Volume Title: China's Growing Role in World Trade

Volume Author/Editor: Robert C. Feenstra and Shang-Jin Wei, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-23971-3

Volume URL: http://www.nber.org/books/feen07-1

Conference Date: August 3-4, 2007

Publication Date: March 2010

Chapter Title: Please Pass the Catch-Up: The Relative Performance of Chinese and Foreign Firms in Chinese Exports

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Chapter URL: http://www.nber.org/chapters/c10473

Chapter pages in book: (475 - 509)

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Please Pass the Catch-Up
The Relative Performance of Chinese and Foreign Firms in Chinese Exports

Bruce A. Blonigen and Alyson C. Ma

12.1 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 firms' (FIEs) share of Chinese exports has risen from around 10 percent in 1990 to almost 60 percent in 2004 (figure 4). The Chinese experience in this regard is unique in that a substantial portion of FIE presence is by investors from Hong Kong, Macau, and Taiwan—regions that 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

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The authors would like to thank Robert Feenstra, Raymond Robertson, Shang-Jin Wei, and participants of a seminar at the California State University, Sonoma, and the National Bureau of Economic Research (NBER) conferences connected with this book for helpful comments and suggestions. We also thank Helen Naughton and Laura Kerr-Valentic for excellent research assistance. Any remaining errors are our own.

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 firms a profit tax lower than that applied to domestic firms. Through the 1980s, the number of these government-policy 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 (WTO), which specifies "national treatment" of tax policies.[1]

There are a couple features of the Chinese government's policy objectives toward FIEs that will be important for our analysis and that 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) use provincial data on FIE presence from 1984 through 1995 to estimate 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 firms. Technology transfer agreements are often an 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). 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, causing China to miss out on the type of technological spillovers that would occur naturally.

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

The evidence on the net effect of such technology transfer policies is far from known, with only a 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 (forthcoming) 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 firms. Chen and Swenson (2006) find 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 (forthcoming) find that such spillovers are only positive for the most technologically advanced Chinese firms.

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 percent, they account for over 20 percent of the Chinese economy and around 40 percent of its recent growth. Their conclusion is that the sustainability of China's export growth and, indeed, its overall gross domestic product (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 (chapter 2 in this volume) analyze 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 firms 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

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

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 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 firm (wholly-owned foreign-invested firms, SOEs, joint ventures, etc.) to analyze the evolution of Chinese export market shares and unit values over time during our sample period of 1997 to 2005.

The remainder of the chapter is organized as follows. Section 12.2 provides the literature review, while section 12.3 presents a model of foreign investment into China. We briefly discuss the descriptive analysis of exports and unit values over time in section 12.4. Section 12.5 offers the empirical analyses, and section 12.6 concludes.

12.2 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 reexports of Chinese products involve an average of around 25 percent 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 percent 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. Feenstra and Hanson (2005) develop a property-rights model to explain when the foreign party will own the plant 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 2001 World Bank survey of 1,500 firms across five major Chinese cities. Hale and Long (forthcoming) 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 et al. (forthcoming) 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 (forthcoming). 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

3. Chen and Swenson (2006) also examine productivity spillovers from foreign firms to domestic ones in China but use the same data set we examine in this study. While this data set 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.

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 (forthcoming). Rodrik (2006) compares the composition of China's exports and finds that it is much closer to that of Organization for Economic Cooperation and Development (OECD) countries than its level of per capita income would suggest. This bodes well for China in that a related paper by Hausmann, Hwang, and Rodrik (2007) finds a strong correlation between the sophistication of a country's export basket and its economic growth. Schott (forthcoming) 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." 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.

12.3 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 share of Chinese exports by foreign firms.

12.3.1 Producers

We employ a partial equilibrium setup, 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_{CH}; that is, $K_F > K_{CH}$.[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_{CH}) of the low-quality Chinese

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

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] Because of this difference, the foreign firm has incentives to not locate production in the Chinese market, everything else equal.

12.3.2 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 h indexes the consumer with income of h. 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 $U_0 h$, where $U_0 > 0$. If they purchase the good from a supplier, they receive utility of $U(K_i)(h - p_i)$, where p is the price charged by the supplier, and $i = CH, F$. 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.

With this setup, 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 in the preceding), the high-quality firm will always charge a higher price than the low-quality firm in equilibrium ($p_F > p_{CH}$). Thus, demand along the unit interval of consumers can be divided into the sections shown in figure 12.1, 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 cutoff income levels: h_F designates the consumer indifferent to purchasing either the high- or low-quality variety, while h_{CH} 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 h_F:

$$U(K_F)(h_F - p_F) = U(K_{CH})(h_F - p_{CH}). \tag{1}$$

Letting x denote $U(K_F)$ and y denote $U(K_{CH})$, we can easily derive the following expression for h_F:

$$h_F = \frac{(x\,p_F - y\,p_{CH})}{(x - y)}. \tag{2}$$

In similar fashion, h_{CH} can be solved as:

$$h_{CH} = \frac{(y\,p_{CH})}{(y - U_0)}. \tag{3}$$

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

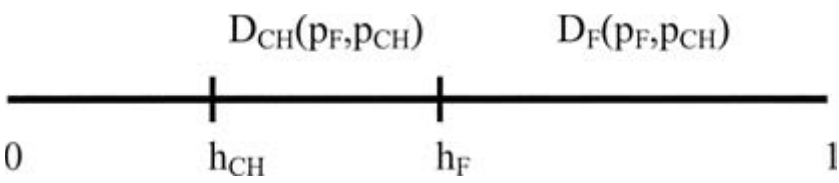

Fig. 12.1 Firm demands and cutoff points along the distribution of consumers

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

$$D_F(p_F, p_{CH}) = 1 - h_F = 1 - \frac{(x\,p_F - y\,p_{CH})}{(x - y)}, \tag{4}$$

and

$$D_{CH}(p_F, p_{CH}) = h_F - h_{CH} = \frac{(x\,p_F - y\,p_{CH})}{(x - y)} - \frac{(y\,p_{CH})}{(y\,U_0)}. \tag{5}$$

12.3.3 Timing of Decisions

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 China. 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 firm chooses a $\lambda \in [0,1]$ that leaves it with a new quality level $K_{\text{Tech}} = (1-\lambda)\,K_{CH} + \lambda K_F$. 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_{CH}. The associated level of consumer utility connected with this new level of quality is $U(K_{\text{Tech}})$. Costs of technology transfer are increasing in λ, via a quadratic function, $C_{\text{Tech}}(\lambda) = \theta\lambda^2$. 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 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 $\Pi_i^t(p_{CH}^t, p_F^t, K_{CH}, K_F, \lambda, c)$, where t denotes the period-subgame combination.

12.3.4 Solving for Equilibrium

We solve for the subgame-perfect equilibrium of the model in the usual fashion by solving backward 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:

$$\Pi_{CH}^{2N} \equiv \Pi_{CH}(p_{CH}^{2N}, p_F^{2N}, K_{CH}, K_F, 0, c) \tag{6}$$

$$\Pi_F^{2N} \equiv \Pi_F(p_{CH}^{2N}, p_F^{2N}, K_{CH}, K_F, 0, c), \tag{7}$$

where p_{CH}^{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_{CH} to K_{Tech} 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:

$$\Pi_{CH}^{2T} \equiv \Pi_{CH}(p_{CH}^{2T}, p_F^{2T}, K_{CH}, K_F, \lambda, c) \tag{8}$$

$$\Pi_F^{2T} \equiv \Pi_F(p_{CH}^{2T}, p_F^{2T}, K_{CH}, K_F, \lambda, c), \tag{9}$$

where p_{CH}^{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 equilibrium price to the Chinese firm's equilibrium price is decreasing in the amount of technology transfer. (See appendix for proof.)*

PROPOSITION 1b. *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.)*

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:

$$\underset{\lambda}{\text{Max}}\,\Pi_{CH}^{\text{Net}} \equiv \Pi_{CH}^{2T}(p_{CH}^{2T}, p_F^{2T}, K_{CH}, K_F, \lambda, 0) - \theta\lambda^2 \tag{10}$$

From this optimization problem, we can derive:

PROPOSITION 2. *The level of technology transfer chosen by the Chinese firm is decreasing in the cost or 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 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.)*

COROLLARY 3b. *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.)*

Corollaries 3a and 3b are a primary focus for our empirical work in the following, 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 or 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 or 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 1*N*), then equilibrium prices and profits are identical to those in subgame 2*N* described in the preceding. 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 1*L*) are:

$$\Pi_{CH}^{1L} \equiv \Pi_{CH}(p_{CH}^{1L}, p_F^{1L}, K_{CH}, K_F, 0, 0) \tag{11}$$

$$\Pi_F^{1L} \equiv \Pi_F(p_{CH}^{1L}, p_F^{1L}, K_{CH}, K_F, 0, 0), \tag{12}$$

where p_{CH}^{1L}, p_F^{1L} 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:

$$\Pi_F^{1L} > \Pi_F^{1N} \equiv \Pi_F^{2N} \text{ and} \tag{13}$$

$$\Pi_F^{2T} \leq \Pi_F^{2N}. \tag{14}$$

This leads us to an analysis of the foreign firm's initial decision whether to engage in FDI 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:

$$\Pi_F^{1L} + \Pi_F^{2T} - F > \Pi_F^{1N} + \Pi_F^{2N}. \tag{15}$$

This leads to:

PROPOSITION 4. *The FDI decision by the foreign firm into China is more likely (a) the greater the cost savings, and (b) the greater the cost or difficulty of technology transfer. (See appendix for proof.)*

While our empirical work in the following 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 or costly. Thus, we may find little evidence of convergence of relative export prices and increases in Chinese market share after FDI increases in an industry. Our empirical analysis will account for this potential endogeneity bias.

12.3.5 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 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 equation (15) 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 locating to China is 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 or arrange for technology transfer. A promi-

nent example of this is the automobile industry. This 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. However, both the higher fixed costs of FDI and greater technology transfer makes it less likely that the foreign firm would enter.

12.3.6 Ownership Structure

For simplicity, we do not consider alternative forms of FDI ownership structure in our model. However, the data we explore in the following have considerable information on the amounts of activity from both joint venture and wholly-owned foreign firms. 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 engage in a joint venture, we should expect a greater decrease in relative foreign-to-Chinese market shares and unit values over time than in the case where the foreign firm chooses to be an independent, wholly-owned foreign firm.

12.4 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 includes both ordinary and processing trade. An important feature of the data is that it disaggregates export trade activity by the type of firm, namely, foreign-invested enterprises (FIEs), state-owned enterprises (SOEs), contractual joint ventures (CJVs), equity joint ventures (EJVs), collectively owned enterprises (COEs), and privately owned enterprises (POEs). Foreign-invested firms are firms wholly-owned by foreign funded firms and overseas Chinese companies. State-owned enterprises are the traditional noncorporation economic units, where the entire assets are owned by the state. Collectively owned enterprises are collectively owned economic units, including township and village firms. Privately owned enterprises 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 agree-

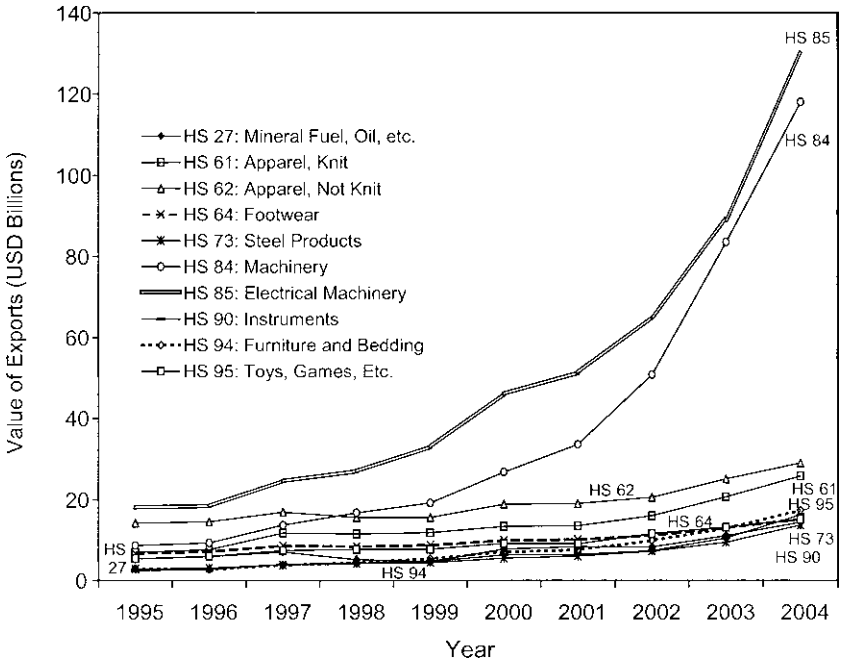

Fig. 12.2 Chinese exports by top industries at two-digit HS Level, 1995–2004

ments, 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 firms in Chinese exporting patterns.

Figure 12.2 provides the value of exports over time for the top ten industries at the two-digit Harmonized System (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 12.3 shows the export shares of all Chinese exports for years 1995, 2000, and 2005 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 2005. For purposes of our

7. We use the end-of-sample 2004 rankings of export shares to determine the top ten sectors.

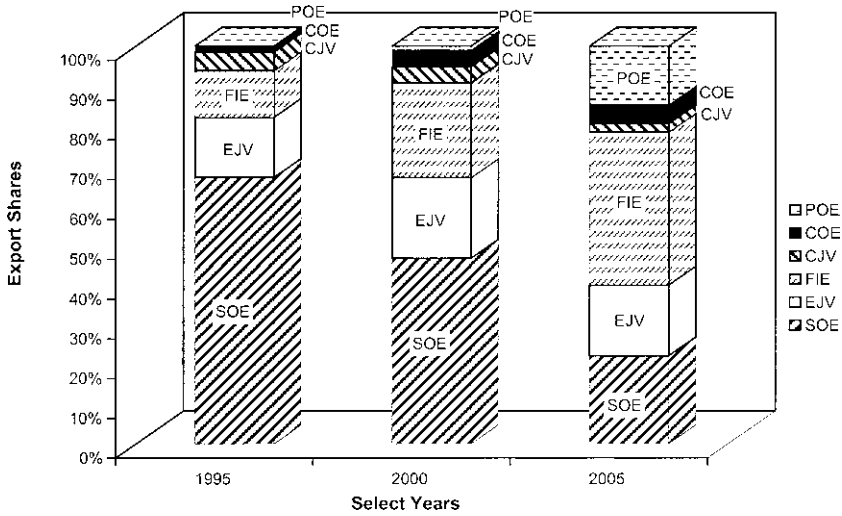

Fig. 12.3 Export shares of all Chinese exports, selected years

analysis, 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.

12.5 Empirical Analysis

12.5.1 Specification

We now turn to a statistical analysis of relative market shares and unit values for foreign and Chinese exports from 1997 through 2005. Our focus is the changes over time in 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 our empirical models specified as the following:

$$(16) \qquad FS_{jt} = \alpha + \sum_{t=1998}^{2005} \beta_t \mathrm{YD}_t + \sum_{m=1}^{M} \sum_{t=1998}^{2005} \gamma_{tm} (\mathrm{YD}_t \times Z_j^m) + \psi_j + \varepsilon_{jt}$$

$$(17) \quad \ln UV_{jt}^F - \ln UV_{jt}^{CH} = \alpha + \sum_{t=1998}^{2005} \beta_t \mathrm{YD}_t + \sum_{m=1}^{M} \sum_{t=1998}^{2005} \gamma_{tm} (\mathrm{YD}_t \times Z_j^m) + \psi_j + \varepsilon_{jt},$$

where FS_{jt} is the foreign firm's share of Chinese exports for a given six-digit HS (HS6) product code j and year t; UV_{jt}^F and UV_{jt}^{CH} are Chinese export unit values for the foreign and Chinese firms for the HS6 product code j

and year t, respectively; YD_t are year dummy variables; Z_j^m are a set of M variables representing product attributes or policy variables that are hypothesized to affect technology transfer and market competition between the Chinese and foreign firms; ψ_j are the HS6 product fixed effects, and ε_{jt} is an assumed white-noise random error term.

Given the specification of the dependent variable in equation (16), the coefficients on our year dummies in our "export market share regressions" show the *percentage point* difference in the foreign market share from our base year, 1997.[8] For the "unit value difference regressions" in equation (17), the year dummy coefficients capture the *percentage* difference from the base year, 1997. A key focus is also on the double-summation term in each equation, which represents sets of year-dummy interactions with our focus variables related to our model's hypotheses. We describe these factors that comprise Z_j^m next.

Our theoretical model in section 12.3 suggests three types of factors that may affect the evolution of our dependent variables: (a) cost of technology transfer, (b) government policies, and (c) ownership structure. Measures of technology transfer costs are difficult to observe, so we rely on two proxies: (a) product differentiation and (b) research and development (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 scientists and engineers per 1,000 employees in R&D-performing companies, is from the National Science Foundation's *Research and Development in Industry* (various years). The identification of differentiated goods comes 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, restricts, or prohibits 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 HS codes using the U.S. International Trade Commission (USITC) tariff database search engine, available at http://dataweb.usitc.gov/scripts/tariff2003.asp. As discussed in section 12.3, our model predicts that encouragement of FDI will increase the relative foreign firm's share of exports but may accentuate technology transfer, leading to a greater decrease

8. We exclude the first year (1997) of our year-dummy variables and sets of year-dummy interactions to avoid perfect multicollinearity with our constant.

in the unit value relative to domestic firms. On the other hand, restrictions on FDI should lead to greater decreases in both the foreign firm's export share and relative unit value.

Likewise, as discussed in section 12.3, we would expect to see greater decreases in both the foreign firm's export share and relative unit value for joint ventures (where the foreign firm is working in close connection with a Chinese partner) than with a wholly-owned (and independent) FIE. Because these are not product-level attributes or policies, we do not empirically assess this impact through interactions with year dummies in our full sample. Rather, we will address these hypotheses by examining our estimates when we reconstruct our dependent variables in terms of only FIE or only joint venture transactions, respectively.

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 export share variable, where continual FDI can lead us to see increasing foreign export 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. Ideally, one would like to control for the relative entry rates of domestic and foreign firms by HS6 product categories. But no such data exist.

However, there are a number of important points in regard to this issue. First, both the ratio of FDI stock in China relative to GDP and the ratio of annual net FDI inflows to gross domestic capital formation in the Chinese economy have been fairly constant since the early 1990s, as shown in figure 12.4. In fact, both ratios have actually fallen some over our sample period from 1997 to 2005. This argues against an upward-trending bias of foreign export share in our sample from greater growth in foreign capital than domestic Chinese capital. However, to the extent that one still thinks such bias may exist, it only modifies our connection to our model's hypothesis in the sense 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 due to other reasons. Finally, at the end of our empirical section, we regress unit value gaps not only on year dummies, but also on lagged foreign market share to control for the dynamic changes in FDI patterns explicitly and more clearly identify any net technology transfer effect.

12.5.2 Base Results

Columns (1) and (2) of table 12.1 provide our results when we estimate our foreign firms' export share specification (equation [16]), first without

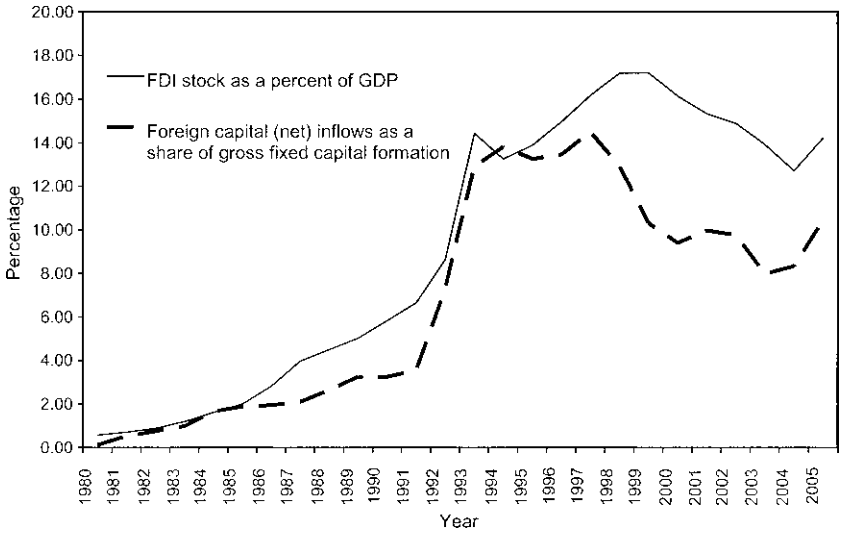

Fig. 12.4 FDI in China relative to domestic output and capital formation, 1980–2005

Sources: FDI stock data come from UNCTAD's *World Investment Report,* various issues; and GDP, net foreign capital inflow, and gross fixed capital formation data from the World Bank's *World Development Indicators.*

interactions between the year dummies and the set of Z_j^m variables, and then with these year-dummy interactions. Likewise, columns (3) and (4) of table 12.1 provide analogous results for our unit value differences specification (equation [17]). Statistical significance of these regressions is generally quite good with R^2-statistics over 0.8 in the foreign share equations and over 0.6 in the unit value differences equations. Most of the variation in the data is explained by the HS6 product fixed effects.

Our coefficients on the year dummy variables in columns (1) and (3) of table 12.1 show us how our dependent variables are changing, on average, across our sample and over time. Surprisingly, these estimates provide evidence that domestic Chinese firms are "falling behind," rather than "catching up" to, foreign firms. In our foreign firms' export share equation (column [1]), these estimates suggest that the share of foreign firms responsible for Chinese exports has been increasing over our sample for the average HS6 product. By 2005, the average foreign firm export share in an HS6 product climbed 4.9 percentage points from its level in 1997 of 50.6 percent. The coefficients on the year dummy terms in the unit value difference estimates (column [3]) also suggest significant "falling behind" by domestic Chinese firms, with unit value differences 9.5 percent higher at the end of our sample in 2005 than the first year of the sample, 1997. Interestingly, the relative differences in unit values had grown by over 13 percent from 1997 to 2003,

Table 12.1 **National annual changes in relative market shares and unit values of Chinese exports (1997–2005)**

	Relative market shares		Relative unit values	
	(1)	(2)	(3)	(4)
Year 1998	0.012	0.017	0.017	–0.067
	(0.009)	(0.028)	(0.028)	(0.076)
Year 1999	0.009	0.026	0.057***	–0.041
	(0.009)	(0.027)	(0.023)	(0.058)
Year 2000	0.018**	0.046**	0.113***	–0.028
	(0.008)	(0.023)	(0.023)	(0.050)
Year 2001	0.027***	0.058***	0.117***	–0.037
	(0.008)	(0.022)	(0.025)	(0.050)
Year 2002	0.029***	0.064***	0.112***	0.025
	(0.008)	(0.022)	(0.026)	(0.054)
Year 2003	0.035***	0.069***	0.138***	–0.063
	(0.007)	(0.021)	(0.025)	(0.054)
Year 2004	0.044***	0.073***	0.093***	–0.032
	(0.007)	(0.021)	(0.026)	(0.053)
Year 2005	0.049***	0.081***	0.095***	0.007
	(0.008)	(0.022)	(0.026)	(0.051)
Year 1998 • Differentiated		–0.005		0.044
		(0.027)		(0.060)
Year 1999 • Differentiated		–0.020		0.076
		(0.023)		(0.049)
Year 2000 • Differentiated		–0.034		0.102**
		(0.022)		(0.048)
Year 2001 • Differentiated		–0.037*		0.161***
		(0.021)		(0.051)
Year 2002 • Differentiated		–0.049***		0.090*
		(0.021)		(0.054)
Year 2003 • Differentiated		–0.052***		0.151***
		(0.021)		(0.054)
Year 2004 • Differentiated		–0.047***		0.131***
		(0.021)		(0.053)
Year 2005 • Differentiated		–0.048***		0.151***
		(0.022)		(0.051)
Year 1998 • R&D intensity		–0.0003		0.002
		(0.0003)		(0.001)
Year 1999 • R&D intensity		–0.0002		0.001
		(0.0004)		(0.001)
Year 2000 • R&D intensity		–0.0002		0.002**
		(0.0002)		(0.028)
Year 2001 • R&D intensity		–0.0002		0.001
		(0.0002)		(0.001)
Year 2002 • R&D intensity		–0.0001		0.001
		(0.0002)		(0.001)
Year 2003 • R&D intensity		0.00004		0.002**
		(0.0002)		(0.001)
Year 2004 • R&D intensity		0.0000003		0.0004
		(0.0002)		(0.001)
Year 2005 • R&D intensity		–0.00005		–0.0004
		(0.0002)		(0.001)

Table 12.1 (continued)

	Relative market shares		Relative unit values	
	(1)	(2)	(3)	(4)
Year 1998 • Encouraged FDI		0.033		0.136
		(0.024)		(0.098)
Year 1999 • Encouraged FDI		0.032		0.124**
		(0.026)		(0.063)
Year 2000 • Encouraged FDI		0.036**		0.090
		(0.017)		(0.061)
Year 2001 • Encouraged FDI		0.031**		0.057
		(0.014)		(0.074)
Year 2002 • Encouraged FDI		0.024**		–0.048
		(0.011)		(0.053)
Year 2003 • Encouraged FDI		0.018*		0.040
		(0.011)		(0.051)
Year 2004 • Encouraged FDI		0.024**		0.045
		(0.010)		(0.053)
Year 2005 • Encouraged FDI		0.027**		0.045
		(0.012)		(0.051)
Year 1998 • Restricted FDI		0.035**		–0.204***
		(0.018)		(0.071)
Year 1999 • Restricted FDI		0.037**		–0.134**
		(0.017)		(0.064)
Year 2000 • Restricted FDI		0.019		–0.151*
		(0.013)		(0.089)
Year 2001 • Restricted FDI		0.015		–0.106
		(0.013)		(0.071)
Year 2002 • Restricted FDI		0.004		–0.082
		(0.017)		(0.056)
Year 2003 • Restricted FDI		–0.005		–0.070
		(0.016)		(0.057)
Year 2004 • Restricted FDI		0.007		–0.037
		(0.014)		(0.078)
Year 2005 • Restricted FDI		0.002		–0.133**
		(0.014)		(0.066)
Constant	0.506***	0.505***	0.318***	0.306***
	(0.007)	(0.007)	(0.018)	(0.022)
Province dummies	No	No	No	No
HS6 dummies	Yes	Yes	Yes	Yes
No. of observations	116,854	116,854	86,443	86,443
F-test	10.91	3.11	7.09	3.60
Prob > *F*	0.0000	0.0000	0.0000	0.0000
R^2	0.8382	0.8390	0.6011	0.6069
Root MSE	0.1274	0.1271	0.4069	0.4040

Notes: Weighted by value of total exports in 6-digit Harmonized System (HS6) sector. Robust standard errors are in parentheses. Winsorize bottom 5 percent and top 5 percent of sample.

MSE = mean square error.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

but then fell to just 9.5 percent greater than 1997 by 2005. This may be evidence of catching up over the 2003 to 2005 period, but, nevertheless, the broad trends suggest Chinese firms losing export share and relative sophistication (i.e., unit values) over the period.

We next turn to examination of estimates connected with our year-dummy variable interactions with the set of Z_j^m variables, which are connected to our model's hypotheses. These are shown in the specifications in columns (2) and (4) of table 12.1. The coefficients on the interaction terms show the *marginal* difference in the yearly effect for the associated Z_j^m variable. To get the total annual change in the dependent variable for an HS6 product with the associated Z_j^m attribute, one must add up these marginal difference coefficients from the appropriate interaction terms with the year-dummy coefficients.

We have two proxies for ease of technology transfer in our set of Z_j^k variables: product differentiation and R&D intensity. Our estimates do not suggest that higher R&D intensity has any differential effect on the evolution of foreign export share or unit value differences from other products in our sample. However, there are significant differences between differentiated and undifferentiated products. Consistent with corollary 3b, we find strong evidence that foreign unit values have increased significantly more over our sample for differentiated goods, where technology transfer is presumed more difficult, than undifferentiated ones. The gain in the foreign firms' unit values for differentiated products has increased more than 10 percentage points over the gains shown in undifferentiated products. Thus, Chinese firms appear to be falling behind even faster for these products. However, counter to corollary 3a, we actually find that the foreign firms' share in Chinese exports actually increases less for differentiated products than for undifferentiated products. Thus, the data suggest that Chinese-owned firms maintain their market share of exports as they fall quickly in terms of sophistication (as proxied by unit values) relative to the FOEs in differentiated products.

Our set of Z_j^m variables also includes two Chinese government policies directed at FDI into various HS products: encouragement and restrictions. According to our discussion in section 12.3.5, policies encouraging FDI are expected to increase the export share of foreign firms and also make catching up by Chinese firms more likely (that is, a decline in the unit value differences). While our estimates show that the export shares of foreign firms grow significantly more over time in our sample for "encouraged" HS6 products, there are no differences for these "encouraged" sectors in terms of their changes in relative unit values. In other words, it does not lead to greater catching up by domestic-owned Chinese firms. For "restricted" sectors, we would expect lower shares of foreign firms in Chinese exports, but greater catching up. We find no statistical effect on the evolution of foreign firms' share of Chinese exports. However, we do find that unit value differences were significantly lower for these restricted sectors for a number of years in sample, especially prior to 2000. This may suggest that Chinese government

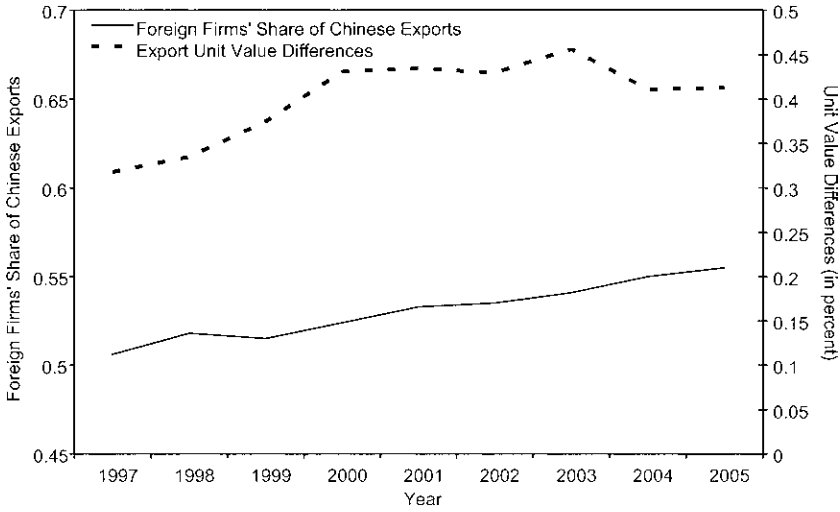

Fig. 12.5 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Sample average

restrictions on technology sharing for these sectors decreased or became less effective over time.

Figure 12.5 through 12.9 provide a visual summary of our coefficient estimates. Figure 12.5 displays the evolution of foreign firms' share of Chinese exports and the relative difference in foreign versus domestic-owned Chinese firms' export unit values based on our estimates for the general sample. Figures 12.6 through 12.9 show evolution of these same variables for products with Z_j^m attributes (e.g., differentiated products in figure 12.6). These come from our estimates in columns (2) and (4) of table 12.1.

In summary of these base results, we largely find no evidence for catching up by Chinese firms based on the evolution of unit value differences and even significant falling behind in the case of differentiated goods. There is also a general increase in foreign firms' share of Chinese exports over the 1997 to 2005 period, which is even larger in "encouraged" sectors, but actually smaller for differentiated goods.

12.5.3 Controlling for Potential Cost Differences—Provincial-Level Data

Our theoretical model assumes identical cost conditions for foreign- and domestic-owned firms in China. However, foreign and domestic firms within an HS6 product category may be in quite different locations, particularly because we know that Chinese policy (especially in earlier years) only allowed foreign investment in certain regions of China. Thus, one may wonder if our results in the preceding are driven by differences in evolving costs conditions

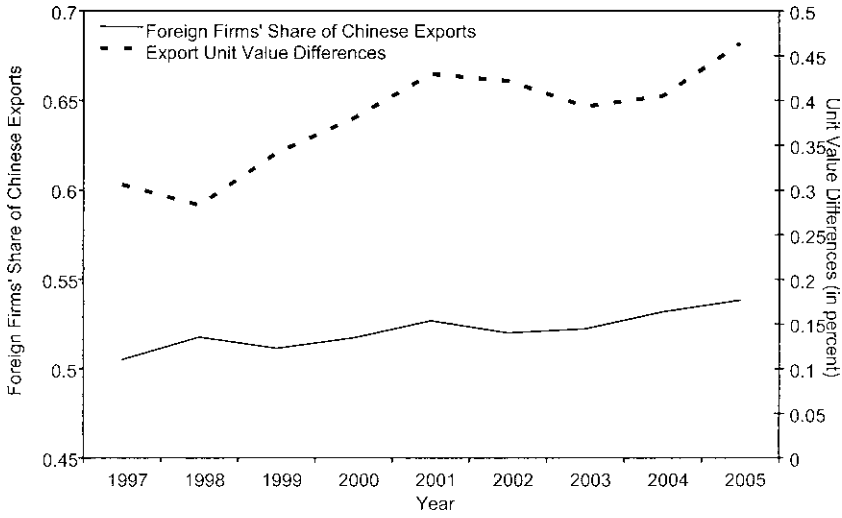

Fig. 12.6 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Differentiated Products

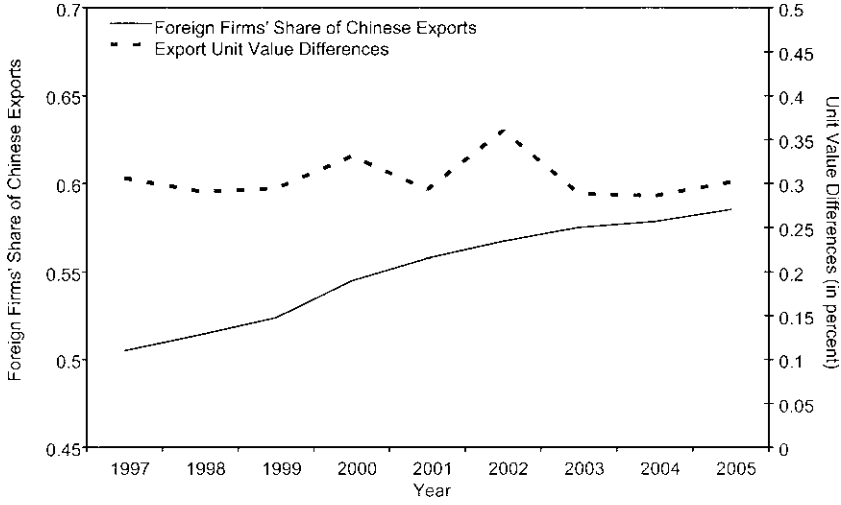

Fig. 12.7 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: High R&D products

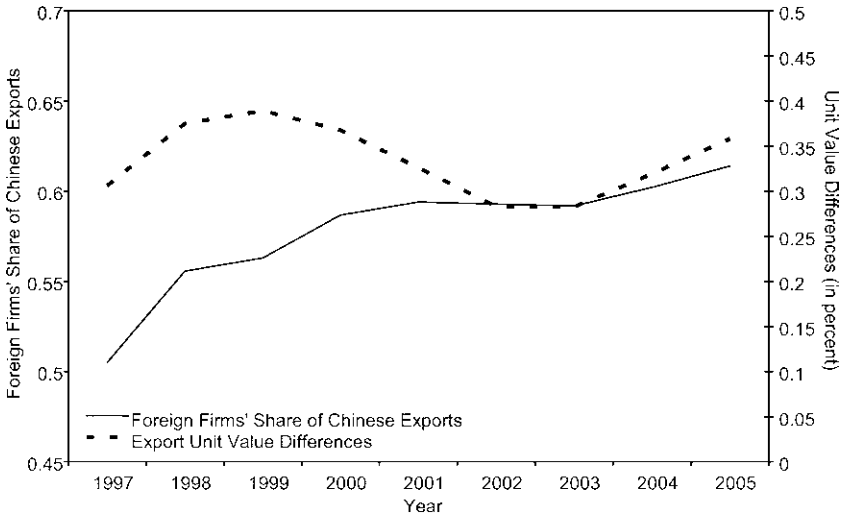

Fig. 12.8 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Encouraged products

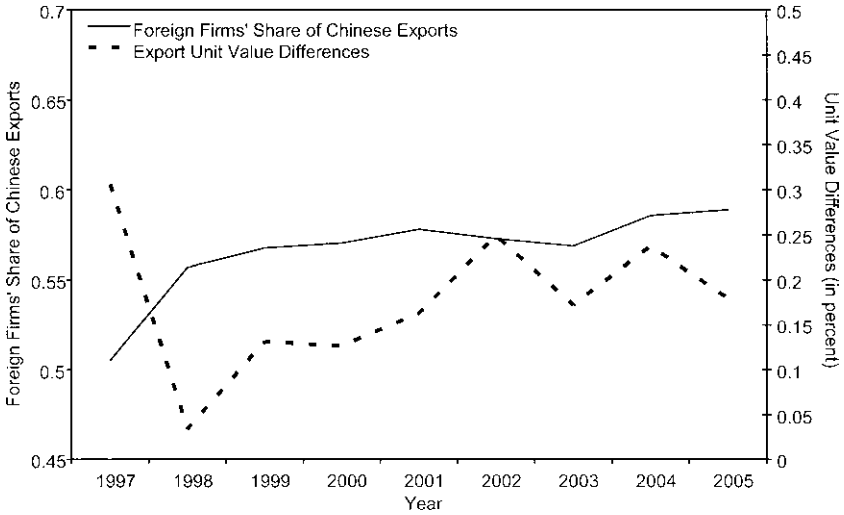

Fig. 12.9 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Restricted products

across the differing locations foreign- and domestic-owned firms in China. Controlling for such cost differences is also hopefully helpful in assigning any differences and changes in relative unit values as due to product quality or sophistication factors.

To address this, we next disaggregate our sample of observations to the level of province-product-year observations and reestimate equations (16) and (17). This increases our sample size by an order of magnitude. Our dependent variables now compare relative export shares and unit values for foreign and domestic firms within the same HS *and province.* We also include provincial fixed effects, which will control for any other unobserved time-invariant provincial fixed effects (such as relatively fixed differences in province-specific encouragement of FDI).

Table 12.2 presents our results for this province-level sample in analogous fashion to table 12.1. (Figures 12.10 through 12.14 show our the effects visually in analogous fashion to figures 12.5 through 12.9.) There is much more variance in these data, resulting in lower, but still respectable, R^2-statistics (over 0.60 in the foreign export share equations and over 0.30 in the unit value differences equations). Surprisingly, we get qualitatively identical results to our estimates in the previous section. The share of foreign firms in Chinese exports increases significantly over time, and there is no significant change in relative unit values. As before, foreign firms in "encouraged" sectors see even larger-than-average increases in export shares, while firms in differentiated product sectors see much smaller increases in export shares.

12.5.4 Ownership Structures

As discussed in section 12.3.6, we expect to find that the foreign-firm export market share and unit value difference both decrease for joint ventures relative to FIEs. To examine these hypotheses we reconstruct our dependent variables, first in terms of joint ventures relative to domestic Chinese firms, then in terms of FIEs relative to domestic Chinese firms, and then we reestimate equations (16) and (17). We estimate these models using province-level data and include province fixed effects. Our estimates indicate that the share of FIEs in Chinese exports rising quite significantly (over 10 percentage points) over our sample period, while the share of joint ventures in Chinese exports does not change over time in any statistically significant manner. This is in line with our hypotheses. With respect to unit value differences, both FIEs and joint ventures export unit values do not change over time. Thus, for both types of foreign-owned firms, there is no evidence of catching up by domestic-owned Chinese firms, even for joint ventures where we would most expect to see such effects. We don't report these results here for the sake of space, but they are available from the authors upon request.

Table 12.2 **Provincial annual changes in relative market shares and unit values of Chinese exports (1997–2005)**

	Relative market shares		Relative unit values	
	(1)	(2)	(3)	(4)
Year 1998	0.012*	0.017	0.031	0.014
	(0.007)	(0.020)	(0.021)	(0.053)
Year 1999	0.009	0.020	0.069***	–0.054
	(0.007)	(0.019)	(0.025)	(0.075)
Year 2000	0.018***	0.042**	0.101***	0.057
	(0.007)	(0.021)	(0.022)	(0.058)
Year 2001	0.027***	0.051***	0.090***	–0.023
	(0.007)	(0.019)	(0.020)	(0.051)
Year 2002	0.029***	0.057***	0.119***	–0.013
	(0.007)	(0.017)	(0.022)	(0.061)
Year 2003	0.035***	0.061***	0.157***	0.006
	(0.007)	(0.017)	(0.025)	(0.066)
Year 2004	0.044***	0.063***	0.111***	0.002
	(0.007)	(0.017)	(0.025)	(0.061)
Year 2005	0.049***	0.070***	0.150***	–0.001
	(0.006)	(0.018)	(0.026)	(0.061)
Year 1998 • Differentiated		–0.005		–0.017
		(0.019)		(0.043)
Year 1999 • Differentiated		–0.018		0.013
		(0.017)		(0.044)
Year 2000 • Differentiated		–0.034**		0.005
		(0.019)		(0.046)
Year 2001 • Differentiated		–0.035**		0.112***
		(0.018)		(0.042)
Year 2002 • Differentiated		–0.046***		0.081
		(0.016)		(0.050)
Year 2003 • Differentiated		–0.046***		0.118***
		(0.016)		(0.052)
Year 2004 • Differentiated		–0.039***		0.137***
		(0.016)		(0.051)
Year 2005 • Differentiated		–0.038**		0.201***
		(0.017)		(0.048)
Year 1998 • R&D intensity		–0.0003		0.001
		(0.0002)		(0.001)
Year 1999 • R&D intensity		–0.0002		0.003
		(0.0003)		(0.002)
Year 2000 • R&D intensity		–0.0002		0.001
		(0.0002)		(0.001)
Year 2001 • R&D intensity		–0.0002		0.001
		(0.0002)		(0.001)
Year 2002 • R&D intensity		–0.0001		0.002
		(0.0002)		(0.001)
Year 2003 • R&D intensity		0.00002		0.001
		(0.0002)		(0.001)
Year 2004 • R&D intensity		–0.00002		0.0002
		(0.0002)		(0.001)

(*continued*)

Table 12.2 (continued)

	Relative market shares		Relative unit values	
	(1)	(2)	(3)	(4)
Year 2005 • R&D intensity		–0.0001		–0.0002
		(0.0002)		(0.001)
Year 1998 • Encouraged FDI		0.040**		0.089
		(0.020)		(0.065)
Year 1999 • Encouraged FDI		0.036**		0.176***
		(0.019)		(0.071)
Year 2000 • Encouraged FDI		0.036***		0.188***
		(0.015)		(0.066)
Year 2001 • Encouraged FDI		0.033***		0.105
		(0.014)		(0.065)
Year 2002 • Encouraged FDI		0.024**		–0.006
		(0.012)		(0.051)
Year 2003 • Encouraged FDI		0.021**		0.073
		(0.012)		(0.049)
Year 2004 • Encouraged FDI		0.025***		–0.0005
		(0.011)		(0.047)
Year 2005 • Encouraged FDI		0.028***		0.042
		(0.012)		(0.048)
Year 1998 • Restricted FDI		0.027*		–0.158**
		(0.015)		(0.073)
Year 1999 • Restricted FDI		0.032**		–0.116**
		(0.015)		(0.058)
Year 2000 • Restricted FDI		0.015		–0.185***
		(0.013)		(0.063)
Year 2001 • Restricted FDI		0.007		–0.107
		(0.013)		(0.068)
Year 2002 • Restricted FDI		–0.007		–0.011
		(0.018)		(0.071)
Year 2003 • Restricted FDI		–0.012		–0.170***
		(0.020)		(0.065)
Year 2004 • Restricted FDI		–0.0001		0.008
		(0.016)		(0.077)
Year 2005 • Restricted FDI		–0.002		–0.050
		(0.018)		(0.073)
Constant	0.506***	0.316***	0.279***	0.138
	(0.006)	(0.016)	(0.017)	(0.103)
Province dummies	No	Yes	No	Yes
HS6 dummies	Yes	Yes	Yes	Yes
No. of observations	1,125,254	1,125,254	329,231	329,231
F-test	9.93	92.95	10.38	8.41
Prob > *F*	0.0000	0.0000	0.0000	0.0000
R^2	0.6060	0.6510	0.3166	0.3176
Root MSE	0.2292	0.2157	0.5628	0.5584

Notes: See table 12.1.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

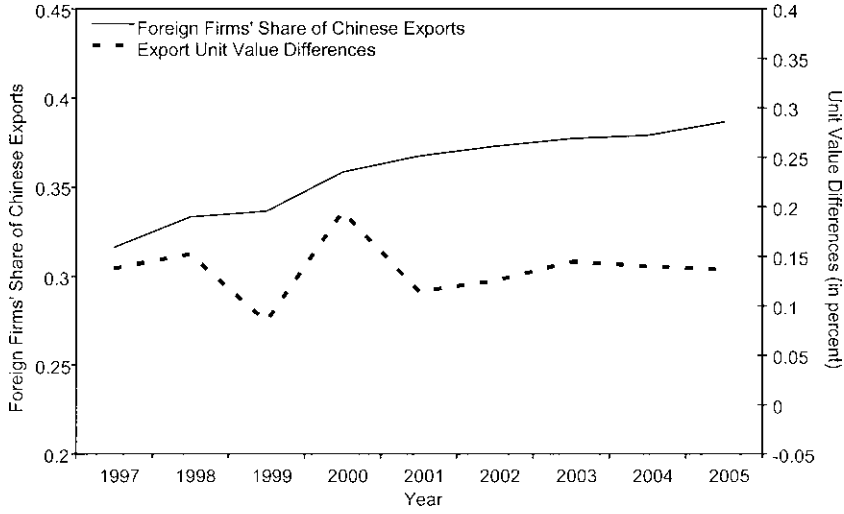

Fig. 12.10 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Sample average with provincial-level data

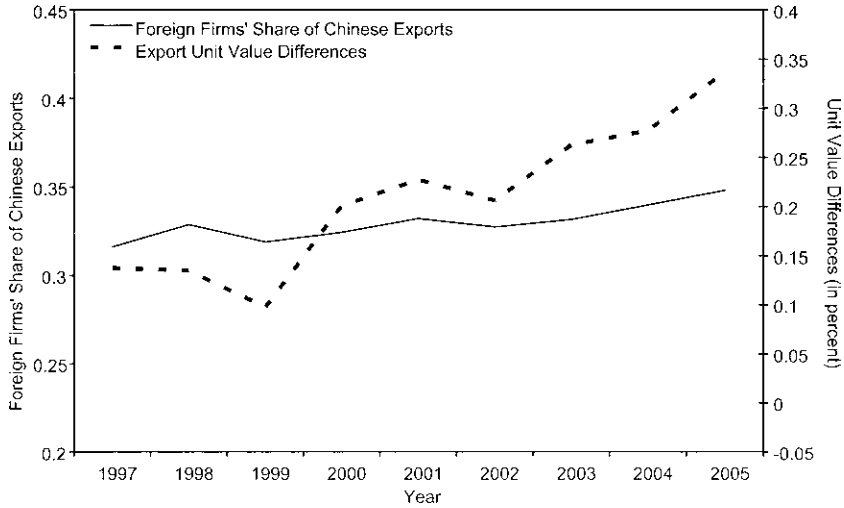

Fig. 12.11 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Differentiated products with provincial-level data

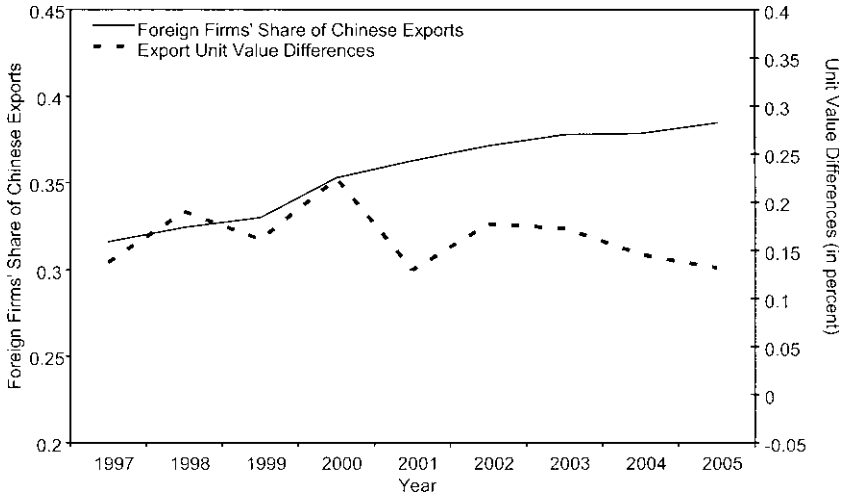

Fig. 12.12 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: High R&D products with provincial-level data

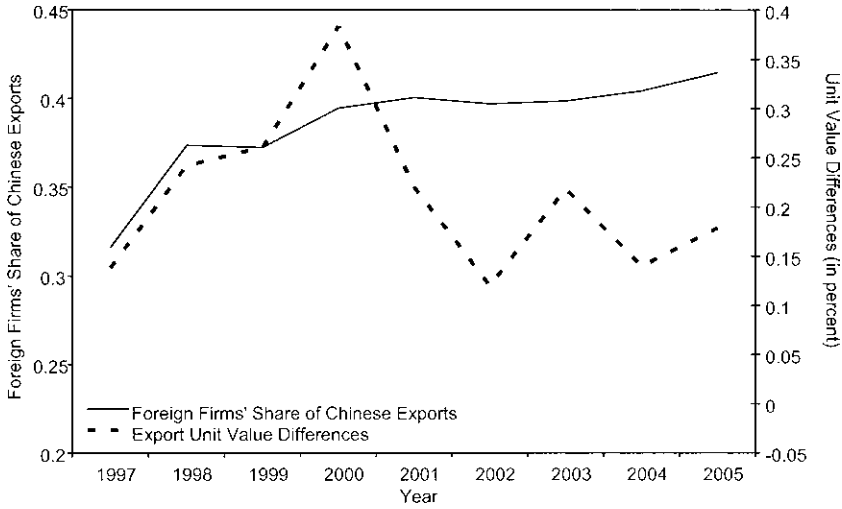

Fig. 12.13 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Encouraged products with provincial-level data

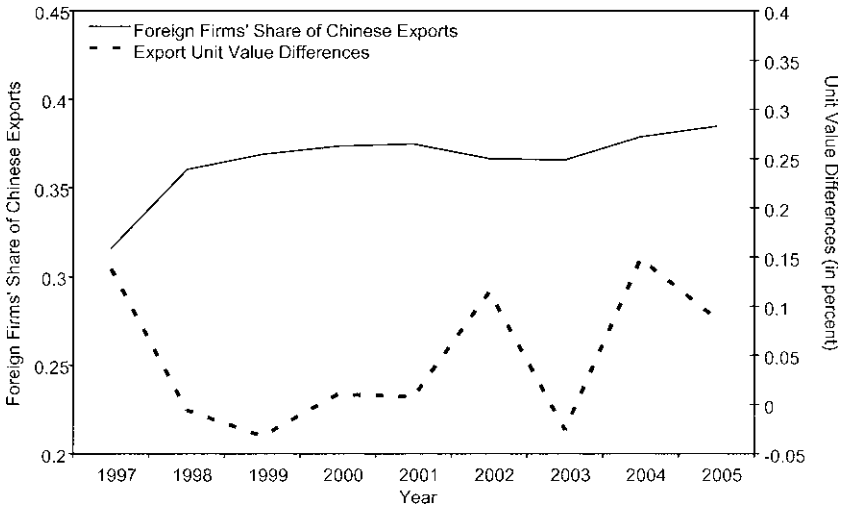

Fig. 12.14 Foreign firms' share of Chinese exports and export unit values relative to Chinese-owned firms, 1997–2005: Restricted products with provincial-level data

12.5.5 Exploring Other Subsamples

We also examined whether evolution of foreign firms' share of exports or relative export unit values varies for some notable subsamples of our data.[9] First, one may suspect that catching-up effects may differ for exports to markets that are industrialized than for developing economies. This may be particularly true in that the foreign-owned firms that export to industrialized countries from China are likely to be from these same industrialized countries, and thus more technologically advanced. However, when we sample only observations of Chinese exports to the United States, Japan, and the European Union (EU), we get qualitatively identical results as those with the full sample.

We also estimated separate results for the machinery (HS84) and electrical machinery (HS85) sectors because these two sectors are easily the top two in terms of Chinese exports—see figure 12.2. Both the electrical and machinery sectors yield qualitatively similar results to our full sample, with a couple of notable exceptions. First, in the machinery results, restricted sectors show foreign firms gaining significantly more than export share over our sample than other HS6 products in the machinery sector and also show some relatively small catching up effects for differentiated machinery products. In contrast, there are fairly large "falling behind" effects for Chinese firms in the electrical machinery sectors. These results highlight the potential for

9. Results in this section are also not reported for sake of brevity but are available from authors upon request.

exploring sectoral heterogeneity in future analyses, though we caution that smaller sample sizes certainly lower precision of estimates.

12.5.6 Is Increasing FDI Masking "Catch-Up" Effects?

As discussed earlier, a potential concern with our estimates is the possibility of increasing FDI activity over time. Obviously an increase of FDI into China of export-oriented foreign firms could 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. As discussed, the aggregate trends shown in figure 12.4 argue against this scenario of faster growing foreign firm formation or entry. However, in this section, we explore this issue in one final manner. While we do not have data on FDI by industries into China over time (much less at the HS6 product level), we can use prior foreign market share in an HS6 product as a proxy for previous FDI. Thus, we estimate the following specification:

$$(18) \quad \ln UV_{jt}^{F} - \ln UV_{jt}^{CH} = \alpha + \theta_1 FS_{jt} + \theta_2 \text{Lag}FS_{jt} + \psi_j + \nu_t + \varepsilon_{jt},$$

where FS_{jt} and $\text{Lag}FS_{jt}$ are terms that control for current and previous (lagged) foreign firms' export share in a HS6 product, while ψ_j and ν_t control for HS6 product fixed effects and year fixed effects, respectively.[10] There are a number of ways in which we could specify the lagged foreign firm export share term, but we chose to construct it as a moving average of the previous three years of the foreign market share (FS_{jt}) in a given HS6 product j.[11] Our focus will be on the coefficient estimates for FS_{jt} and $\text{Lag}FS_{jt}$ in this analysis, not those for the year dummies. If foreign firms are continuously bringing into China production of evermore-sophisticated products, we would expect a positive coefficient on current foreign firm export share (FS_{jt}), but if there is catching up by domestic Chinese firms due to technology transfer from foreign firms, then we would expect a negative coefficient on prior foreign-firm export share ($\text{Lag}FS_{jt}$).

Column (1) of table 12.3 provides our results from estimating equation (18). There is a significant and large coefficient on current FDI export share, suggesting that new FDI brings in more-sophisticated products for production and export from China. There is also a statistically insignificant coefficient on lagged FDI export share, which is consistent with our other findings that the Chinese firms are not gaining technology from foreign firms and then catching up over time, on average.

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.

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

Table 12.3 **Changes in relative unit values of Chinese exports with lagged foreign market share (2000–2005)**

	Benchmark		Foreign-invested enterprises		Joint ventures	
	(1)	(2)	(3)	(4)	(5)	(6)
FS	0.403***	0.036	0.129***	0.141	0.029	–0.100**
	(0.024)	(0.075)	(0.045)	(0.088)	(0.045)	(0.052)
LagFS	–0.060	–0.178	–0.024	–0.112	–0.130**	–0.019
	(0.046)	(0.113)	(0.059)	(0.150)	(0.059)	(0.134)
FS • Differentiated		0.375***		0.260***		0.060
		(0.050)		(0.077)		(0.052)
LagFS • Differentiated		0.074		0.166		0.059
		(0.107)		(0.151)		(0.143)
FS • R&D intensity		0.002		–0.004***		0.003**
		(0.002)		(0.001)		(0.001)
LagFS • R&D intensity		–0.0001		0.0002		–0.004***
		(0.001)		(0.001)		(0.002)
FS • Encouraged		0.069		0.104		–0.143**
		(0.056)		(0.067)		(0.067)
LagFS • Encouraged		0.190**		–0.166		0.172
		(0.096)		(0.115)		(0.122)
FS • Restricted		–0.312***		–0.532***		–0.230***
		(0.072)		(0.107)		(0.080)
LagFS • Restricted		–0.025		0.011		0.059
		(0.087)		(0.120)		(0.162)
Constant	0.404***	0.314***	0.504***	–0.552	0.193	0.206*
	(0.082)	(0.105)	(0.097)	(0.108)	(0.118)	(0.118)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
HS6 dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	198,414	198,414	198,422	198,422	226,466	226,466
F-test	16.29	17.39	7.80	9.16	10.26	9.80
Prob > *F*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.3682	0.3743	0.3544	0.3640	0.4077	0.4113
Root MSE	0.4807	0.4784	0.4859	0.4823	0.5330	0.5314

Notes: Weighted by value of total exports in a 6-digit Harmonized System (HS6) sector. Robust standard errors in parentheses. Winsorize bottom 5 percent and top 5 percent of sample. Lags created using a three-year moving average.

MSE = mean square error; FS = foreign enterprises' share of Chinese exports.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

In column (2) of table 12.3, we interact our variables proxying for costly technology transfer (product differentiation and R&D intensity) and Chinese government policies (encourage and restrict) with our current and lagged foreign export share variables. These results show a couple effects of note. First, the introduction of increasingly sophisticated products is primarily coming in the differentiated product sectors, as seen by the large positive coefficient on current foreign export share interacted with a differentiated

product dummy. On the other hand, the restricted sector shows a large negative coefficient on current foreign export share, suggesting that the restrictions are leading to introduction of much-less-sophisticated products in these sectors. The effects of lagged foreign export share continue to be statistically insignificant, indicating no evidence of catching up by Chinese firms.

Finally, columns (3) through (6) in table 12.3 show results when we run the same specifications defining foreign firms first as only wholly-owned FIEs, and then as only joint ventures. While again, there is no evidence of catching up for the FIEs, we estimate a 13 percent catch up in relative unit values for Chinese firms from the previous three years of foreign joint venture firm export activity. This is consistent with our hypotheses that technology transfer to Chinese firms is more likely when partnering with a foreign firm in a joint venture than from wholly-owned FIEs in their own sector.

12.6 Conclusion

Facilitating technology transfer to allow 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 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 may gain sophistication relative to foreign firms present in China (i.e., catching up) by first building a model of market competition between foreign and domestic firms where products are vertically differentiated, but Chinese firms can close the quality gap in products through technology transfer. We term this effect "catching up" by the Chinese firms. We then estimate the catching up by Chinese firms (and related hypotheses) using detailed Chinese export data that separately reports exports from foreign and Chinese firms. The general patterns over our time period, 1997 to 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. These results are quite robust to a number of specifications and varying samples of our data, though a final specification examining how previous foreign market share affects current unit value gaps finds only modest catching up for Chinese domestic firms from joint venture activity.

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 $U(K_{CH})$, and x_{Tech} denote $U(K_{\text{Tech}})$, recalling that $K_{\text{Tech}} = (1 - \lambda)K_{CH} + \lambda K_F$.

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:

$$D_F^{2T} = \frac{2(x - x_{\text{Tech}})}{(4x - 3U_0 - x_{\text{Tech}})}, \tag{A1}$$

$$D_{CH}^{2T} = \frac{(x - U_0)}{(4x - 3U_0 - x_{\text{Tech}})}. \tag{A2}$$

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

$$\Theta^{2T} \equiv \frac{D_F^{2T}}{D_{CH}^{2T}} = \frac{2(x - x_{\text{Tech}})}{(x - U_0)} \tag{A3}$$

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

$$\frac{\partial \Theta^{2T}}{\partial \lambda} = \frac{\partial \Theta^{2T}}{\partial x_{\text{Tech}}} \frac{\partial x_{\text{Tech}}}{\partial \lambda} = -2(x - U_0) < 0 \tag{A4}$$

QED

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:

$$p_F^{2T} = \frac{[2(x - U_0)(x - x_{\text{Tech}})]}{[x(4x - 3U_0 - x_{\text{Tech}})]}, \tag{A5}$$

$$p_{CH}^{2T} = \frac{[(x_{\text{Tech}} - U_0)(x - x_{\text{Tech}})]}{[x_{\text{Tech}}(4x - 3U_0 - x_{\text{Tech}})]}. \tag{A6}$$

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

$$\Omega^{2T} = \frac{p_F^{2T}}{p_{CH}^{2T}} = \frac{[2x_{\text{Tech}}(x - U_0)]}{[x(x_{\text{Tech}} - U_0)]} \tag{A7}$$

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

(A8)
$$\frac{\partial \Omega^{2T}}{\partial \lambda} = \frac{\partial \Omega^{2T}}{\partial x_{\text{Tech}}} \frac{\partial x_{\text{Tech}}}{\partial \lambda} = \left[\frac{2(x - U_0)}{x(x_{\text{Tech}} - U_0)}\right]\left[1 - \frac{x_{\text{Tech}}}{(x_{\text{Tech}} - U_0)}\right](K_F - K_{CH})$$

Given the parameter values and assumed relationships presented in the text, this is easily signed as negative. QED

PROOF OF PROPOSITION 2. We assume that optimal second-period prices and demands are known functions of parameters for the Chinese firm when choosing the optimal λ. Then, provided second-order sufficient conditions hold for profit maximization in equation (10), we can write and sign the relevant comparative static as follows:

(A9)
$$\frac{\partial \lambda^*}{\partial \theta} = \frac{-(\partial \Pi^{2T}_{CH} / \partial \lambda \partial \theta)}{\partial \Pi^{2T}_{CH} / \partial \lambda \partial \lambda} = \frac{2\lambda}{\partial \Pi^{2T}_{CH} / \partial \lambda \partial \lambda} < 0.$$

QED

PROOF OF COROLLARIES 3a AND 3b. Using notation for relative price and unit values in the preceding, we can derive the following expressions:

(A10)
$$\frac{\partial \Theta^{2T}}{\partial \lambda} = \frac{\partial \Theta^{2T}}{\partial \lambda} \frac{\partial \lambda}{\partial \theta} \text{ and } \frac{\partial \Omega^{2T}}{\partial \lambda} = \frac{\partial \Omega^{2T}}{\partial \lambda} \frac{\partial \lambda}{\partial \theta}.$$

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

PROOF OF PROPOSITION 4. Π^{1N}_F and Π^{2N}_F are decreasing in c, while c is a nonvarying parameter in Π^{1L}_F and Π^{2T}_F. Thus, by the envelope theorem, an increase in c (i.e., greater cost savings when the firm locates in China) lowers the right-hand side of equation (9) in the text and makes FDI more likely. Likewise, the technology cost variable, θ, is only an argument in Π^{2T}_F on the left-hand side of equation (9). By the envelope theorem, Π^{2T}_F is increasing in θ, thus making FDI more likely. QED

References

Brambilla, Irene. Forthcoming. Multinationals, technology, and the introduction of new goods. NBER Working Paper no. 12217. *Journal of International Economics.*

Branstetter, Lee G., and Robert C. Feenstra. 2002. Trade and foreign direct investment in China: A political economy approach. *Journal of International Economics* 58 (2): 335–58.

Chen, Huiya, and Deborah L. Swenson. 2006. Multinational firms and new Chinese export transactions. University of California, Davis. Mimeograph.

Feenstra, Robert C., Wen Hai, Wing T. Woo, and Shunli Yao. 1998. The U.S.-China bilateral trade balance: Its size and determinants. NBER Working Paper no. 6598. Cambridge, MA: National Bureau of Economic Research.
Feenstra, Robert C., and Gordon H. Hanson. 2004. Intermediaries in entrepot trade: Hong Kong re-exports of Chinese goods. *Journal of Economics and Management Strategy* 13 (1, special issue): 3–35.
———. 2005. Ownership and control in outsourcing to China: Estimating the property-rights theory of the firm. *Quarterly Journal of Economics* 120 (2): 729–61.
Feenstra, Robert C., Gordon H. Hanson, and Songhua Lin. 2004. The value of information in international trade: Gains to outsourcing through Hong Kong. *Advances in Economic Analysis and Policy* 4 (1): 1–35.
Feenstra, Robert C., and Barbara J. Spencer. 2005. Contractual versus generic outsourcing: The role of proximity. NBER Working Paper no. 11885. Cambridge, MA: National Bureau of Economic Research.
Graham, Edward M. 2004. Do export processing zones attract FDI and its benefits? The experience from China. *International Economics and Economic Policy* 1 (1): 87–103.
Hale, Galina, and Cheryl Long. Forthcoming. What determines technological spillovers of foreign direct investment: Evidence from China. *Pacific Economic Review.*
Hausmann, Ricardo, Jason Hwang, and Dani Rodrik. 2007. What you export matters. *Journal of Economic Growth* 12 (1): 1–25.
Li, Feng, and Jing Li. 1999. *Foreign investment in China.* New York: St. Martin's.
Park, Albert, Dean Yang, Xinsheng Shi, and Yaun Jiang. Forthcoming. Exporting and firm performance: Chinese exporters and the Asian financial crisis. *Review of Economics and Statistics.*
Rauch, James E. 1999. Networks versus markets in international trade. *Journal of International Economics* 48 (1): 7–35.
Rodrik, Dani. 2006. What's so special about China's exports? NBER Working Paper no. 11947. Cambridge, MA: National Bureau of Economic Research.
Rosen, Daniel H. 1999. *Behind the open door: Foreign firms in the Chinese marketplace.* Washington, DC: Institute for International Economics.
Schott, Peter K. Forthcoming. The relative sophistication of Chinese exports. NBER Working Paper no. 12173. *Economic Policy.*
Whalley, John, and Xian Xin. 2006. China's FDI and non-FDI economies and the sustainability of future high Chinese growth. NBER Working Paper no. 12249. Cambridge, MA: National Bureau of Economic Research.

Comment Raymond Robertson

Like many developing countries in the 1990s, China pursued export-led market liberalization with the intention of fostering development. China seems to stand out in several important dimensions, including the share of exports in manufacturing and the kinds of products that China exports. Several papers have documented that China's exports are more on the "high end" of

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