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Reverse Imports, Foreign Direct Investment and Exchange Rates

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Abstract

This paper investigates linkages among "reverse imports", foreign direct investment, and exchange rates. As an example we have in mind the competition in the Japanese market of a Japanese multinational firm and a Chinese domestic firm. Products are differentiated based on Japanese consumers' brand name recognition. The model shows that yen appreciation leads to an increase in Japanese production in China and "reverse imports", and a decrease in Japanese domestic production. Due to the barriers in brand name, the exports of the Chinese firm could fall, because the increase of reverse imports may erode the market share of the Chinese firm, even though total exports from China increase. Further, we find that yen appreciation may improve the profits of the Japanese firm and welfare in Japan under reverse imports, against conventional wisdom. The predictions of the model fit well with the actual numbers, and shed light on the current debate on the Chinese currency.

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Keywords: Reverse Imports, FDI, Exchange Rate, Brand Name, China

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1. Introduction

China's exports have experienced two-digit growth rates in the past decade. "Made in China" is available in almost every corner of the global market. Many point to the relatively low labor cost as the `secret of success'. While we do not wish to down play the importance of labor costs, we note that labor in China was even cheaper ten years ago compared with that of today. Why was "Made in China" not popular then?

A quick reality check reveals that the devaluation of the Chinese yuan since the late 1980s played an important role in fostering China's export growth in the last two decades, especially through the indirect effect-- the influx of export oriented foreign direct investment (FDI). In fact, this indirect effect has been far more important in increasing exports than the direct effect, which is on the exports of Chinese domestic firms. For instance, from 1992 to 2005, China's exports more than tripled from $US84.94 billion to $US762.00 billion (China Statistics Yearbook, various years). But such dramatic increase is mainly the contribution of foreign multinationals, i.e., the subsidiaries of global multinational enterprises (MNEs) in China, because the exports of foreign invested firms surged from $US1.74 billion to $US 444.20 billion over the same period. China has become the largest destination country for FDI in the developing world. Multinationals flock to China for its cheap labor, land and other inputs (which Krugman (1998) calls "fire-sale FDI"), to conduct export-processing operations. These have caused cries of "deindustrialization" and "hollowing out" in the home countries of the MNEs.[1]

The present paper sets out to investigate the linkages among "reverse imports", FDI and exchange rates. We especially have in mind Japanese subsidiaries producing in China and then importing back to Japan for consumption, i.e., the so-called "reverse imports".[2] One Chinese and one Japanese firm compete in the Japanese market. The Japanese firm can also produce in China. Products are differentiated due to brand name recognition. We find that exchange rate changes, wage differentials, and barriers in brand name recognition contribute to increases in Japanese outward FDI and reverse imports.

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[1] For example, some U.S. lobby groups allege that the Chinese currency had made lots of American workers jobless. The U.S. Senate even voted on April 6, 2005 to increase tariffs on Chinese imports to 27.5% if China does not revaluate the yuan within 6 months. Former Japanese Finance Minister M. Shiokawa repeatedly accused China of "exporting deflation" to Japan.

[2] While we use China and Japan as examples, the model and its predictions also apply to other countries in similar situations of close economic ties, such as the US and Mexico, Japan and Korea, the US and China, etc.

Specifically, the appreciation of the yen leads to an increase in Japanese FDI in China and "reverse imports", and a decrease in Japanese domestic production. Due to the barriers in brand name, the exports of the Chinese firm could fall, because the increase of reverse imports may erode the market share of the Chinese firm, even though total exports from China increase. In addition, yen appreciation may improve the profits of the Japanese firm and welfare in Japan under reverse imports, which is contrary to conventional wisdom. This implies that outsourcing has made the Chinese economy and those of the MNEs' home countries interdependent, as is recently recognized by not only business groups but also the Japanese government and the media that a major contribution for the Japanese GDP growth in 2003 and 2004 was "the China factor."

It is counter intuitive that the yuan's depreciation may erode the Chinese firm's market share. This arises under the possibility of reverse imports: Yen appreciation helps the Japanese firm to gain an edge on the Chinese firm in acquiring cheaper Chinese inputs, leading to more Japanese FDI and reverse imports. The relatively low cost of reverse imports together with high consumer recognition enhances the competitiveness of the Japanese MNE in the Japanese domestic market. If the substitutability between the products of the Chinese firm and the Japanese affiliates in China are high, then these increased reverse imports will replace goods made by the Chinese firm.

The model sheds light on the current China debate, because the predictions of the model fit well with the actual figures of China. The sudden popularity of "Made in China" can be ascribed to China's devaluation in the early 1990s, in addition to other factors. The devaluation reduced the input cost and improved the relative wealth of foreign investors, leading to more FDI inflows and eventually higher reverse imports to other countries. In 2001, more than 50% of China's exports are produced by foreign firms. In other words, it is the influx of export-oriented FDI, which contributed to China's export boom.

There are numerous studies on China's FDI boom, for instance, Lardy (1995), Henly et al (1999), Cheng and Kwan (2000) and Zhang (2001) identify potential market size, low labor cost, preferential policies (e.g., tax credits), openness, geographic proximity, good infrastructure and political stability as primary factors attracting FDI inflows to China; Branstetter and Feenstra (2002) show that FDI inflows

reflect political openness and state ownership in China; Feenstra and Hanson (2003) examine the organization of export processing operations of foreign MNEs in China and test the property rights model. However, they abstract from analyzing the role of exchange rate fluctuations. In a recent paper, Greaney (2003) generates reverse imports in a model of trade and FDI networks. Ekholm, Forslid and Markusen (2003) and Yeaple (2003) analyze the MNE's location choices in three-country models, but focusing on trade and transportation costs and production technology. In the present paper, we focus on the effects of exchange rate movements, based on the Sino-Japanese trade and FDI.

Essentially, there are two channels through which currency devaluation impacts FDI inflows: a wealth effect and a relative production cost effect, both benefiting the foreign investor and leading to more FDI inflow. Theoretical models in this strand include Kohlhagen (1977), Cushman (1985, 1988), and Froot and Stein (1991), and a few empirical studies provide evidence supporting the theoretical arguments, see for instance, Klein and Rosengren (1994), Goldberg and Kolstad (1995) and Kiyota and Urata (2004). Blonigen (1997) argues that Japanese FDI into the U.S. during 1985-1990 were motivated by the desire to acquire the knowledge assets of U.S. firms, in addition to the low value of the U.S. dollar (see also Feenstra, 1999, for an excellent survey). As a complement to this literature, the present paper shows that reverse imports are another means through which exchange rate fluctuations can affect FDI flows.

In addition, Zhao and Xing (2006) model the production allocation choices of a multinational enterprise in a three-country framework -- a northern country and two southern countries. The paper finds that a currency appreciation in the southern country (X) producing the lowest-quality good with the lowest cost may reduce production (employment) in the north, while an appreciation in the other southern currency (Y) always raises production in the north. A northern depreciation against both southern currencies may increase production in country X, but always reduces that in country Y. While Zhao and Xing (2006) mainly analyze production shifting and competition between two southern countries, in the present paper we focus on whether exchange rate changes can benefit both a northern and a southern country under reverse imports.

The rest of the paper is organized as follows. Section 2 presents some stylized facts on reverse imports, exchange rates, and Japanese FDI in China; section 3 sets up the basic model, section 4 derives the equilibrium and its properties, section 5 looks into the conditions for FDI and reverse imports to arise, section 6 investigates the impacts of exchange rate changes on profits and welfare, and section 7 provides concluding remarks.

2. Some Stylized Facts on FDI, Exchange Rates and Exports in China

Fact #1: The contribution of foreign invested firms to China's exports

In 2005, the exports of foreign invested firms in China amounted to $444.2 billion, about 58.3 percent of China's total exports (China Statistic Bureau, 2006). Figure 1 compares the export performance of domestic firms with that of foreign invested firms, for the period of 1994 to 2005. The former averaged about 12.6 percent annually, while the latter showed much higher and more consistent growth during the period at 26.1 percent. The empirical evidence indicates that the exceptional growth of China's exports largely relies on the robust growth of foreign invested firms. **<<Figure 1 here>>**

Fact #2: The correlation between Japanese FDI and the real exchange rate

Figure 2 outlines the trends of Japanese FDI in China and the real exchange rate index between the yen and the yuan from 1980 to 2001. A higher index implies a real appreciation of Japanese yen. It is obvious that there exists a significant positive correlation between the yen's exchange rate and Japanese FDI in China. In particular, when the depreciation of yen started in late 1995, it was followed by a sharp drop of FDI inflow from 1996 to 1998. As yen appreciated in 1998, Japanese FDI started to climb again. **<<Figure 2 here>>**

Fact #3: High shares of reverse imports--Japanese outsourcing in China

Figure 3 presents the quarterly trends of reverse imports as the percentage of the total sales of Japanese affiliates in China, in selected manufacturing sectors: industrial machinery, electrical machinery, precision machinery, and transportation equipment. These are the sectors that Japanese industrial competitiveness holds strong globally. Since the last quarter of 1996, the share of reverse imports in

electrical machinery has been more than 20 percent. Corresponding shares in the other three sectors are much higher, and have experienced significant increases. **<<Figure 3 here>>**

3. Basic Model Setup

3.1 Consumer Demand

With the above stylized facts in mind, we consider two firms competing in the Japanese market à la Cournot. A typical Japanese consumer consumes a numeraire good *m*, and three differentiated goods: *x*, *y*, and *z*. Good *x* is made by a Chinese firm and sold under the Chinese brand, good *y* is made by a Japanese firm in China and sold under Japanese brands, and good *z* is also made by the Japanese firm, but in Japan. All goods are sold in Japan only. Thus, China's total exports to Japan is $x+y$.

The products made in Japan have the highest recognition in both brand name and quality. In contrast, the goods made by the Chinese firm and sold under its brand name have low acceptance by Japanese consumers, due to problems of brand recognition. They are usually considered as low quality goods as well, compared with those made in Japan or by the Japanese firm in China. In addition, the goods made by the Japanese firm in China and sold under Japanese brand names enjoy much better recognition. However, since they are made in China, Japanese consumers still consider them as lower quality compared with those made in Japan.

Before going on to the consumer's maximization problem, let us provide some justification for our model of horizontally rather than vertically related firms. We are interested in how Chinese exports (final goods) compete in the world market (Japan as a stylized example). In 2003, 60% of the outputs of Japanese affiliated manufacturers in China were finished products.[3] OEM (Original Equipment Manufacturing, i.e., manufacturing in China under foreign brand names) has become the major form (accounting for more than 85 percent of the total) of China's TV exports, especially in the markets of Japan, USA, and EU. Between

[3] *Source: The Business Condition of Japanese Affiliated Manufacturers in Asia: China, Hong Kong, Taiwan, and Korean*, JETRO 2004. Also from Nikkei Weekly, various issues: Fast Retailing Co., which markets UNIQLO casual wear in Japan, exclusively produces in China; Pioneer Co. produces more than 90% of its DVD recording devices in Guangdong province (China), mainly for exports; Hitachi Household Appliance Co. exports 60% of air conditioners made in Anhui province back to Japan; Fuji Zerox Co. will start to produce digital copy machines in Shanghai for exporting to Japan, US and EU markets.

January and June, 2005, China's OEM Color TV exports increased by 43% over the same period a year ago, while the TV exports of Chinese brands decreased by 30.3%.[4]

Thus, it seems that Japanese affiliates in China produce and export mainly final goods. In the present model, we abstract from modeling China's imports of intermediate goods, but are interested in how Chinese made final goods compete with products made in other countries. A horizontally related structure seems to be an appropriate choice, and is relevant to the current debate on whether the Chinese exchange rate enhances the competitiveness of Chinese firms against foreign competitors.[5]

Given the above, the typical Japanese consumer can be assumed to maximize the following utility function: [6]

$$V(m,x,y,z) = m + U(x,y,z), \tag{1a}$$

where $$U(x,y,z) = ax + by + cz - (x^2 + y^2 + z^2)/2 - (\gamma_1 xz + \gamma_2 xy + \gamma_3 yz). \tag{1b}$$

In (1b), we assume that $a,\ b,\ c > 0$ and

$$0<\gamma_1<\gamma_2<1, \quad \text{and} \quad 0<\gamma_1<\gamma_3<1, \tag{2}$$

which hopefully capture the preferences of the northern consumers roughly. The parameter γ_1 indicates the substitutability between goods *x* and *z*; γ_2 does the same between goods *x* and *y*; and γ_3 between goods *y* and *z*. Assumption (2) implies: (i) the three goods are imperfect substitutes; (ii) goods *x* and *z* are more differentiated than any other pair of goods. If $\gamma_i = 0$, there is zero substitutability; and if $\gamma_i = 1$, there is perfect substitutability. We exclude these two special cases in the present model.

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[4] Source: Chamber of Commerce (China) for Imports and Export of Machinery and Electronic Products, http://tv.ea3w.com/2005/0906/19883.shtml.

[5] See also Lawrence J. Lau's testimony in the US congress, Sept. 24, 2003.

[6] This function is often used in models of product differentiation. Classics include, for instance, Dixit (1979). It is strictly concave in the arguments, and generates tractable linear demand functions. More importantly, it clearly displays product differentiation with the parameters $\gamma_1, \gamma_2, \gamma_3$ indicating the different degrees of substitution.

Maximization of the consumer's utility in (1a) subject to the standard budget constraint yields the inverse demand functions for goods *x*, *y*, and *z* in units of good *m*.

$$p_x = a - x - (\gamma_2 y + \gamma_1 z), \tag{3a}$$

$$p_y = b - y - (\gamma_2 x + \gamma_3 z), \tag{3b}$$

$$p_z = c - z - (\gamma_1 x + \gamma_3 y). \tag{3c}$$

3.2 Production

On the production side, we assume that both capital and labor are used as inputs.[7] For simplicity, we normalize such that one unit of output requires one unit of *each* input for all firms. The reason for this assumption is that we want to focus on market segmentation based on brand recognition, i.e., products separated by consumer preferences, ignoring possible explicit differences in production technology.

Let the total cost of hiring one unit of capital *and* one unit of labor in China and Japan be $w_i, \quad i = C, J$. Then the profit function of the Chinese firm can be written as

$$\pi_C = (p_x - e w_C) x, \tag{4}$$

where *e* denotes the exchange rate, i.e., the price of the yuan in terms of the yen. The exchange rate enters because the firm's cost is paid in the Chinese currency, and profits are expressed in the Japanese yen because all products are sold in Japan.

The profit function of the Japanese firm consists of two parts: the sum of those from Japan as well as from China.

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[7] Also see the literature on the new FDI theory (e.g., Markusen, 1984; Helpman, 1985; Ethier, 1986, Glass and Saggi, 1999), in which FDI does not need to involve physical capital movement abroad.

$$\pi_J = \{p_z - w_J\}z + (p_y - ew_C)y. \quad (5)$$

Fixed cost and transportation cost are assumed to be zero.[8] For analysis stressing fixed costs and transportation costs of FDI, see e.g., Dei (1990) and Markusen and Venables (1998).

4. The Equilibrium and Its Properties

4.1 The Equilibrium

The two firms compete in the Cournot fashion. The equilibrium is determined by choosing outputs to maximize profits. For the Chinese firm, substituting (3a) into (4) and maximizing it with respect to *x* yields the following first order condition (FOC):

$$a - 2x - (\gamma_2 y + \gamma_1 z) - ew_C = 0. \quad (6a)$$

Simultaneously, the Japanese firm chooses *y* and *z* to maximize (5). The FOCs are

$$b - 2y - (\gamma_2 x + 2\gamma_3 z) - ew_C = 0, \quad (6b)$$

$$c - 2z - (\gamma_1 x + 2\gamma_3 y) - w_J = 0. \quad (6c)$$

We assume that all necessary conditions for an interior solution are satisfied. For any given (e, w_C, w_J, γ_i), $i = 1, 2, 3$, conditions (6a), (6b), and (6c) jointly determine a unique solution (x, y, z), which is a Nash equilibrium.[9]

4.2. Comparative Statics Analysis

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[8] Incorporating transportation or fixed cost for imports changes the levels of profits and welfare, but not the qualitative results of the model.

[9] Closed form solutions of the endogenous variables can be obtained, but in messy algebraic forms.

Total differentiation of conditions (6a-6c) yields the following matrix.

$$-\begin{pmatrix} 2 & \gamma_2 & \gamma_1 \\ \gamma_2 & 2 & 2\gamma_3 \\ \gamma_1 & 2\gamma_3 & 2 \end{pmatrix} \begin{pmatrix} dx \\ dy \\ dz \end{pmatrix} = w_C \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix} de \qquad (7)$$

The determinant of the Hessian matrix is $\Delta = 2(\gamma_1^2 + \gamma_2^2 + 4\gamma_3^2) - 4\gamma_1\gamma_2\gamma_3 - 8 < 0$, given assumption (2). From (7), some interesting comparative statics results can be derived.

$$\frac{dy}{de} = [2\gamma_1\gamma_3 + 4 - (\gamma_1^2 + 2\gamma_2)]w_C / \Delta < 0\,, \qquad (8a)$$

$$\frac{dz}{de} = -(2 - \gamma_2)(\gamma_1 + 2\gamma_3)w_C / \Delta > 0\,, \qquad (8b)$$

$$\frac{dx}{de} = 2[2(1 - \gamma_3^2) + (\gamma_1\gamma_3 - \gamma_2)]w_C / \Delta\,. \qquad (8c)$$

Conditions (8a) and (8b) state that an appreciation of the yen leads to an increase in Japanese overseas production and reverse imports, and a decrease of output in Japan. These may seem obvious by casual observation. The importance is that these arise from the existence of "reverse imports", i.e., the increased Japanese production in China which is eventually imported back to Japan for consumption. Our results complement the recent literature such as Klein and Rosengren (1994), Goldberg and Kolstad (1995), and Blonigen (1997), who also show that yen appreciation increases Japanese FDI but not based on reverse imports.

Through FDI, the Japanese firm can take advantage of yen appreciation by buying Chinese inputs more cheaply, enabling it to gain an edge over the Chinese firm (which buys Chinese inputs with the Chinese currency). Note that in the absence of reverse imports, products are sold in China and profits are

repatriated back to Japan in yen. Then yen appreciation does not benefit the Japanese firm after profits are repatriated, and hence exchange rate movements do not affect FDI flows, as in the classic literature.

The sign of dx/de in (8c) is ambiguous, suggesting that the appreciation of Japanese yen does not necessarily benefit the Chinese firm. On the contrary, it is possible that the Chinese firm's exports to Japan will decrease rather than increase. The specific condition for this to arise is:

Proposition 1: *An appreciation of the yen leads to a decrease in the exports of the Chinese firm if* $(\gamma_2 - \gamma_1\gamma_3)/2 > 1-\gamma_3^2$.

Some intuition for proposition 1 follows. The conventional wisdom is that yen appreciation will increase the market share of Chinese firms. However, proposition 1 implies that this may not be true. The Japanese firm may shift production to China and engage in reverse imports. As a result, Japanese production in China increases by so much that the Chinese firm's output is crowded out. More specifically, the appreciation of yen raises the price of good z, reducing its demand correspondingly. As y is a closer substitute for z than *x,* the reduced demand will mainly shift to y, especially since y is produced in China with a reduced cost by the yen appreciation. If goods x and y are close enough substitutes, specifically, if $(\gamma_2 - \gamma_1\gamma_3)/2 > 1-\gamma_3^2$ is satisfied, then the increase in y will squeeze out the market share of x. Consequently, the demand for *x* actually decreases rather than increases following the appreciation of the yen. These findings are in line with the Chinese data. During 1995-2004, beverage and tobacco exports by foreign invested firms grew by 23% annually, while that of the domestic firms decreased by 47%. The exports of foreign invested firms in the food sector grew 20% annually, but those of domestic firms grew only 2.6%. As a result, the exports of domestic firms in these two sectors have been gradually replaced by foreign invested firms. (Zhao, 2006).

Note that the assumption that the Japanese firm is a multi-product multinational is crucial to obtain Proposition 1. Because of this assumption, the firm chooses both *y* and *z* to maximize profits,

which is identical to each of the two branches of the multinational maximizing the firm's total profits. Yen appreciation reduces *z*, which in turn leads the Japanese multinational to increase *y* more than if *y* and *z* were produced by two independent firms (since the Japanese multinational needs to recover some of the losses on *z*). As a consequence, *x* cannot increase as much as when *y* and *z* were produced by two independent firms. In addition, *y* is a closer substitute to *z* than *x*, so *z* is substituted more intensively by *y* than by *x*. In contrast, if *y* and *z* were produced by two independent firms, they would maximize their own independent profits. When the yen appreciates, *y* would not increase as much as when both *y* and *z* are produced by a single Japanese multinational, and *x* would always increase.

Next, let us investigate the total exports from China by combining (8a) and (8c).

$$\frac{d(x+y)}{de} = [8-(\gamma_1 - 2\gamma_3)^2 - 4\gamma_2]w_C / \Delta < 0 . \qquad (8d)$$

And the impact on the Japanese firm's total output is:

$$\frac{d(z+y)}{de} = [2(2-\gamma_1-\gamma_2)(1-\gamma_3)+\gamma_1(\gamma_2-\gamma_1)]w_C / \Delta < 0 . \qquad (8e)$$

Condition (8d) and (8e) give rise to the following:

Proposition 2: *An appreciation in the Japanese yen, (i) increases China's total exports to Japan; (ii) raises the total output of the Japanese firm.*

While part (i) is straightforward, part (ii) contrasts with conventional wisdom. It arises under the possibility of reverse imports. That is, due to proposition 1, the increase in China's exports to Japan (part (i)) may be mainly attributed to the increase of the Japanese firm's production in China, i.e., reverse imports, while the exports of the Chinese firm rise little or can even fall. More precisely, as part (ii) shows, the increase in *y* (reverse imports) exceeds the reduction in *z* such that the Japanese firm's total

output rises. While this may be contrary to conventional wisdom, as described in section 2, the empirical evidence supports all of our theoretical results.

5. FDI and Reverse Imports

Whether the Japanese firm produces in China or not and how much it produces depend on a number of factors: the exchange rate, the relative wage and capital costs between China and Japan, the preferences of Japanese consumers, and the substitutability between goods *x*, *y*, and *z*. Next we investigate the conditions for foreign production and reverse imports to arise.

Solving (6a), (6b) and (6c) together, we derive

$$y = (Aew_C - Bw_J + D)/\Delta, \tag{9}$$

where $A = (4 - 2\gamma_2 + 2\gamma_1\gamma_3 - \gamma_1^2) > 0,\ B = (4\gamma_3 - \gamma_2\gamma_1) > 0,\ D = 2(\gamma_2 - \gamma_1\gamma_3)a + (\gamma_1^2 - 4)b + (4\gamma_3 - \gamma_2\gamma_1)c.$

If the Japanese firm produces nothing in China at all, then $y = 0$. In other words, there are no reverse imports. Substituting $y = 0$ into equation (9) and rearranging yields

$$e = \frac{Bw_J - D}{Aw_C}. \tag{10}$$

We assume conditions for $e > 0$ are satisfied. A sufficient condition is that w_J is high enough. From (10) we can establish

Proposition 3: *(i) If* $e = (Bw_J - D)/Aw_C$, *the Japanese firm is indifferent between producing in China or Japan; (ii) If* $e > (Bw_J - D)/Aw_C$, *it produces only in Japan; (iii) If* $e < (Bw_J - D)/Aw_C$, *it also produces in China and conducts reverse imports. As the difference* $(Bw_J - D)/Aw_C - e$ *increases, the Japanese firm will increase production in China.*

Proposition 3 states that if the Chinese currency is valued high, then the Japanese firm produces in Japan only; and if the Chinese currency becomes cheap, then FDI and reverse imports arise. A similar result on the comparison of wages and capital rental can be obtained. That is, if the Japanese wage and capital costs are relatively low, then the Japanese firm produces in Japan only; and if they become relatively high, then FDI and reverse imports arise.

We have analyzed how exchange rate changes affect Japanese FDI and reverse imports. Next, we investigate the marginal effects of changes in the average production cost and consumer preferences. Let $G = w_J - (Aew_C + D)/B$. Differentiation yields:

$$dG/dw_J > 0, \tag{11a}$$

$$dG/dw_C < 0, \tag{11b}$$

$$dG/dc < 0. \tag{11c}$$

That is, an increase in the Japanese wage and capital costs leads to more overseas production and reverse imports; on the other hand, an increase in the Chinese wage and capital costs, or an increase in the relative preference for products made in Japan, causes exactly opposite effects.

6. Profits and Welfare

In this section, we look into the welfare effects of exchange rate changes under reverse imports. First, the national welfare in China is simply the firm profits because consumption occurs in Japan only, which can be defined as

$$\Phi_C = \pi_C = (p_x - ew_C)x. \tag{12}$$

Differentiating (12) with respect to *e* and using (6a) and (3a), we derive

$$\frac{d\Phi_C}{de} = -(\gamma_2 \frac{dy}{de} + \gamma_1 \frac{dz}{de} + w_C)x \,. \tag{13}$$

Substituting equations (8a) and (8b) into the above and simplifying yield

$$\frac{d\Phi_C}{de} = \frac{4xw_C}{\Delta}[2(1-\gamma_3^2) + (\gamma_1\gamma_3 - \gamma_2)] = 2x\frac{dx}{de} \,. \tag{13'}$$

Equation (13') measures the impact of the bilateral exchange rate movements on China's welfare. Comparing (13') with (8c), it is immediate to see that, the necessary and sufficient condition for $d\Phi_C / de < 0$, i.e., for devaluation of the yuan to increase Chinese welfare, is identical to the condition that devaluation boosts the Chinese firm's exports to Japan (*not* China's total exports). Alternatively, China gains nothing if yuan devaluation fails to boost the exports of its domestic firms.

Next, we look into the effects on the profits of the Japanese firm and the national welfare of Japan. They are more complicated because the Japanese firm produces in both countries and products are consumed in Japan. We first investigate the profits of the Japanese firm. Differentiation yields

$$\frac{d\pi_J}{de} = \frac{\partial \pi_J}{\partial x}\frac{dx}{de} + \frac{\partial \pi_J}{\partial y}\frac{dy}{de} + \frac{\partial \pi_J}{\partial z}\frac{dz}{de} + \frac{\partial \pi_j}{\partial e} \,. \tag{14}$$

From (6b) and (6c), we know that $\partial \pi_J / \partial y = \partial \pi_J / \partial z = 0$. Equation (14) can now be simplified to

$$\frac{d\pi_J}{de} = -yw_C - (\gamma_1 z + \gamma_2 y)\frac{dx}{de} \,. \tag{14'}$$

According to proposition 1, if goods x and y are close substitutes (high γ_2), then $dx / de > 0$, which gives rise to a negative sign for (14').

Proposition 4: *An appreciation of the Japanese yen raises the Japanese firm's total profits under reverse imports, if goods x and y are close substitutes.*

The intuition is that, the Yen appreciation reduces the production of *z*, which is substituted by *y* and *x*, but more by *y* because *y* is a closer substitute. If *x* and *y* are close substitutes, a portion of the Chinese firm's output and market share is replaced by Japanese reverse imports, leading to the net profit gains of the Japanese firm.

Now we turn to the national welfare in Japan, which is the sum of firm profits and consumer surplus,

$$\Phi_J = \pi_J + U(x+y+z) - xp_x - yp_y - zp_z . \tag{15}$$

Denoting $u(x(e), y(e), z(e)) = U(x+y+z) - xp_x - yp_y - zp_z$, then differentiating (15) yields

$$\frac{d\Phi_J}{de} = \frac{d\pi_J}{de} + \frac{\partial u}{\partial x}\frac{dx}{de} + \frac{\partial u}{\partial y}\frac{dy}{de} + \frac{\partial u}{\partial z}\frac{dz}{de} + \frac{\partial u}{\partial e} . \tag{16}$$

Using (3a-3c), the above becomes

$$\frac{d\Phi_J}{de} = (p_z - w_J)\frac{dz}{de} + (p_y - ew_C)\frac{dy}{de} - w_C y - x\frac{dp_x}{de} , \tag{16'}$$

where $\frac{dp_x}{de} = -(\frac{dx}{de} + \gamma_2 \frac{dy}{de} + \gamma_1 \frac{dz}{de}) > 0$, obtained by differentiating (3a) and using (8a-8c).

Equation (16') indicates that the change of Japanese welfare due to an appreciation of the yen (i.e., a decrease in *e*) consists of four parts: the first is the profit reduction of the Japanese firm due to its reduced output in Japan, i.e., the decrease in *z*; the second is the increased profit generated from production expansion in China, i.e., the increase in y; the third is a decrease of production cost in China due to less expensive Chinese labor and capital measured in yen; and the last part is an increase in Japanese consumer surplus induced by a decrease in the price of good *x*. The first component contributes to Japanese welfare negatively while the second, third and the last terms contribute positively. In general the sign of (16') is ambiguous.

Given that $(p_z - w_J)$ and $(p_y - ew_C)$ measure the profit margins of goods *z* and *y* respectively, as long as the latter dominates the former, i.e., the profit margin of Japanese production being higher in China than in Japan, yen appreciation improves Japan's welfare.

Proposition 5: *Under reverse imports, a devaluation of the yuan is welfare enhancing to China if and only if devaluation could raise the Chinese firm's exports; and it is welfare enhancing for Japan if the Japanese firm's profit margin is higher in China than in Japan.*

Proof: The proof for the first part is straightforward from (14'). We now prove the second part. From (8a), (8b) and (8e), we must have

$$0 < \frac{dz}{de} < -\frac{dy}{de}. \tag{17a}$$

If the profit margin of the Japanese firm is higher in China than in Japan, then,

$$0 < (p_z - w_J) < (p_y - ew_C). \tag{17b}$$

Multiplying (17a) and (17b) and rearranging lead to

$$\frac{dz}{de}(p_z - w_J) + \frac{dy}{de}(p_y - ew_C) < 0. \tag{18}$$

Since $dp_x / de > 0$, using (18), the sign of equation (16') can be determined as

$$\frac{d\Phi_J}{de} < 0. \tag{16"}$$

It states that Japan's welfare increases if yen appreciates under reverse imports.

QED

Proposition 5 implies that as yen appreciation drives Japanese production facilities overseas, it also improves their total profits as long as the profit margins are higher overseas. Under reverse imports, products are imported back to the Japanese domestic market, enhancing Japanese consumers' surplus. Therefore, the total effects of the yen's appreciation result in an increase in the national welfare.

Finally, combining Propositions 1 and 5, we can establish the following straightforwardly:

Corollary 1: *If* $(\gamma_2 - \gamma_1\gamma_3)/2 < 1 - \gamma_3^2$, *an appreciation of the yen will enhance the welfare of both China and Japan.*

7. Concluding Remarks

This paper assumed a structure in which a Japanese MNE produces in both Japan and China and engages in reverse imports from its Chinese affiliate, and a Chinese firm competes with the Japanese firm. We investigated the conditions for reverse imports to arise, and found that exchange rate changes, wage and capital cost differentials, and barriers in brand name recognition contribute to increases in Japanese overseas production and reverse imports.

The model could shed light on the current China debate. One of the most important markets for Japanese affiliates in China is Japan itself. Yen appreciation raises the relative production cost in Japan, driving production to low cost countries through FDI and importing back for serving the Japanese domestic market. The model showed that due to the barriers in brand name recognition, it is uncertain whether the exports of the Chinese firm rise or not when the yuan depreciates against the yen. It is likely that the growth of reverse imports erodes the market share of Chinese firm. In other words, Chinese firms could be a loser of yen appreciation, due to the strong competition of reverse imports by Japanese MNEs. The predictions of the model fit well with the actual data. Depending on product differentiability, yen appreciation may improve profits of the Japanese firm and welfare in Japan under reverse imports.

One might argue that even though Japanese welfare increases under reverse imports, Japanese employment may fall because the MNE shifts production to China. We conjecture that the gain from reverse imports may be smaller taking consideration of unemployment assistance and training.

We have assumed that firms compete in quantity with differentiated products. They could also compete in prices. It is well known that prices are lower and outputs higher under price competition than under quantity competition (see for instance, Cheng, 1985). Also, a quasi-linear utility function (which generates linear demands functions) has been assumed. More complicated demand and utility functions will give more variations. In addition, sales in China were assumed to be zero for simplicity. If we allow positive sales in China, as long as there is market segmentation, our analysis on reverse imports, FDI and the exchange rate remains robust.

We have investigated the impact of exchange rate changes. The mechanism is the same if wages or other production costs increase in China. Further, commercial policy such as tariffs can be incorporated into the model. Increases in import tariffs cause similar effects as currency depreciation in Japan. In particular, in the presence of reverse imports, an increase in the import tariff might hurt domestic firms with overseas subsidiaries. This implies that the optimal tariff is lower than in the absence of reverse imports.

Finally, production in the present model consists of one stage only. The analysis becomes more complicated in a structure with both intermediate and final productions. This remains a fruitful avenue for further research.

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Figure 1

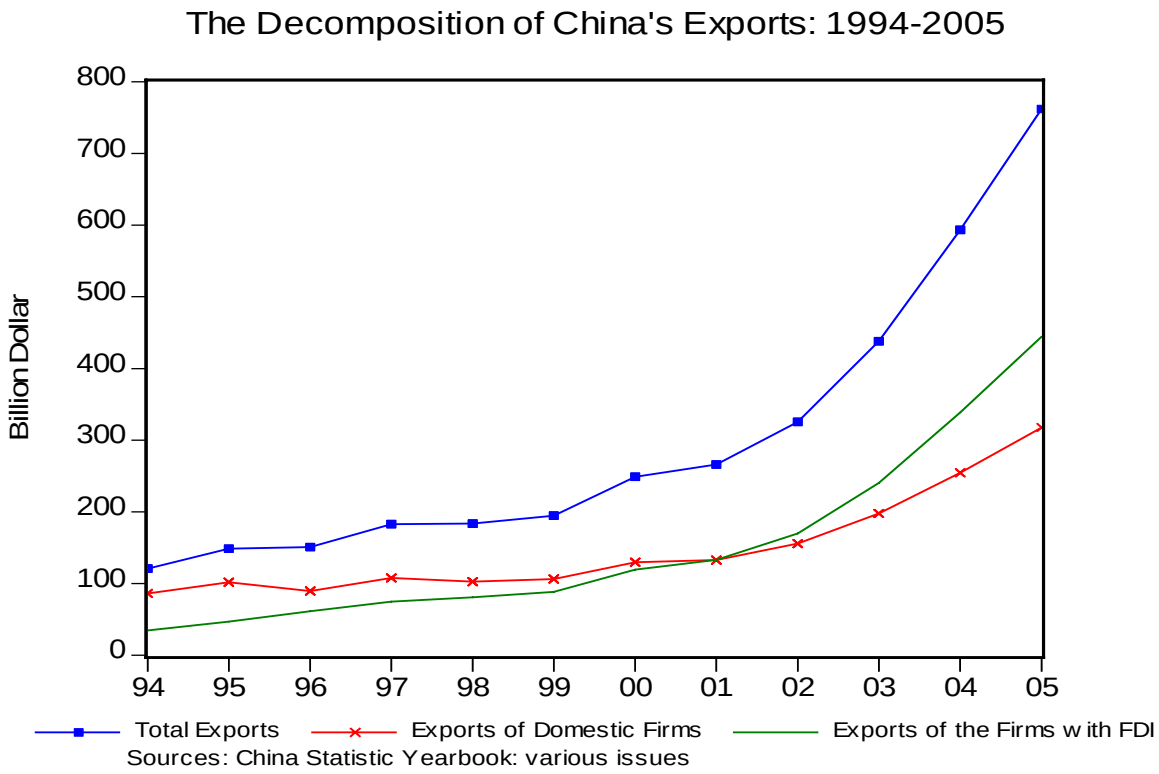


Figure 2

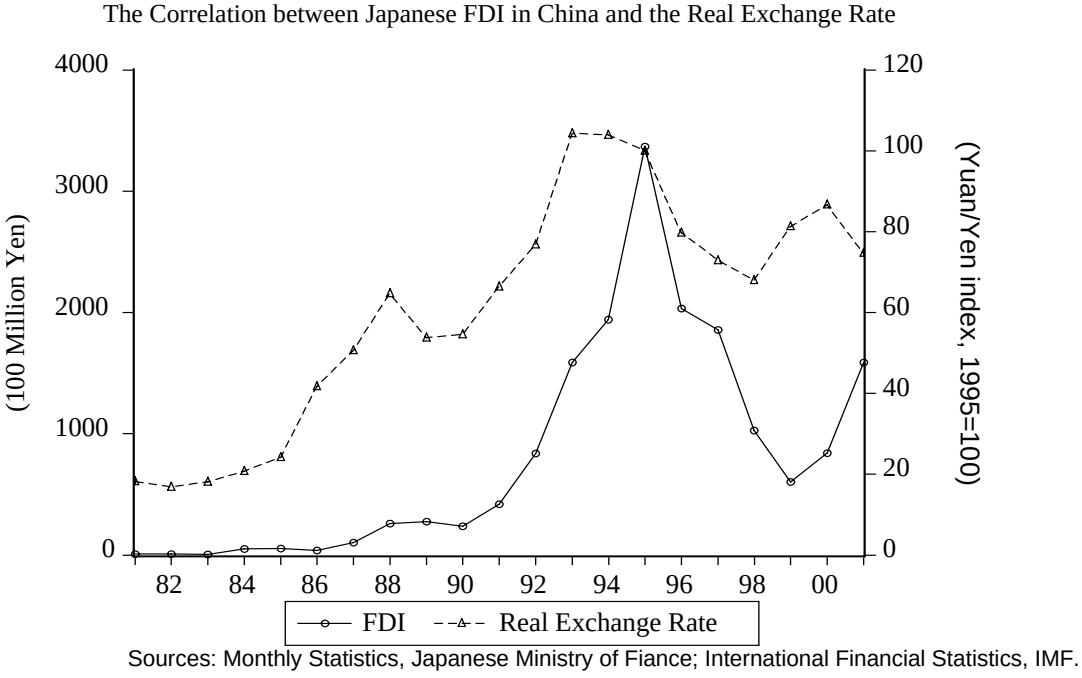
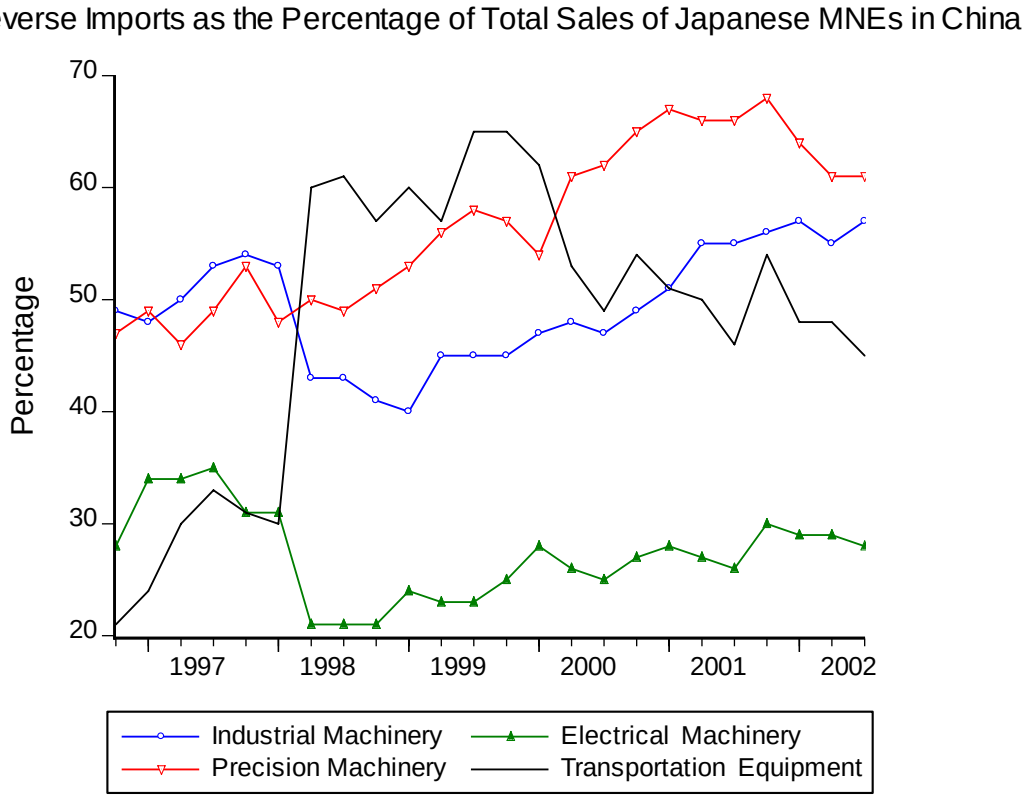


Figure 3



Sources: Quarterly Survey of Business Activities, Japanese Ministry of Economy, Trade and Industry

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