experience. With respect to foreign direct investment (FDI), market openness really began with the creation of special economic zones (SEZs) in Guangdong and Fujian provinces in 1979 that allowed FIEs for the first time, charging such enterprises a profit tax lower than that applied to domestic enterprises. Through the 1980s, the number of these special zones increased substantially, and by 1991 many of the restrictions limiting FIEs to SEZs were lifted. Nevertheless, there continues to be substantial government oversight with respect to FDI in that all new FIE projects require approval from the central government and regional governments. In addition, FIEs are often subject to

performance requirements regarding export percentages, local content and technology transfer. In 1997, the Chinese government published the "Catalogue for the Guidance of Foreign Investment Industries", which provided explicit information on which sectors it encourages, restricts, or prohibits FDI. Tax policies toward FIEs has changed over time as well, with initially lower tax rates for FIEs to recent elimination of such special treatment in accordance with China's accession to the World Trade Organization which specifies "national treatment" of tax policies.[1]

There are a couple features of the Chinese government's policy objectives towards FIEs that will be important for our analysis and which have been deemed important by previous literature as well. The first is the Chinese government's concern with the negative competition effects of FIEs on state-owned enterprises (SOEs) and its intention to limit domestic access to FIEs. The first SEZs were purposely chosen to be in regions that had little industrial (and, hence, SOE presence). Branstetter and Feenstra (2002) estimate using provincial data on FIE presence from 1984 through 1995 find that the Chinese government's FIE policies are inherently weighting the welfare of the SOEs four to seven times larger than consumer welfare. In addition, wholly-owned FIEs are almost always subject to minimum export targets and local content requirements in order to limit their domestic sales, but keep their domestic purchases high. Nevertheless, the share of SOEs in the Chinese economy and its exports have been falling significantly as the share of FIEs and, more recently private firms, has increased.

A second Chinese policy objective with respect to FDI is facilitation of technology transfer from FIEs to domestic enterprises. Technology transfer agreements are often an

[1] More detailed discussion of these policies and policy changes are discussed by Li and Li (1999), Rosen (1999), and Graham (2004).

implicit *quid pro quo* necessary for approval of an FIE project, and are explicitly necessary to get approval of an FIE project that will also have access to the domestic market. (Rosen, 1999, p. 72) The clear intent is to improve the Chinese's own productive capabilities allowing them to fully appropriate the profits from their manufactures of technological goods and increasing their long-run growth potential. The risk is that such policies are discouraging FDI in these sectors and, thus, missing out on the type of technological spillovers that would occur naturally.

The evidence on the net effect of such technology transfer policies is far from known with only a little bit of evidence to date. For example, the Chinese government has required foreign automakers to partner with domestic producers, and Shanghai Automotive recently announced plans to start up its own factory to produce a luxury sedan based on plans purchased from Rover after jointly producing autos in China with General Motors and Volkswagen for many years. Whether Shanghai Automotive will be successful in this independent venture is clearly uncertain. Chen and Swenson (2006) and Hale and Long (2006) provide the first careful evidence on productivity spillovers from foreign firms to domestic ones in China. Both find evidence for such spillovers, but for very limited groups of Chinese enterprises. Chen and Swenson (2006) finds evidence for positive own-industry productivity spillovers for private domestic firms in China (which are still a fairly small portion of the Chinese economy), while Hale and Long (2006) finds that such spillovers are only positive for the most technologically advanced Chinese enterprises.

The extent to which Chinese firms are able to develop their own productive capabilities and transition from state-controlled firms to private, market-oriented firms is extremely important. Whalley and Xin (2006) undertake a growth accounting exercise that

finds that while the employment share of FIEs is only 3%, they account for over 20% of the Chinese economy and around 40% of its recent growth. Their conclusion is that the sustainability of China's export growth and, indeed its overall GDP growth, is suspect if inward FDI flows plateau. This would be especially true if productivity spillovers are limited. This point also relates to recent analysis by Rodrik (2006), which shows that the composition of Chinese exports is much closer to that of a developed economy than other developing economies and, that this "advanced" composition of China's export basket is correlated with higher long-run growth potential.[2] However, the extent to which FIEs are behind such compositional differences, as well as spillover potential, clearly affects this assertion. Wang and Wei (forthcoming) in this volume analyzes this further by examining the factors affecting the evolution of Chinese exports vis-à-vis the rest of the world. In contrast, our focus is on the internal comparison of how Chinese firms have fared relative to foreign-owned firms, with an eye toward understanding how much Chinese firms are "catching up" and the extent to which Chinese policies have facilitated a "catch-up" effect.

In summary, foreign investment and exports by foreign-owned enterprises have become quite important to the Chinese economy. At the same time, the Chinese government has been quite active in trying to "manage" foreign investment into China and, particularly, to encourage technology transfer, so that their own Chinese-owned firms can "catch up" in their technological know-how.

This chapter examines these issues by first presenting a model of potential foreign investment into a vertically-differentiated industry, with a foreign firm producing a higher quality product than its Chinese rival. The two-period model begins with a foreign firm

[2] Schott (2006) points out that the unit values of the Chinese goods in the more "advanced" products are much lower than for developed economies.

deciding whether to locate production into China, knowing that foreign investment into China will lower its production costs, but may lead to greater technology transfer due to closer proximity to the Chinese firm. The model generates a number of predictions for relative market shares and prices (unit values) charged by the two firms. We also generate predictions about how Chinese government policies toward FDI will affect these patterns as well. We then examine these hypotheses using detailed data on Chinese exports by type of enterprise (wholly-owned foreign invested enterprises (FIEs), state-owned enterprises (SOEs, joint ventures, etc.) to analyze the evolution of Chinese export market shares and unit values over time during our sample period of 1997-2005.

The remainder of the chapter is organized as follows. Section 2 provides the literature review while section 3 presents a model of foreign investment into China. We briefly discuss the descriptive analysis of exports and unit values over time in section 4. Section 5 offers the empirical analyses and section 6 concludes.

2. Literature Review

A significant portion of the previous academic literature on export activities of China and the role of FIEs has concerned itself with ownership issues. Feenstra and Hanson (2004) and Feenstra, Hanson, and Lin (2004) examine the prominent role of Hong Kong investors as intermediaries in China's trade to the rest of the world. They find that Hong Kong's re-exports of Chinese products involve an average of around 25% markups, which are even larger for differentiated products and allow for price discrimination across different destinations. They also develop a discrete choice model of the decision whether to use Hong Kong as an intermediary for trade. Their empirical analysis based on this model estimates

that the benefits of using Hong Kong intermediaries are equivalent to 16% of the value of the product on average. This is evidence that Hong Kong traders have significant informational advantages over traders and investors from other countries.

A related literature has examined the type of FIE chosen by all foreign investors in China. Initially, the Chinese government only allowed joint ventures, not wholly-owned FIEs. In addition, exports receive different Customs treatment depending on whether imported inputs are supplied by the foreign party or not. Feenstra and Hanson (2005) develop a property-rights model to explain when the foreign party will own the plant and/or make input decisions, and when such ownership and input decisions will be made by the Chinese party. Their model and empirical analysis finds that foreign owners will be more likely to cede control over input decisions when the value added in processing those inputs is higher (such as for more-technologically-advanced products) and when contracts are easier to write. A complementary study by Feenstra and Spencer (2005) develops a model to understand the economic forces that determine whether foreign firms outsource intermediate inputs through pure external transactions, through contractual arrangements, or through their own foreign affiliates. They use data on Chinese export behavior by these various types of arrangements to verify their model's predictions that the variety of exported intermediate inputs from foreign affiliates and contractual arrangements increases more relative to "ordinary" exports the lower the (internal) transport costs within China.

There is a very recent empirical literature that has begun to examine export behavior and productivity spillovers using a 2001World Bank survey of 1500 firms across 5 major Chinese cities. Hale and Long (2006) estimate productivity spillovers from foreign to domestic firms in the same industry and city using these data and find evidence for such

effects only for the most technologically advanced Chinese firms. Further investigation finds that a significant part of this effect is due to these firms' higher share of managers with foreign-firm experience, suggesting that spillovers are occurring through labor mobility.[3] Park, Yang, Shi, and Jiang (2006) use the Asian financial crisis as a natural experiment to examine whether exporting affects productivity of the foreign firms in the sample.[4] Variation in export destinations and their currency devaluation with the crisis is used to identify the effect of exporting experience on firms' productivity. The study estimates that such "learning-by-exporting" effects are significant for firms exporting to developed countries, but not those exporting via Hong Kong or directly to less-developed countries. A final paper that uses these World Bank survey data, and which is perhaps closest in topic to this chapter, is Brambilla (2006). This study presents a model that connects experience and productivity to firms' ability to develop new product varieties. She finds that foreign firms in the sample introduce about twice as many new varieties as domestic ones and, consistent with the model's predictions, a significant portion of this is due to productivity differences.

The papers we have surveyed to this point are mainly microeconomic and relatively static in their analysis, using detailed firm- or product-level data to document patterns of firm organization and performance for a given period of time. A number of papers have taken a broader view of Chinese exporting patterns. For our purposes, we focus on Rodrik (2006) and Schott (2006). Rodrik (2006) compares the composition of China's exports and finds that it is much closer to that of OECD countries than its level of per-capita income would

[3] Chen and Swenson (2006) also examine productivity spillovers from foreign firms to domestic ones in China, but use the same dataset we examine in this study. While this dataset is not firm-level data *per se*, it has trade data by type of firm and city code for later years of the sample. Their productivity spillover analysis finds that the export presence of foreign firms in the same city and sector is correlated with an increased variety of exported product codes and higher unit values for private Chinese firms.

[4] They can only examine the foreign firms, as domestic Chinese firms do not report their export destinations which is key for the study to identify firm-specific exchange-rate shocks.

suggest. This bodes well for China in that a related paper by Hausmann, Hwang, and Rodrik (2006) find a strong correlation between the sophistication of a country's export basket and its economic growth. Schott (2006) verifies this increasing sophistication of the export bundle in terms of the types of products exported by China, but finds that its "exports sell at a substantial discount relative to its level of GDP and the exports emanating from the OECD." (p. 17). Neither paper examines the role of FIEs in these export patterns. Yet Whalley and Xin's (2006) analysis suggests that FIEs account for the majority of exports from China and find that overall growth of the Chinese economy is quite dependent on the highly-productive FIEs in their economy.

3. A Model of Foreign Investment into China

In this section we present a simple model to motivate what one may expect to happen to FDI decisions by foreign firms into China, technology transfer from foreign firms to Chinese ones, and the ultimate impact on the market share and relative unit values of Chinese exports by foreign firms.

3.1 Producers

We employ a partial equilibrium set-up, with one foreign firm and one domestic Chinese firm producing a good. For convenience, we assume away demand in the Chinese market so that both firms only supply consumers in the foreign country. Thus, prior to any FDI decision by the foreign firm, the Chinese firm is the sole source of Chinese exports of the good to the foreign country.

There is vertical differentiation of the good supplied by the two firms, with the foreign firm producing a higher quality good with quality level K_F, and the Chinese firm producing with a lower quality level K_C; i.e., $K_F > K_C$.[5] Variable production costs are lower for any firm located in the Chinese market, with an assumed zero constant marginal cost of production in China, and a marginal cost of $c>0$ in the foreign market. Thus, FDI into the Chinese market is attractive to the foreign firm due to the lower costs of production. However, we also assume that technology transfer may occur between the firms if the foreign firm locates in the Chinese market. This technology transfers raises the quality (K_C) of the low-quality Chinese producer, but comes at a cost. For convenience, we assume that technology transfer is zero if the foreign firm does not locate production in the Chinese market.[6]

3.2 Consumers

Consumers have identical preferences for goods, but vary in their income levels. We assume that income levels are distributed uniformly over the unit interval where t indexes the consumer with income of t. Consumers may purchase the good from either the foreign or domestic producer or choose not to purchase. If they do not purchase the good, they receive a level of utility equal to $U_0 \times t$, where $U_0>0$. If they purchase the good from a supplier, they receive utility of $U(K_i) \times (t-p_i)$, where p is the price charged by the supplier and $i=C,F$. We make the natural assumption that $U(.)$ is increasing in K so that higher quality means higher utility. We also restrict $U(K)>U_0$ for all K so that all consumers would prefer to purchase a product (regardless of its quality) if its price is zero.

[5] We assume away fixed costs of production for convenience.

With this set-up we can now solve for the demand function for each firm in the following way. Given the parameter space we consider (particularly our restrictions on marginal cost above), the high-quality firm will always charge a higher price than the low-quality firm in equilibrium ($p_F > p_C$). Thus, demand along the unit interval of consumers can be divided into the sections shown in Figure 1, with the highest-income consumers choosing the high-quality variety and lower-income consumers choosing the low quality variety or possibly not purchasing the good. This gives us two cut-off income levels: t_F designates the consumer indifferent to purchasing either the high- or low-quality variety, while t_C designates the consumer indifferent between purchasing the low-quality variety or not purchasing the good. Formally, the following expression of indifference obtains for the consumer at t_F:

$$U(K_F)(t_F - p_F) = U(K_C)(t_F - p_C).$$

Letting x denote $U(K_F)$ and y denote $U(K_C)$, we can easily derive the following expression for t_F:

$$t_F = [U(K_F)\, p_F - U(K_C)\, p_C] \;/\; [U(K_F) - U(K_C)].$$

In similar, fashion t_C can be solved as:

$$t_C = [U(K_C)\, p_C] \;/\; [U(K_C) - U_0].$$

General expressions of demand for each firm are then easily derived as:

$$D_F(p_F, p_C) = 1 - t_F = 1 - [U(K_F)\, p_F - U(K_C)\, p_C] \;/\; [U(K_F) - U(K_C)], \text{ and}$$

$$D_C(p_F, p_C) = t_F - t_C = [U(K_F)\, p_F - U(K_C)\, p_C] \;/\; [U(K_F) - U(K_C)] - [U(K_C)\, p_C] \;/\; [U(K_C) - U_0] .$$

3.3 Timing of Decisions

[6] This keeps the model simple, but captures the idea that it is easier for technology to transfer when firms are geographically closer.

We assume that the foreign firm is initially producing a high-quality variety in the foreign country with per-unit costs of c, while the Chinese firm is producing a low-quality variety in the domestic Chinese market with per-unit costs of 0. In period 1, the foreign firm first decides whether to invest into the China or not. If they locate into China, their per-unit production costs are immediately reduced to 0. Then both firms choose their prices simultaneously to compete for consumers.

If the foreign firm locates into China in the first period, then in period 2 the Chinese firm decides how much to invest in transferring technology from the foreign firm. In particular, we assume that the Chinese chooses an optimal level of technology transfer, $\lambda \in [0,1]$, that leaves it with a new quality level $K_T = (1-\lambda)K_C + \lambda K_F$. The Chinese firm may choose to not engage in technology transfer activities ($\lambda=0$), which would leave it with its original level of quality, K_C. The associated level of consumer utility connected with this new level of quality is $U(K_T)$. Costs of technology transfer are increasing in λ, via a quadratic function, $C_T(\lambda) = \theta\lambda^2$. Once a level of technology transfer is chosen, indexed by λ, then the firms compete in prices again. If the foreign firm did not locate in the foreign market, the firms compete in prices again under the same conditions as in the first period with no foreign firm relocation. Profits for each firm in each period take the general form of $\Pi_i^j(p_C^j, p_F^j; K_C, K_F, \lambda, c)$, where j denotes the period-subgame combination.

3.4 Solving for equilibrium

We solve for the subgame-perfect equilibrium of the model in the usual fashion by solving backwards beginning with period 2 of our model. In period 2, there are two possible subgames – one where the foreign firm did not locate in China and, thus, technology transfer

did not occur (which we denote as 2N) and one where the foreign firm located in China and technology transfer has potentially occurred to the Chinese firm (which we denote as subgame 2T). In subgame 2N, the foreign firm does not locate production into China and continues to have a cost disadvantage (i.e., $c>0$), but no technology transfer occurs ($\lambda=0$). In this case, we denote the respective Nash Equilibrium profits of the foreign and Chinese firms as

$$\Pi_C^{2N} \equiv \Pi_C(p_C^{2N}, p_F^{2N}; K_C, K_F, 0, c),$$

$$\Pi_F^{2N} \equiv \Pi_F(p_C^{2N}, p_F^{2N}; K_C, K_F, 0, c),$$

where p_C^{2N}, p_F^{2N} are the optimally chosen prices by the Chinese and foreign firm, respectively. These equilibrium prices and profits will be identical to those in period 1 when the foreign firm does not relocate to China (denoted subgame 1N).

The more interesting and relevant case for our purposes is subgame 2T, where the foreign firm has located into China and reduced its production costs from c to 0, but the Chinese firm has the ability to increase its quality from K_C to K_T through technology transfer. Given costs, qualities and optimally chosen technology transfer, the firms simultaneously choose their own price to maximize profits. We denote the respective Nash Equilibrium profits of the foreign and Chinese firms in this subgame as

$$\Pi_C^{2T} \equiv \Pi_C(p_C^{2T}, p_F^{2T}; K_C, K_F, \lambda, 0),$$

$$\Pi_F^{2T} \equiv \Pi_F(p_C^{2T}, p_F^{2T}; K_C, K_F, \lambda, 0),$$

where p_C^{2T}, p_F^{2T} and are the optimally chosen prices by the Chinese and foreign firm, respectively, and λ is the optimal degree of technology transfer chosen by the Chinese firm. From this, we get Propositions 1a and 1b:

Proposition 1a: The ratio of the foreign firm's market share to the Chinese firm's market share in equilibrium is decreasing in the amount of technology transfer. (See appendix for proof)

Proposition 1b: The ratio of the foreign firm's equilibrium price to the Chinese firm's equilibrium price is decreasing in the amount of technology transfer. (See appendix for proof)

The results in propositions 1a and 1b are quite intuitive. It is easy to show in the model that a higher quality firm will charge a higher price. Thus, as technology transfer leads to the quality of the two firms converging, the equilibrium prices charged by the firms also converge. An increase in technology also allows the low-quality firm to "steal" market share away from the high-quality firm even though the high-quality firm will optimally respond by lowering its equilibrium price some.

Now we turn to the Chinese firm's optimal technology transfer decision as represented by their choice of λ prior to the market competition in period 2. The Chinese firm's problem is to choose λ to maximize second-stage profits net of technology transfer costs:

$$\underset{\lambda}{Max}\,\Pi_C^{Net} = \Pi_C^{2T}(p_C^{2T}, p_F^{2T}; K_C, K_F, \lambda, 0) - \theta\lambda^2.$$

From this optimization problem, we can easily derive:

Proposition 2: The level of technology transfer chosen by the Chinese firm is decreasing in the cost/difficulty of such transfer (θ). (See appendix for proof)

This leads to the following corollaries:

Corollary 3a: The greater the cost of technology transfer, the higher the ratio of the foreign firm's market share to the Chinese firm's market share in equilibrium for the case where the foreign firm locates in China. (See appendix for proof)

Corollary 3b: The greater the cost of technology transfer, the less the Chinese firm's equilibrium price moves closer to the foreign firm's equilibrium price for the case where the foreign firm locates in China. (See appendix for proof)

Corollaries 3a and 3b are a primary focus for our empirical work below where we examine how the relative prices and export market shares of the Chinese and foreign firms evolve after FDI into China. In particular, our hypotheses stemming from these corollaries is that factors that make technology transfer more costly/difficult mitigates positive spillover effects from foreign firm presence to the Chinese firms. In the case, of prices, more costly/difficult technology transfer means that Chinese firms' export prices do not catch up to foreign firm export prices for the same good very quickly or at all. In the case of market shares, more costly/difficult technology transfer means that Chinese firms' relative export market share will increase less or even decline with foreign firm presence.

Finally, we solve the first-period of the model. If the foreign firm does not locate in China (subgame 1N) then equilibrium prices and profits are identical those in subgame 2N described above. If the foreign firm locates in the Chinese market, production costs are lowered, but technology transfer has not yet occurred. Equilibrium profits in this subgame (denoted subgame 1L) are:

$$\Pi_C^{1L} \equiv \Pi_C(p_C^{1L}, p_F^{1L}; K_C, K_F, 0, 0),$$

$$\Pi_F^{1L} \equiv \Pi_F(p_C^{1L}, p_F^{1L}; K_C, K_F, 0, 0),$$

where p_C^{1L}, p_F^{1L} and are the optimally chosen prices by the Chinese and foreign firm in this subgame. It's easy to show the following relationships between equilibrium profits for the foreign firm:

$$\Pi_F^{1L} > \Pi_F^{1N} \equiv \Pi_F^{2N}, \text{and}$$

$$\Pi_F^{2T} \leq \Pi_F^{2N}.$$

This leads us to an analysis of the foreign firm's initial decision whether to engage in FDI or not by locating in China. Assuming a one-time fixed cost of FDI, which we denote as F, the foreign firm decides to locate to China if

$$\Pi_F^{1L} + \Pi_F^{2T} - F > \Pi_F^{1N} + \Pi_F^{2N}. \quad \textbf{(1)}$$

This leads to

Proposition 4: The FDI decision by the foreign firm into China is more likely, 1) the greater the cost savings, and 2) the greater the cost/difficulty of technology transfer . (See appendix for proof)

While our empirical work below does not examine data on FDI into China, Proposition 4 highlights that FDI is endogenous with the ability of Chinese firms to transfer technology from the foreign firm. When technology transfer is made relatively easy by the FDI, the foreign firm is less likely to locate in China. This selection issue suggests that we may only observe FDI into industries where technology transfer is difficult/costly. Thus, we may find little evidence of convergence of relative export prices and increases in Chinese market share as FDI increases in an industry.

3.5 Role of government policies

The Chinese government has active policies to encourage or restrict FDI into certain industries or products. A simple way to examine the impact of these policies in the model is to simply think of these policies as either lowering or raising the fixed costs of FDI (F). Encouragement of FDI (lowering of F) would obviously lead to the condition in (1) being more likely satisfied, increasing the probability of FDI. The immediate effect would be to increase the foreign firm market share (from zero when no FDI takes place). However, the foreign firms that did not engage in FDI in the first place were ones for which technology

transfer would be more significant or production cost decreases from location to China less significant. If the encouragement policy selects a foreign firm into China that otherwise would have stayed out because of technology transfer concerns, then by Proposition 1a and 1b, we may expect the encourage policy to lead to a greater decrease in the ratio of foreign-to-Chinese market shares and unit values over time.

Of course, all of these effects stemming from a policy of encouraging FDI would be the exact opposite with a Chinese government policy of restricting FDI, if such restrictions simply increase the costs of FDI. However, in many cases, Chinese restrictions on FDI involve requiring foreign firms to partner with a Chinese firm and/or arrange for technology transfer. A prominent example of this is the automobile industry. Such a restriction can easily be modeled as a lowering of technology transfer costs (θ) in our model, which by corollaries 3a and 3b would make the ratio of foreign-to-Chinese market shares and unit values decrease in the second period, ceteris paribus. Balancing this effect, however, both the higher fixed costs of FDI and greater technology transfer makes it less likely that the foreign firm would enter in the first place.

3.6 Ownership structure

For simplicity, we do not consider alternative forms of FDI ownership structure in our model. However, the data we explore below have considerable amounts activity from both joint venture and wholly-owned foreign enterprises. Joint venture activity presumably facilitates greater technology transfer (i.e., lower costs of transfer for the Chinese firm). A foreign firm could conceivably be interested in pursuing a joint venture, nevertheless, if it lowered its fixed costs of FDI or provided an even greater reduction in production costs.

This would lead to a positive selection effect, making it more likely that a foreign firm will invest in China despite technology transfer concerns. Thus, while we have not modeled a foreign firm's decision of ownership structure, this discussion suggests that when a foreign firm does choose to joint venture, we should expect a greater decrease in relative foreign-to-Chinese market shares and unit values over time then in the case where the foreign firm chooses to be an independent, wholly-owned foreign enterprise.

4. A Brief Descriptive Analysis of Exports and Unit Values over Time

Before examining our hypotheses, we briefly describe and look at some general trends in the primary data set on Chinese exports we use for our analysis. These Chinese trade data span the years from 1995 to 2005 and were made available through the Customs General Administration of the People's Republic of China, as part of the project described in Feenstra et al. (1998). Our data set include both ordinary and processing trade. An important feature of the data is that it disaggregates export trade activity by the type of enterprise; namely, foreign-invested enterprises (FIEs), state-owned firms (SOEs), contractual-joint ventures (CJVs), equity-joint ventures (EJVs), collectively-owned enterprises (COEs), and privately-owned enterprises (POEs). FIEs are enterprises wholly-owned by foreign funded enterprises and overseas Chinese companies. SOEs are the traditional non-corporation economic units, where the entire assets are owned by the state. COEs are collectively owned economic units, including township and village enterprises. POEs are economic units owned by private, domestic Chinese individuals. Finally, CJVs are joint ventures between Chinese corporations and foreign partners, where profits and risks are shared in accordance with their agreements, whereas EJVs are joint ventures where profits

and risks are shared in accordance with the percentage of shareholdings and the foreign entity may not own more than 50 percent of the venture. These distinctions will allow us to understand the various and changing role of foreign and domestic enterprises in Chinese exporting patterns.

Figure 2 provides the value of exports over time for the top ten industries at the 2-digit HS level.[7] Machinery (HS 84) and Electrical Machinery (HS 85) clearly represent the largest exporting sectors in China and have been a primary driving force in the growth of Chinese exports over this period. These two sectors are followed by the two main apparel sectors (HS 61 and 62), the Furniture and Bedding sector (HS 94) and the Toys and Games sector (HS 95). Figure 3 shows the export shares of all Chinese exports for years 1995, 2000, and 2004 by firm types. Although the share of SOE exports in 1995 is the largest, the value of exports by SOE has been significantly decreasing relative to the other firm types over the years. In place of the declining SOE export shares is the rise in exports by FIEs, EJVs, COEs, and POEs. Most significant is the relatively large increase in export shares by POEs from 2000 to 2004. For purposes of our analysis below, we will primarily separate our data into two groups which we call the foreign firms, consisting of the CJVs, EJVs, and FIEs, and the Chinese firms consisting of the COEs, POEs, and SOEs.

5. Empirical Analysis

We now turn to a statistical analysis of relative market shares and unit values for foreign and Chinese exports from 1997 through 2005.[8] Our focus is the changes over time in

[7] We use the end-of-sample 2004 rankings of export shares to determine the top ten sectors.
[8] We start our sample in 1997, even though we have data back to 1995, because our policy variables do not have any variation until 1997. This affects identification of coefficients in the years 1995 and 1996 in some of our specifications (specifically, when we interact these policy variable with year dummies). We get qualitatively

these relative foreign-to-Chinese measures and how various factors, as suggested by our model, affect these dynamic patterns. Our estimation strategy is quite simple with benchmark models specified as the following:

$$FS_{jt} = \alpha + \sum_{t=1998}^{2005} \beta_t YD_t + \psi_j + \varepsilon_{jt}, \quad \textbf{(2)}$$

$$\ln UV_{jt}^{F} - \ln UV_{jt}^{C} = \alpha + \sum_{t=1998}^{2005} \beta_t YD_t + \psi_j + \varepsilon_{jt}, \quad \textbf{(3)}$$

where FS_{jt} is the foreign enterprises' share of Chinese exports for a given 6-digit HS product code and year, UV_{jt}^{F} and UV_{jt}^{C} are Chinese export unit values for the foreign and Chinese enterprises for the 6-digit HS product code j and year t, respectively, YD_t are year dummy variables, ψ_j are the 6-digit HS product fixed effects, and ε_{jt} is an assumed white-noise random error term. Given that we exclude the year dummy for our sample's first year, 1997, our year dummy coefficients capture the difference in the dependent variable from 1997, allowing one to easily chart the progression of these relative measures over time. Given the specification of the dependent variable in (2), the coefficients on our year dummies in our "market share regressions" show the percentage point different in the foreign market share from our base year, 1997. For the "unit value regressions" in (3), the year dummy coefficients capture the percentage difference (in decimal form) from the base year, 1997.

From this base model, we explore a number of factors that may affect the evolution of relative market shares and unit values over time, as motivated by the theoretical model in section 3. We do this by introducing interaction of these factors, in turn, with our year dummies. Our model suggests three types of factors that may affect evolution of our

identical statistical results in other specifications (which do not have issues) regardless of whether we start our sample in 1995 or 1997. identical

dependent variables: 1) cost of technology transfer, 2) government policies, and 3) ownership structure.

Measures of technology transfer costs are difficult to observe, so we rely on two proxies: 1) product differentiation and 2) R&D intensity. Our hypotheses are that sectors with higher R&D intensity and product differentiation will be ones for which technology transfer is more costly for the Chinese firm. Thus, by corollaries 3a and 3b, these factors should be associated with lower declines in relative foreign-to-Chinese market shares and unit values. The R&D intensity, defined as the number of R&D scientist and engineers per 1000 employees in R&D-performing companies, is from the National Science Foundation's Research and Development in Industry (various years). The classification of goods is taken from Rauch (1999).

With respect to government policies, we focus on official lists from the Chinese government indicating in which sectors they are encouraging or restricting FDI. Information on industries that the Chinese government encourages or restricts comes from the Catalogue for the Guidance of Foreign Investment Industries, first published by the Chinese government in 1997, and significantly updated in 2002. The listed industries and products are not identified with any formal industrial classification system. We use key words in the industry/product description for both the 1997 and 2002 lists to search for associated Harmonized System codes using the U.S. International Trade Commission tariff database search engine, available at http://dataweb.usitc.gov/scripts/tariff2003.asp. As discussed in section 3 our model predicts that encouragement of FDI will increase the relative foreign market share, but may accentuate technology transfer, leading to a greater decrease in the relative unit value gap. On the other hand, restrictions on FDI should lead to greater

decreases in both foreign market share and relative unit value gap. Likewise, as discussed in section 3, we would expect to see greater decreases in both foreign market share and relative unit value gap for joint ventures (where the foreign firm is working in close connection with a Chinese partner) than with a wholly-owned (and independent) FIE.

Before turning to our results, it is important to note that our hypotheses come from a model of one-time competition between a single foreign firm and a single Chinese firm. In reality, of course, there are likely many foreign and Chinese firms for even a given HS6 product and there has been ongoing FDI into China over our sample period. This most obviously affects our foreign market share variable, where continual FDI can lead us to see increasing foreign market shares even if significant technology transfer is taking place. Likewise, unit value gaps may increase over time if foreign firms are locating ever more sophisticated products into China. On one hand, this is not a significant issue in examining the role of various factors in catch-up – it simply means that a factor that would lead to greater declines in foreign market share in our pure theoretical model simply translates into smaller increases in foreign market share in a world where foreign market shares are generally increasing over time. However, we will have to careful not to assert the absence of technology catch-up if we do not find falling foreign market shares or unit value gaps in our analysis. To address this further, at the end of our empirical section, we regress unit value gaps not on only on year dummies, but also on lagged foreign market share to control for the dynamic changes in FDI patterns explicitly and thereby more clearly identify any net technology transfer effect.

On a final note, our estimates could be potentially biased by sample selection issues. Whether foreign firms locate into China in the first place is affected by what will occur with

technology transfer and other factors affecting their performance vis-à-vis the Chinese firms, as shown in our theoretical model. This is of particular concern with our relative unit value regressions since this variable is not observable for HS6 categories with no foreign firm activity. In unreported results, we applied a sample selection correction to our unit value regressions. Since statistical tests often showed that sample selection bias did not exist and our results were qualitatively identical with or without the sample selection correction, we report the estimates without such corrections here.

5.1 Benchmark

To explore the evolution of relative foreign and Chinese export market shares and unit values we first regress each of our dependent variables on year dummies to uncover the general dynamic pattern over our sample. Our model explains about 84% of the variation in relative foreign and Chinese export market share and roughly 60% in relative unit values. We lose approximately one-third of our observations in estimating (3) due to cases in which only one of the two firm types export in a sector for a particular year. The results of the benchmark estimation are provided in columns 1 and 2 of Table 1. In what follows relative foreign and Chinese export market shares (FS) will be presented in the first of the two columns, whereas relative unit values (UV) will be is given in the second. We find that conditional on foreign investment in an industry, foreign firms are gaining export market share relative to Chinese firms over time. More specifically, as compared to 1997 the relative foreign-to-Chinese export market shares increased by 1.2% in 1998 and 4.9% percent in 2005. Moreover, the unit value gap between foreign firms and Chinese firms is increasing over time during our sample period.

In the reminder of the section, we will explore how the dynamic patterns systematically differ for various attributes beginning with the cost of technology transfer.

5.2 Cost of Technology Transfer

As previously mentioned, we use two methods to measure of cost technology transfer costs: 1) product differentiation and 2) R&D intensity. Table 1 presents the findings for production differentiation in columns 3 to 8. Contrary to our hypotheses, the results in column 3 suggest that sectors with product differentiation decline in relative foreign-to-Chinese market shares. However as expected the higher cost of technology transfer leads to an increase in the relative foreign-to-Chinese unit values. Namely, there is no evidence of catch-up by Chinese firms for differentiation products even though their export market share is increasing relative to the foreign firms.

To further analyze the cost of technology transfer, we identify goods shipped to the G-3 countries (columns 5 and 6) and Hong Kong (columns 7 and 8).[9] Considering goods exported only to the G-3 countries help to account for the increasingly role of Western and Japanese FDI in China during the 1990s (Branstetter and Feenstra, 2002). Moreover, the opportunity for spillover is larger with G-3 countries since they are the source of technological advancement. The motivation to control for sales to Hong Kong stems from its role as intermediaries in China's export performance (Feenstra and Hanson, 2004). Comparing columns 3, 5, and 7, we find that while the relative foreign-to-Chinese market shares are declining, the decrease in foreign market shares is smaller for goods destined for the G-3 countries. Furthermore, the unit value gap is larger for goods shipped to the G-3 countries and Hong Kong relative to the entire sample across all countries.

The results of our second proxy for cost of technology transfer, R&D intensity, is provided in Table 2. The findings in columns 1 and 2 are not statically different from the overall general trends. However, the sum of the R&D intensity and the interaction between the G-3 dummy and R&D intensity for the given year, shows that the relative foreign-to Chinese market share is increasing, although the increases are smaller after 2003.
The results for goods exported to Hong Kong have the opposite results although not significant in all years. In general, the relative unit values are also rising for good shipped to the G-3 countries and Hong Kong. Taken together, our findings suggest Chinese firms fail to catch-up in sectors that are more costly in terms of technology transfer.

5.3 Government Policies

A "encourage" policy means that the Chinese government offers incentives to promote inflows of FDI. Presented in columns 1 to 6 in Table 3 the results show that regardless of export destination relative foreign-to-Chinese market shares increase more in these encouraged industries. Thus, there is evidence that encouragement brings in FDI by foreign firms. While the change in relative unit value differences is unclear, it should be noted that the relative unit value is negative and significant in the latter two years for goods exported to the G-3 countries. This result supports the finding by Park, Yang, Shi, and Jiang (2006) that "learning-by-exporting" effects are significant for firms exporting to developed countries, but not those exporting via Hong Kong.

Contrary to policies that encourage FDI, the Chinese government may restrict the activities of foreign firms for a number of reasons: i) to limit competition in the domestic market, ii) to control strategic sectors (such as national defense or natural resources), or iii) to promote technology transfer. The results of the estimation with the "restrict" policy is also

[9] Industrial Countries are defined as EU15, Japan, and the United States.

provided Table 3. Columns 7 and 8 show that there is no change in relative foreign-to-Chinese market shares, but obvious decrease in relative unit value differences over time relative to general trend, suggesting that the technology transfer is occurring in restricted industries. The technology transfer is evident in the earlier years for goods exported to the G-3 countries. Moreover, the relative foreign-to-Chinese market shares increase for goods shipped to these rich countries. By contrast, the findings on the relative market shares and unit value are mostly insignificant for goods exported to Hong Kong.

5.4 Ownership Structure

In addition to cost of technology transfer and government polices we expect that the structure of the firm ownership may also affect the evolution of our dependent variables. Specifically, we expect to find that the foreign market share and relative unit value gap to decrease for joint ventures (JV) relative to wholly-foreign owned FIEs. The annual changes in relative market shares and unit values for JV and FIEs are shown in Table 4. Columns 1 and 2 presents the JV results for relative foreign-to Chinese market shares and unit value, respectively; whereas columns 3 and 4 gives the wholly-foreign owned FIEs findings in columns 3 and 4. As expected, the relative market shares are decreasing for joint ventures. Moreover, the relative market shares are decreasing at an increasing rate over the years as compared to 1997. The results, however, are opposite for FIEs. For both ownership types, the relative unit value gap is increasing, which suggests a lack of technology transfer.

As a further analysis, we examine the evolution of our dependent variables for the two industrial sectors that account for a large share of Chinese exports: i) machinery given in

Table 5 and ii) electronics shown in Table 6. The results for machinery indicate that there is no evidence of catch-up by Chinese firms even when we account for export destination and government policies. However, the relative foreign-to-Chinese market shares are positive and significant for goods shipped to the G-3 countries. By contrast, foreign firms are losing market shares to the Chinese firms in machinery goods exported to Hong Kong as compared to 1997 for years 1998 to 2002. Likewise, the results in Table 6 suggest that the relative foreign market shares are also rising for G-3 countries bounded electronics and decreasing for those going to Hong Kong. The declining relative market share for electronics exported to Hong Kong, but not to the G-3 countries may indicate more direct involvement via vertical differentiation by foreign firms over the years rather than outsourcing through the Chinese city-state. The electronics results also suggest some, albeit weak, evidence of technology transfer for restricted foreign investment. The results also indicate a widening of the unit value gap for electronics with an encouraging government policy.

5.5 Is Increasing FDI Masking "Catch Up" Effects?

A concern with our estimates, and the unexpected increasing foreign market share and relative unit values, is the issue of increasing FDI activity over time. Obviously an increase of FDI into China of export-oriented foreign firms may be a driving force in the increase in foreign firm export market shares, thus masking any catch-up effects. Likewise, if these new foreign firms are locating products in China that are increasingly more sophisticated, this could be behind the rising gap in foreign-to-Chinese relative unit values as well. However, an important argument against such a concern is that the ratio of FDI in China relative to GDP has been fairly constant around 15% since the early 1990s, as shown

in Figure 4. In fact, FDI stock as a percent of GDP has even fallen some over our sample period from 1997 to 2005. This would suggest that new FDI activity is not a driving force behind increasing foreign market shares in Chinese exports.

As a further way to investigate this issue, we use our available data to control for previous FDI in the 6-digit HS. While we do not have data on FDI by industries into China over time (much less at the HS product level), we can use prior foreign market share in a 6-digit HS product as a proxy for previous FDI. Thus, we estimate the following specification that modifies equation (3):

$$\ln UV_{jt}^{F} - \ln UV_{jt}^{C} = \alpha + \theta_1 FShare_{jt} + \theta_2 LagFShare_{j} + \sum_{t=1998}^{2005} \beta_t YD_t + \psi_j + \varepsilon_{jt},$$

where $LagFShare_j$ is a term that controls for previous (lagged) foreign-firm market share in a 6-digit HS product.[10] There are a number of ways in which we could specify this lagged term, but we chose to construct as a moving average of the previous 3 years of the foreign market share (*FShare*) in a given 6-digit HS product j.[11]

Table 7 provides results from various runs of this specification. Column (1) provides our benchmark specification with now some evidence of fairly modest catch-up by Chinese firms as evidenced by the statistically significant negative coefficient on the lagged foreign market share term. Interestingly, current period foreign market share is strongly associated with much greater increase in the relative foreign-to-Chinese unit values, suggesting that new FDI involves much greater unit values (i.e., sophistication). Comparing the ratios of the two terms suggests that the Chinese firms are able to then close the gap over the next three years by about 12% (-0.122 relative to 1.013).

[10] We do not estimate a similar foreign market share equation due to more serious endogeneity concerns adding lagged foreign market share terms in that setting.

In the subsequent columns, we again examine how various factors may affect this catch-up by interacting these factors with our regressors and reporting the appropriate sums of the coefficients to yield the effect for our sub-sample of interest. The next two columns provide estimates for differentiated products and high technology products, sub-samples for which we would expect that catch-up effects would be lessened. While the catch-up effect is smaller for differentiated products at about 7.4% (-0.104 relative to 1.397), the high-technology sector looks virtually identical to the full sample. The next two columns look at how sectors affected by Chinese government policies vary in their catch-up effect. These sectors are surprisingly much different from the rest of the sample in showing no catch-up effects whatsoever. Thus, to the extent that these government policies are intended to encourage technology transfer, we find no evidence of this. The final two columns of Table 7 provide separate estimates when we look at just FIEs and JVs, respectively. Surprisingly, the catch-up is larger for FIEs than the general sample, though not precisely estimated, while there is no evidence of catch-up for Chinese firms vis-à-vis the JVs where we would expect it to be larger than the general sample.

6. Conclusion

Facilitating technology transfer to allow their domestic firms to catch up to foreign firms invested in their country is an obvious goal of the Chinese government in the policies they have regarding FDI. Recent literature has documented the high level of sophistication of Chinese exports for a country at its general level of development. An important question is whether this is simply driven by the foreign firms in China or whether Chinese firms are

[11] We also tried putting in separate lags of *Fshare* going back up to 4 years, but found that standard errors for our coefficients were often quite high due to multicollinearity amongst the lagged terms.

also gaining greater sophistication from this foreign presence. The answer to this question has significant implications for China's long-term growth potential.

We explore the extent to which Chinese firms are gaining sophistication relative to foreign firms present in China (i.e., catching up) using detailed Chinese export data that separately reports exports from foreign and Chinese enterprises. The general patterns over our time period, 1997-2005, run exactly counter to what one would expect if Chinese firms were catching up – foreign firm's share of exports by product category and foreign unit values relative to Chinese unit values are increasing over time, not decreasing. We see these patterns despite the fact that FDI into China as a percent of GDP has not increased since before our sample. Specifications examining how previous foreign market share affects current unit value gaps finds only modest catching up, at best. We also find no evidence that Chinese policies encouraging or restricting FDI have any impact on catching up of Chinese firms. Nor do we find that joint venturing activity with foreign firms leads to greater catching up in sophistication within a 6-digit HS product code.

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Figure 1
Firm Demands and Cut-off Points Along the Distribution of Consumers

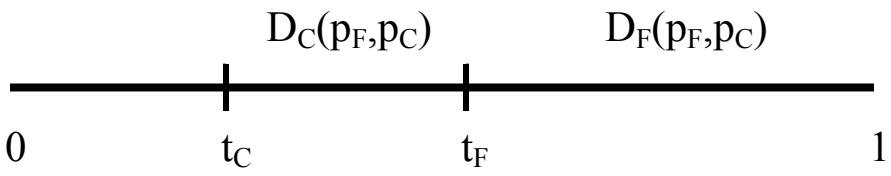


Figure 2: Chinese Exports by Top Industries at 2-digit HS Level, 1995-2004

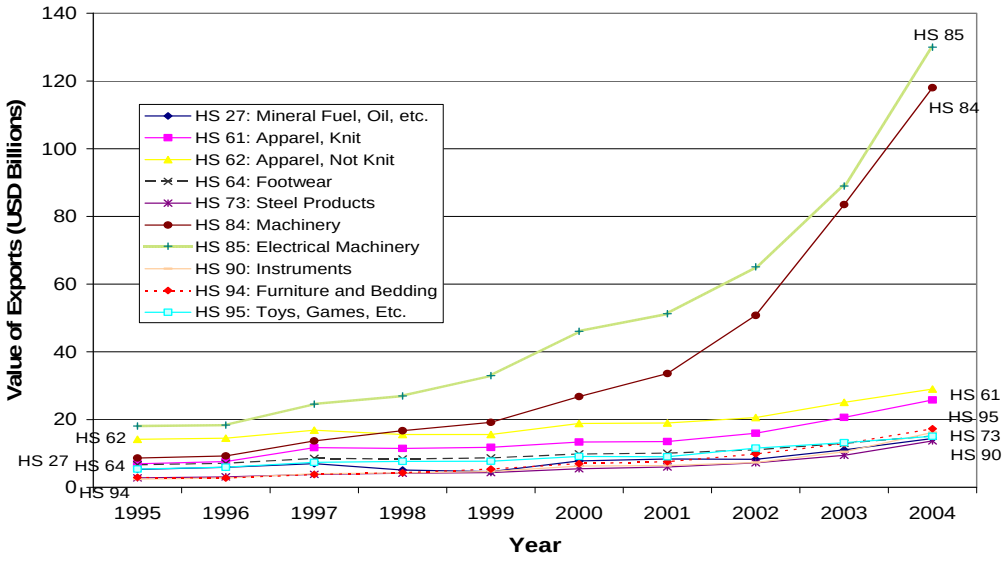


Figure 3: Export Shares of all Chinese Exports, Selected Years

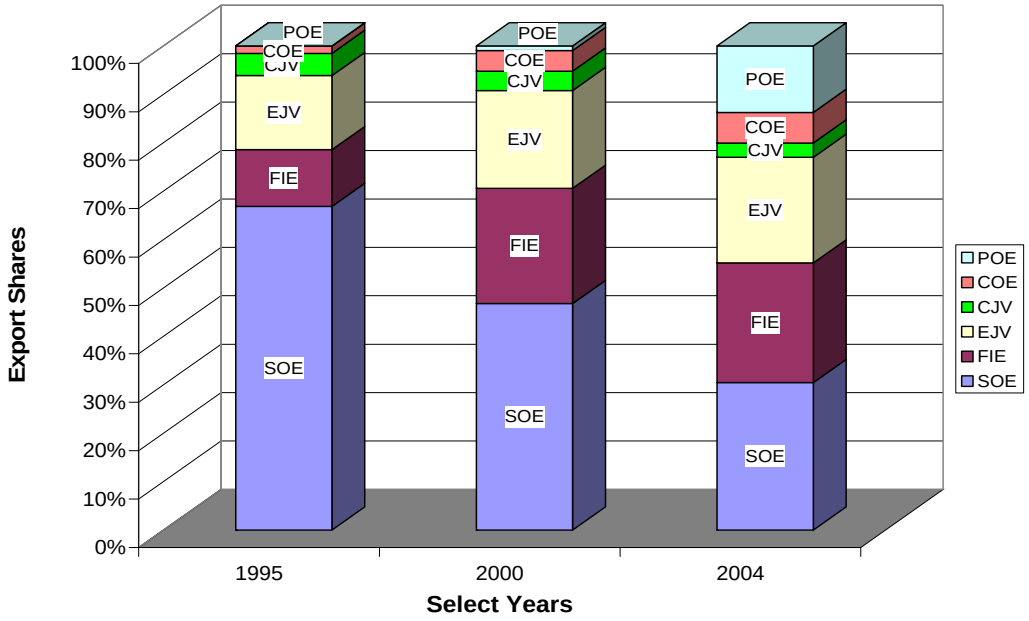
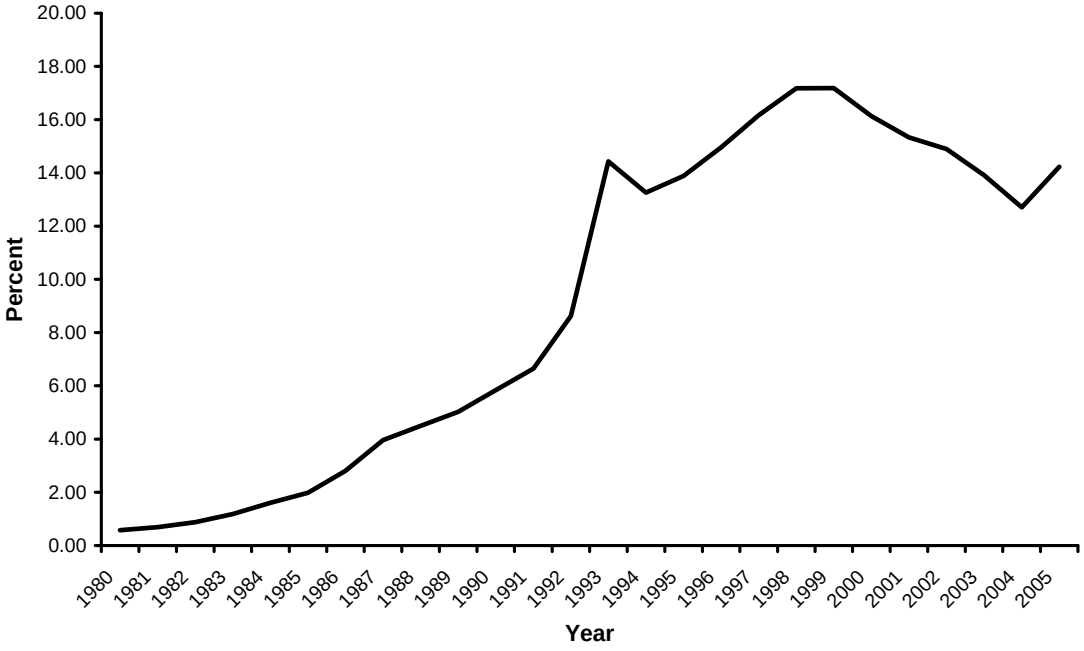


Figure 4: FDI as a Percent of GDP for China, 1980-2005



Sources: FDI stock data come from UNCTAD's *World Investment Report*, various issues, and GDP data come from the World Bank's *World Development Indicators*.

Table 1: Annual Changes in Relative Market Shares and Unit Values of Chinese Exports for Differentiated Goods (1997-2005)

	Benchmark		*Differentiated Goods*		*Differentiated Goods + G-3 Countries*		*Differentiated Goods + Hong Kong*	
	FS	UV	FS	UV	FS	UV	FS	UV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year 1998	0.012	0.018	-0.011	0.027	0.043***	0.141***	-0.020	-0.028
	[0.167]	[0.506]	[0.652]	[0.613]	[0.000]	[0.017]	[0.440]	[0.700]
Year 1999	0.009	0.049**	-0.029	0.067	0.035***	0.200***	-0.055***	-0.042***
	[0.309]	[0.033]	[0.231]	[0.165]	[0.000]	[0.000]	[0.004]	[0.000]
Year 2000	0.018**	0.098***	-0.041**	0.072	0.012***	0.151***	-0.057***	-0.007***
	[0.022]	[0.000]	[0.063]	[0.151]	[0.000]	[0.000]	[0.018]	[0.012]
Year 2001	0.027***	0.096***	-0.043**	0.127***	-0.005***	0.143***	-0.042	0.093
	[0.000]	[0.000]	[0.045]	[0.018]	[0.000]	[0.024]	[0.134]	[0.147]
Year 2002	0.029***	0.111***	-0.056***	0.113**	-0.008***	0.157*	-0.065***	0.241***
	[0.000]	[0.000]	[0.012]	[0.038]	[0.000]	[0.068]	[0.017]	[0.001]
Year 2003	0.035***	0.121***	-0.055***	0.143***	-0.016***	0.144**	-0.053**	0.329***
	[0.000]	[0.000]	[0.012]	[0.010]	[0.000]	[0.034]	[0.043]	[0.002]
Year 2004	0.044***	0.088***	-0.053***	0.114**	-0.010***	0.074**	-0.063***	0.329***
	[0.000]	[0.001]	[0.016]	[0.034]	[0.000]	[0.045]	[0.029]	[0.002]
Year 2005	0.049***	0.085***	-0.056***	0.019***	-0.013***	0.109*	-0.056**	0.248***
	[0.000]	[0.001]	[0.018]	[0.024]	[0.000]	[0.066]	[0.060]	[0.001]
Constant	0.506***	0.321***	0.507***	0.321***	0.506***	0.321***	0.507***	0.311***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.019]	[0.000]	[0.000]
HS6 Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	116854	84213	1116854	84213	116854	84213	116854	82724
F(·)	10.91	5.77	6.09	3.57	41.64	5.98	4.65	5.62
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.8382	0.6012	0.8386	0.6018	0.8522	0.6063	0.8390	0.6086
Root MSE	0.1274	0.3867	0.1273	0.3864	0.1218	0.3823	0.1271	0.3666

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Annual Changes in Relative Market Shares and Unit Values of Chinese Exports with R&D Intensity (1997-2005)

	R&D Intensity		*R&D Intensity + G-3 Countries*		*R&D Intensity + Hong Kong*	
	FS	UV	FS	UV	FS	UV
	(1)	(2)	(3)	(4)	(5)	(6)
Year 1998	-0.0003	0.002	0.001	0.004	-0.001***	0.002
	[0.379]	[0.175]	[0.000]***	[0.309]	[0.000]	[0.266]
Year 1999	-0.0002	0.001	0.001***	0.003***	-0.001***	-0.0002***
	[0.694]	[0.225]	[0.000]	[0.003]	[0.000]	[0.021]
Year 2000	-0.0002	0.002***	0.001***	0.003**	-0.001***	0.001***
	[0.484]	[0.022]	[0.000]	[0.027]	[0.000]	[0.008]
Year 2001	-0.0002	0.001	0.0001***	0.001	-0.0002	0.001
	[0.343]	[0.262]	[0.000]	[0.381]	[0.151]	[0.552]
Year 2002	-0.0001	0.001	0.001***	0.0002	-0.001***	0.001
	[0.743]	[0.522]	[0.000]	[0.740]	[0.000]	[0.813]
Year 2003	0.00001	0.002**	0.0002***	0.001***	-0.0001	0.002**
	[0.937]	[0.035]	[0.001]	[0.035]	[0.342]	[0.031]
Year 2004	-0.00001	0.0003	0.0002***	-0.001***	-0.0002	0.003***
	[0.982]	[0.681]	[0.005]	[0.003]	[0.256]	[0.003]
Year 2005	-0.0001	-0.001	0.0002***	-0.001	-0.0001	0.001
	[0.806]	[0.570]	[0.001]	[0.298]	[0.282]	[0.337]
Constant	0.507***	0.314***	0.507***	0.316***	0.508***	0.315***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HS6 Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observation	116854	84213	116854	84213	116854	84213
F(˙)	5.95	5.84	17.39	5.56	9.67	5.33
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.8383	0.6052	0.8440	0.5897	0.8398	0.6125
Root MSE	0.1274	0.3848	0.1251	0.3810	0.1268	0.3812

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Annual Changes in Relative Market Shares and Unit Values of Chinese Exports with FDI Policy (1997-2005)

	Encourage		*Encourage + G-3 Countries*		*Encourage + Hong Kong*		*Restrict*		*Restrict + G-3 Countries*		*Restrict + Hong Kong*	
	FS	UV	FS	UV	FS	UV	FS	UV	FS	UV	FS	UV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year 1998	0.016	0.190	0.088***	0.404	-0.035**	0.140	0.031**	-0.203***	0.084***	-0.174***	0.016***	-0.173***
	[0.567]	[0.201]	[0.000]	[0.375]	[0.036]	[0.227]	[0.057]	[0.003]	[0.000]	[0.009]	[0.024]	[0.008]
Year 1999	0.022	0.147*	0.114***	0.253*	-0.045***	0.106	0.035**	-0.123**	0.075***	0.067***	0.024***	-0.180
	[0.515]	[0.062]	[0.000]	[0.095]	[0.016]	[0.101]	[0.025]	[0.053]	[0.001]	[0.001]	[0.020]	[0.118]
Year 2000	0.026	0.156***	0.086***	0.215***	-0.007***	0.131**	0.019	-0.200***	0.060***	-0.034***	0.016	-0.313**
	[0.180]	[0.013]	[0.000]	[0.029]	[0.022]	[0.023]	[0.157]	[0.011]	[0.001]	[0.008]	[0.304]	[0.039]
Year 2001	0.021	0.086	0.045**	0.054	0.032	0.072	0.014	-0.106	0.055***	-0.036***	0.021	-0.160
	[0.120]	[0.198]	[0.000]	[0.307]	[0.235]	[0.327]	[0.302]	[0.120]	[0.000]	[0.024]	[0.572]	[0.265]
Year 2002	0.027***	0.016	0.064***	-0.013	0.005***	0.024	0.010	-0.126***	0.064***	-0.072***	0.023	-0.113
	[0.027]	[0.737]	[0.000]	[0.700]	[0.011]	[0.890]	[0.541]	[0.020]	[0.001]	[0.006]	[0.619]	[0.128]
Year 2003	0.026***	0.100**	0.047***	0.015***	0.030*	0.202**	-0.001	-0.108**	0.047***	-0.107*	0.027	-0.017*
	[0.021]	[0.038]	[0.000]	[0.005]	[0.085]	[0.044]	[0.931]	[0.043]	[0.001]	[0.092]	[0.252]	[0.092]
Year 2004	0.029***	0.045	0.058***	-0.146***	0.011***	0.382***	0.012	-0.060	0.061***	-0.015	0.033	0.060
	[0.009]	[0.397]	[0.000]	[0.000]	[0.015]	[0.015]	[0.404]	[0.417]	[0.000]	[0.400]	[0.129]	[0.498]
Year 2005	0.030***	-0.014	0.060***	-0.123***	0.007***	0.063	0.009	-0.126**	0.052***	-0.085	0.031	-0.179
	[0.016]	[0.773]	[0.000]	[0.017]	[0.017]	[0.693]	[0.507]	[0.045]	[0.000]	[0.104]	[0.201]	[0.184]
Constant	0.504***	0.316***	0.504***	0.317***	0.504***	0.314***	0.506***	0.321***	0.506***	0.320***	0.506***	0.311***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HS6 Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	116854	84213	80638	84213	116854	84213	116854	84213	116854	84213	116854	82724
F(˙)	6.14	5.14	12.94	4.93	5.02	3.93	5.95	4.13	8.36	3.58	4.44	3.97
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.8384	0.5791	0.8817	0.6134	0.8390	0.6075	0.8383	0.6021	0.8800	0.6028	0.8383	0.6014
Root MSE	0.1273	0.3859	0.1075	0.3808	0.1271	0.3837	0.1274	0.3863	0.1083	0.3859	0.1274	0.3699

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Annual Changes in Relative Market Shares and Unit Values of Chinese Exports for JV (1997-2005)

	JV FS	JV UV	FIE FS	FIE UV
	(1)	(2)	(3)	(4)
Year 1998	-0.003	-0.006	0.016*	0.020
	[0.662]	[0.818]	[0.088]	[0.482]
Year 1999	-0.018***	0.008	0.027***	0.044
	[0.010]	[0.729]	[0.004]	[0.114]
Year 2000	-0.015**	0.054**	0.033***	0.096***
	[0.040]	[0.040]	[0.000]	[0.000]
Year 2001	-0.020***	0.084***	0.047***	0.084***
	[0.004]	[0.000]	[0.000]	[0.001]
Year 2002	-0.035***	0.086***	0.065***	0.103***
	[0.000]	[0.005]	[0.000]	[0.000]
Year 2003	-0.046***	0.123***	0.081***	0.107***
	[0.000]	[0.000]	[0.000]	[0.000]
Year 2004	-0.056***	0.100***	0.100***	0.084***
	[0.000]	[0.000]	[0.000]	[0.002]
Year 2005	-0.068***	0.096***	0.118***	0.083***
	[0.000]	[0.000]	[0.000]	[0.004]
Constant	0.262***	0.312***	0.244***	0.314***
	[0.000]	[0.000]	[0.000]	[0.000]
HS6 Dummies	Yes	Yes	Yes	Yes
Observation	1116854	73013	116854	65760
F(·)	25.89	7.54	43.77	3.84
Prob > F	0.0000	0.0000	0.0000	0.0000
R-squared	0.6543	0.5426	0.8007	0.5844
Root MSE	0.1200	0.3819	0.1284	0.3789

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Annual Changes in Relative Market Shares and Unit Values of Chinese Exports for Machinery Industry (1997-2005)

	Machinery		*Machinery + G-3 Countries*		*Machinery + Hong Kong*		*Machinery + Encourage*		*Machinery + Restricted*	
	FS	UV	FS	UV	FS	UV	FS	UV	FS	UV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year 1998	-0.008	0.255	0.108***	0.490	-0.094***	0.221	-0.019	0.293	0.037	0.136
	[0.849]	[0.217]	[0.000]	[0.410]	[0.000]	[0.151]	[0.801]	[0.318]	[0.508]	[0.333]
Year 1999	-0.014	0.134	0.115***	0.225	-0.118***	0.107	-0.018	0.143	0.079*	0.140
	[0.765]	[0.305]	[0.000]	[0.489]	[0.000]	[0.557]	[0.951]	[0.539]	[0.079]	[0.435]
Year 2000	-0.005	0.154	0.078***	0.205	-0.062***	0.128	-0.002	0.231	0.026	0.111
	[0.894]	[0.187]	[0.000]	[0.296]	[0.000]	[0.322]	[0.911]	[0.139]	[0.673]	[0.419]
Year 2001	-0.008	0.061	0.018**	0.009	-0.004	0.096	-0.002	0.096	0.023	0.132
	[0.802]	[0.604]	[0.000]	[0.588]	[0.929]	[0.836]	[0.662]	[0.715]	[0.460]	[0.369]
Year 2002	0.008	0.092	0.055***	0.012	-0.024***	0.150	0.009	0.089	0.074	0.168
	[0.809]	[0.441]	[0.000]	[0.383]	[0.021]	[0.413]	[0.971]	[0.667]	[0.391]	[0.506]
Year 2003	0.018	0.171	0.039***	0.126	0.016	0.197	0.019	0.197	0.075	0.273
	[0.556]	[0.148]	[0.009]	[0.249]	[0.869]	[0.334]	[0.860]	[0.342]	[0.343]	[0.172]
Year 2004	0.019	0.035	0.040***	-0.135***	0.009	0.461*	0.015	0.042	0.087	0.056
	[0.522]	[0.772]	[0.009]	[0.001]	[0.750]	[0.062]	[0.556]	[0.949]	[0.214]	[0.904]
Year 2005	0.019	-0.050	0.041***	-0.140	0.008	0.085	0.007*	-0.058	0.069	-0.096
	[0.530]	[0.681]	[0.001]	[0.143]	[0.704]	[0.397]	[0.080]	[0.906]	[0.344]	[0.865]
Constant	0.505***	0.315***	0.505***	0.316***	0.505***	0.307***	0.506***	0.314***	0.505***	0.315***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HS6 Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	116854	84213	116854	84213	116854	82724	116854	84213	116854	84213
F(·)	6.27	5.49	12.93	4.89	9.91	4.23	5.34	3.86	4.38	4.05
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.8383	0.6041	0.8406	0.5868	0.8395	0.6082	0.8385	0.6046	0.8384	0.6042
Root MSE	0.1274	0.3853	0.1265	0.3823	0.1269	0.3668	0.1273	0.3851	0.1273	0.3853

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Annual Changes in Relative Market Shares and Unit Values of Chinese Exports for Electronic Industry (1997-2005)

	Electronics		*Electronics + G-3 Countries*		*Electronics + Hong Kong*		*Electronics + Encourage*		*Electronics + Restricted*	
	FS	UV	FS	UV	FS	UV	FS	UV	FS	UV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year 1998	-0.007	-0.088	0.110***	-0.058	-0.062***	-0.062	0.067	0.271*	0.019	-0.684***
	[0.737]	[0.279]	[0.000]	[0.519]	[0.000]	[0.669]	[0.282]	[0.079]	[0.719]	[0.000]
Year 1999	-0.027	-0.022	0.084***	0.170**	-0.095***	-0.126*	0.080**	0.570***	0.022	-0.226
	[0.193]	[0.775]	[0.000]	[0.042]	[0.000]	[0.094]	[0.049]	[0.001]	[0.158]	[0.425]
Year 2000	-0.014	0.002	0.064***	0.082	-0.066***	-0.047	0.057	0.428**	0.013	-0.394
	[0.443]	[0.981]	[0.000]	[0.461]	[0.000]	[0.776]	[0.204]	[0.030]	[0.476]	[0.208]
Year 2001	-0.199	0.012	0.007***	0.026	-0.050	0.001	-0.034	0.563**	0.002	-0.156
	[0.260]	[0.870]	[0.006]	[0.946]	[0.106]	[0.999]	[0.234]	[0.029]	[0.369]	[0.520]
Year 2002	-0.030	-0.005	0.018***	0.174	-0.072***	-0.130	-0.029	0.267	-0.046	-0.585**
	[0.104]	[0.957]	[0.001]	[0.193]	[0.021]	[0.156]	[0.284]	[0.178]	[0.269]	[0.031]
Year 2003	-0.021	-0.059	0.001***	-0.065	-0.036	0.008	-0.029	0.356***	-0.040	-0.399
	[0.218]	[0.461]	[0.004]	[0.740]	[0.200]	[0.446]	[0.441]	[0.007]	[0.478]	[0.298]
Year 2004	-0.008	0.012	0.028***	0.006	-0.046***	0.018	-0.005	0.488***	-0.034	-0.495***
	[0.656]	[0.888]	[0.000]	[0.987]	[0.001]	[0.932]	[0.926]	[0.002]	[0.824]	[0.003]
Year 2005	0.001	0.084	0.050***	0.123	-0.032***	0.081	0.010	0.466***	-0.180	-0.150
	[0.944]	[0.306]	[0.000]	[0.438]	[0.016]	[0.497]	[0.874]	[0.007]	[0.058]	[0.505]
Constant	0.507***	0.320***	0.507***	0.320***	0.507***	0.311***	0.507***	0.312***	0.507***	0.320***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HS6 Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	116854	84213	116854	84213	116854	82724	116854	84213	116854	84213
F(·)	5.89	3.76	15.46	3.04	9.86	3.73	4.61	3.50	4.28	3.49
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.8384	0.6023	0.8418	0.6042	0.8403	0.6033	0.8386	0.6056	0.8385	0.6042
Root MSE	0.1273	0.3862	0.1260	0.3853	0.1266	0.3691	0.1273	0.3846	0.1273	0.3853

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Changes in Relative Unit Values of Chinese Exports with Lagged Foreign Market Share (2000-2005)

	Benchmark	Differen-tiated	R&D Intensity	Encourage	Restrict	FIEs	JVs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FShare	1.013***	1.397***	1.011***	0.687***	0.177	0.738***	0.939***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.315]	[0.001]	[0.000]
Lagged FShare (3-Year Moving Average)	-0.122***	-0.104**	-0.126	0.041	0.080	-0.155	0.019
	[0.000]	[0.017]	[0.115]	[0.482]	[0.141]	[0.165]	[0.852]
Constant	0.093	-0.033	0.094	0.086	0.098	0.321***	0.233***
	[0.220]	[0.659]	[0.214]	[0.235]	[0.186]	[0.001]	[0.000]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	22828	22828	22828	22828	22828	19504	20722
F(·)	14.34	14.76	11.22	11.51	11.71	3.63	6.78
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000
R-squared	0.8521	0.8553	0.8521	0.8533	0.8534	0.8135	0.8198
Root MSE	0.2412	0.2387	0.2412	0.2403	0.2402	0.2660	0.2641

Notes: i) weighted by value of total exports in an HS6 sector, ii) robust standard errors., iii) Winsorize bottom 5% and top 5% of sample, iv) P-value in brackets, v) G-3 countries are defined as EU15, Japan, and the United States, vi) * significant at 10%; ** significant at 5%; *** significant at 1%

Appendix

This appendix provides proofs for the results in the propositions and corollaries presented in the theory section of the paper. Throughout, we simplify notation by letting x denote $U(K_F)$, y denote $U(K_C)$ and x_T denote $U(K_T)$, recalling that $K_T = (1-\lambda)K_C + \lambda K_F$.

Proof of Proposition 1a: Solving for Nash Equilibrium prices in period 2 after the foreign firm has located to China and technology transfer has taken place (subgame 2T), one can then construct expressions for demands for each firm in terms of parameters as:

$$D_F^{2T} = 2(x - x_T)/(4x - 3U_0 - x_T),$$
$$D_C^{2T} = (x - U_0)/(4x - 3U_0 - x_T).$$

Thus, the ratio of foreign-to-Chinese demands is:

$$\Theta^{2T} \equiv D_F^{2T} / D_C^{2T} = 2(x - x_T)/(x - U_0).$$

Then, the effect of technology transfer on this ratio is the following:

$$\frac{\partial \Theta^{2T}}{\partial \lambda} = \frac{\partial \Theta^{2T}}{\partial x_T}\frac{\partial x_T}{\partial \lambda} = -2/(x - U_0) < 0$$

Q.E.D.

Proof of Proposition 1b: Solving for Nash Equilibrium prices in period 2 after the foreign firm has located to China and technology transfer has taken place (subgame 2T), we obtain:

$$p_F^{2T} = [2(x - U_0)(x - x_T)]/[x(4x - 3U_0 - x_T)].$$
$$p_C^{2T} = [(x_T - U_0)(x - x_T)]/[x_T(4x - 3U_0 - x_T)],$$

Thus, the ratio of foreign-to-Chinese prices is:

$$\Omega^{2T} = p_F^{2T} / p_C^{2T} = [2x_T(x - U_0)/x][x_T - U_0]^{-1}.$$

Then, the effect of technology transfer on this ratio is the following:

$$\frac{\partial \Omega^{2T}}{\partial \lambda} = \frac{\partial \Omega^{2T}}{\partial x_T}\frac{\partial x_T}{\partial \lambda} = \left[\frac{2(x - U_0)}{x(x_T - U_0)}\right]\left[1 - \frac{x_T}{(x_T - U_0)}\right]\left[K_F - K_C\right]$$

Given the parameter values and relationships presented in the text, this is easily signed as negative. Q.E.D.

Proof of Proposition 2: Simple comparative static to be detailed in next draft.

Proof of Corollaries 3a and 3b: Using notation for relative price and unit values above, we can derive the following expressions:

$$\frac{\partial \Theta^{2T}}{\partial \lambda} = \frac{\partial \Theta^{2T}}{\partial \lambda}\frac{\partial \lambda}{\partial \theta} \text{ and } \frac{\partial \Omega^{2T}}{\partial \lambda} = \frac{\partial \Omega^{2T}}{\partial \lambda}\frac{\partial \lambda}{\partial \theta}.$$

By the relationships established in propositions 1a, 1b, and 2, relative foreign demand and unit values are then increasing in θ. *Q.E.D.*

Proof of Proposition 4: By the Envelope Theorem, Π_F^{1N} and Π_F^{2N} are decreasing in c, while c is non-varying parameter in Π_F^{1L} and Π_F^{2T}. Thus, an increase in c (i.e., greater cost savings when the firm locates in China) lowers the RHS of equation (1) in the text and makes FDI more likely. Likewise, the technology cost variable, θ, is only an argument in Π_F^{2T} on the LHS equation (1). By the Envelope Theorem, Π_F^{2T} is increasing in θ, thus making FDI more likely. *Q.E.D.*