Exchange Rates and U.S. Foreign Direct Investment in the Global Processed Food Industry

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This paper focuses on estimating the effects of the real FDI-weighted exchange rate on real U.S. foreign direct investment (FDI) in the global processed food industry. We use a straightforward production possibility framework as our theoretical basis to demonstrate the shift of production between countries on the basis of exchange rate fluctuations. The log-log regression model, derived from the theoretical model, gives statistically robust results to show that for the years 1983 to 2002, the exchange rate fluctuations, the level of fixed capital in the U.S. food industry, and the cost of materials in both the United States and abroad were major determinants of the stock of U.S. FDI in the global processed food industry. As the dollar appreciated, U.S. FDI increased. An overall conclusion is that countries with an undervalued exchange rate will experience increased FDI. Countries with overvalued exchange rates incur costs from lost export opportunities for domestic firms as well as discourage FDI.

Key Words: U.S. foreign direct investment (FDI), global processed food industry, FDI-weighted exchange rates

The dollar has been depreciating on a trade-weighted basis since 2002, changing the environment for U.S. agricultural trade and foreign direct investment (FDI).[1] This depreciation contrasts sharply with the macroeconomic environment of an appreciating dollar in the second half of the 1990s.[2] The purpose of this study is to evaluate the effects of exchange rate fluctuations on the stock of U.S. foreign direct investment in the global food and beverage industries and how the changed macroeconomic environment could portend a change in the direction of FDI growth.

Using a standard theoretical model and the implied empirical model, we demonstrate that exchange rate fluctuations indeed are an important determinant of U.S. FDI abroad. Based on standard theory, an appreciating dollar should lead to growth in U.S. FDI. Between 1990 and 2000, the stock of U.S. FDI in the global processed food industry grew from $16 billion to $36 billion. Profits were high, companies had cash to purchase foreign assets, and production costs were lower in other countries. All these factors contributed to the increased U.S. FDI abroad. With the dollar depreciation against the major currencies in 2003, one would expect a decline in U.S. FDI abroad. A slowdown in FDI started in 2000, but then FDI rebounded to $53 billion in 2004. This rebound may have occurred because of a

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This article is dedicated to the memory of Chris Bolling. It was one of two articles that Chris was working on when she died unexpectedly in April 2006. Chris passionately believed that FDI was the neglected element in understanding the internationalization of agriculture. As we worked to finish this article, we began to feel that way as well. Chris was an economist with the Economic Research Service of the U.S. Department of Agriculture for almost 40 years. Mathew Shane is a senior economist with the Economic Research Service. Terry Roe is a Professor and Co-Chairman of the Economic Development Center at the University of Minnesota. The authors gratefully acknowledge the advice and assistance of Dr. Agapi Somwaru of the Economic Research Service regarding the econometric underpinning of the article. We would also like to acknowledge the assistance of the anonymous reviewers who helped us overcome some of the ambiguities, and better focus the paper. The views expressed do not necessarily represent those of the Economic Research Service or the U.S. Department of Agriculture.

[1] FDI is defined as the stock of FDI and includes the beginning FDI position plus equity capital inflows minus equity capital outflows plus reinvested earnings minus intercompany debt. This is the definition developed by the Bureau of Economic Analysis, U.S. Department of Commerce, and includes full ownership, joint ventures, and other partial ownership situations.

[2] For a full set of macroeconomic data across a broad set of countries, see Economic Research Service (2006a).

redirection of FDI to developing countries where the dollar has kept its value in comparison to the stronger currency areas of Western Europe and Japan. The current exchange rate realignment along with the higher economic growth rates in emerging market countries may lead to a change in firms' strategies on FDI.

The Trends in U.S. Trade and FDI

2004 was a record year for nominal U.S. agricultural exports. The $61.3 billion of U.S. agricultural exports abroad exceeded the previous record of $60.3 in calendar year 1996. Some experts believe that the dollar appreciation of the late 1990s dampened U.S. agricultural exports, and the depreciation of the dollar that began in 2002 may portend future near term growth in U.S. agricultural exports (Figure 1). Long-term U.S. agricultural exports are forecast to grow from $77 billion in FY 2007 to $95 billion in 2016 according to USDA baseline projections (Office of the Chief Economist 2007, p. 67), with the depreciating dollar being a contributing factor along with income and population growth in many major foreign markets.

The appreciating dollar of the late 1990s along with steady increases in U.S. income also meant that U.S. agricultural imports reached record levels. The continued depreciation or pegging of these exporting countries' currencies to the U.S. dollar in the case of Mexico, Brazil, and China, for example, added to their competitiveness. Fruits and vegetables were some of the largest gainers in food imports because they were competitively priced in terms of dollars. The exchange rate effect added to the effect of an assurance of year-round supplies from countries that were counter-seasonal to the United States. The fact that most of these imports came from developing countries with depreciating currencies also figures into the future for U.S. agricultural imports.

Exports of processed food and beverages[3] reached a peak in 2001, and since then have remained stagnant through 2004. Canada, Mexico, Japan, and Korea are our principal processed food export markets. While U.S. processed food exports were stagnant, U.S. companies employed an alternate strategy by building or purchasing subsidiaries abroad (FDI). The stock of U.S. FDI in the global processed food industry grew from a base of $16 billion in 1990 to $53 billion in 2004 (Figure 2). The size and growth of the sales generated abroad from FDI attests to the importance of the FDI phenomenon during the 1990s. Sales from U.S. affiliates abroad (FDI sales) reached $192 billion in 2004, an increase of 134 percent since 1990 (Figure 3). Because of their foreign direct investment, U.S. food companies had sales in markets that they otherwise could not have reached by exports alone. Processed food sales from U.S. affiliates substantially exceed total U.S. agricultural exports in European Union countries, as they do in Brazil and Argentina. Only in a few countries like South Korea where serious investment barriers exist are U.S. processed food exports larger than FDI affiliate sales (Table 1).

In general, sales from FDI affiliates do not compete with U.S. exports, but instead are complements, as demonstrated in recent studies (Marchant, Cornell, and Koo 2002, Makki, Somwaru, and Bolling 2004, Markusen 1997), representing an added avenue for growth for food processing companies. A more recent trend is the increase in sales of foreign-owned companies with affiliates in the United States. Foreign direct investment into the United States declined during the 1990s. Since 2001, however, inward FDI has increased dramatically, particularly in the beverage sector. This has come mostly from OECD countries such as Canada, the European Union, and Japan, where the real exchange rates have appreciated against the dollar.

The Exchange Rate Trends

Through the late 1990s, the dollar appreciated relative to other national currencies, especially the euro and the yen. But in late 2003 the dollar began to depreciate against the currencies of many developing countries.[4] On the basis of a fixed FDI-weighted exchange rate index, the dollar has fallen nearly 15 percent (Figure 4).[5] Most of the

[3] Processed food and beverages are usually associated with the Standard Industrial Classification (SIC) 20. See Epps and Harris (1995) for a complete definition of what is included.

[4] See www.ers.usda.gov/data/exchangerates/ for tables of exchange rates.

[5] The authors developed a fixed FDI-weighted exchange rate index especially for this study. Real exchange rates for each country were

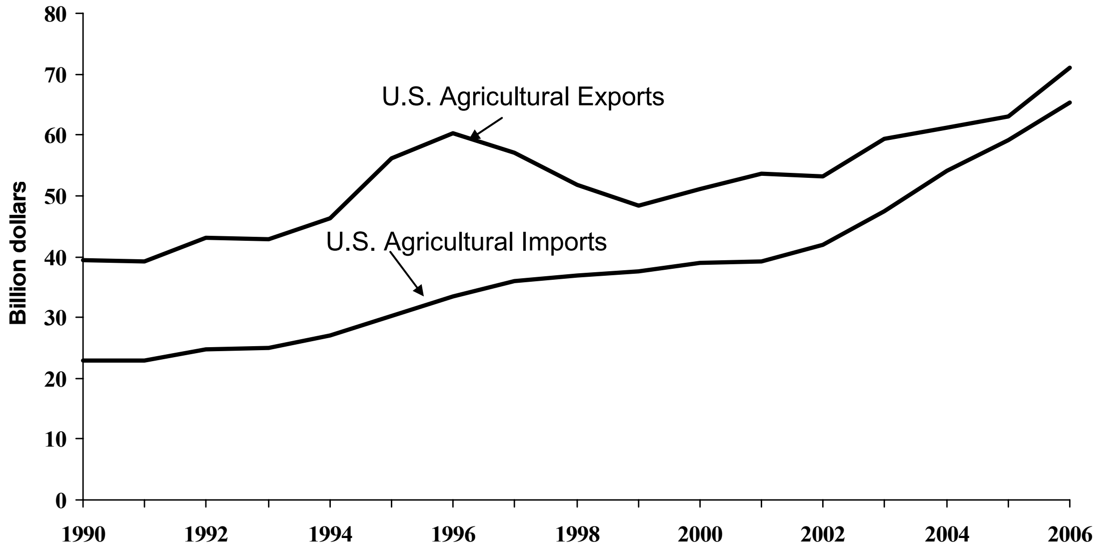

Figure 1. U.S. Agricultural Trade (1990–2006)

Source: Economic Research Service (2007).

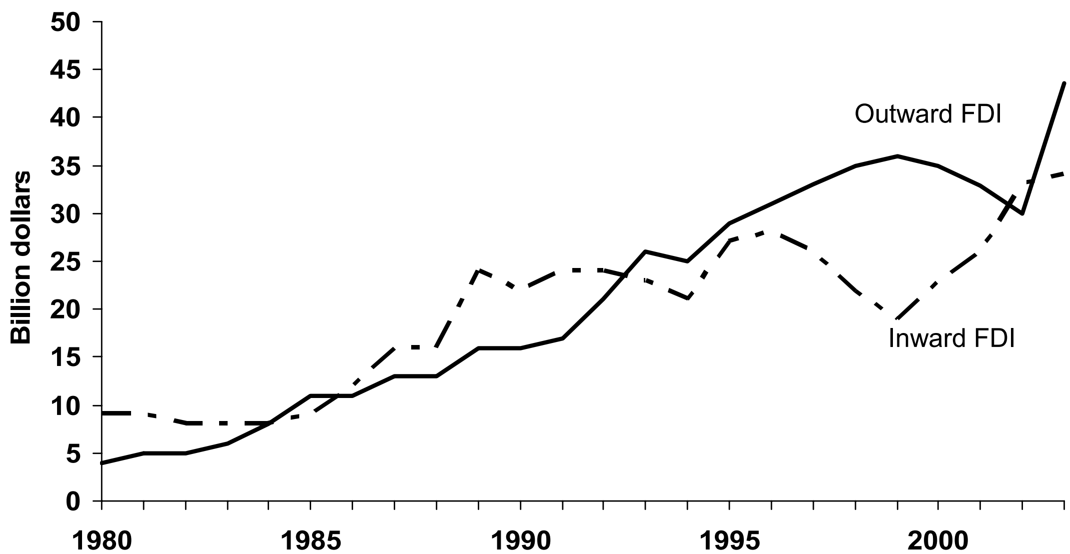

Figure 2. U.S. Inward and Outward FDI in the Food Processing Industry

Notes: Inward FDI is investment by foreign-owned companies in the United States. Outward FDI is investment by U.S.-owned companies in foreign countries.

Source: Bureau of Economic Analysis (2006).

obtained from Economic Research Service (2006b). These exchange rates were weighted by the average U.S. FDI by country from Bureau of Economic Analysis data for 1998 through 2000. The fixed weighted data was then expressed with 2000 as the base year.

decline has occurred in the developed countries (33 percent). While the fall has been less severe in developing countries, the FDI-weighted dollar is back to where it was in 2000.

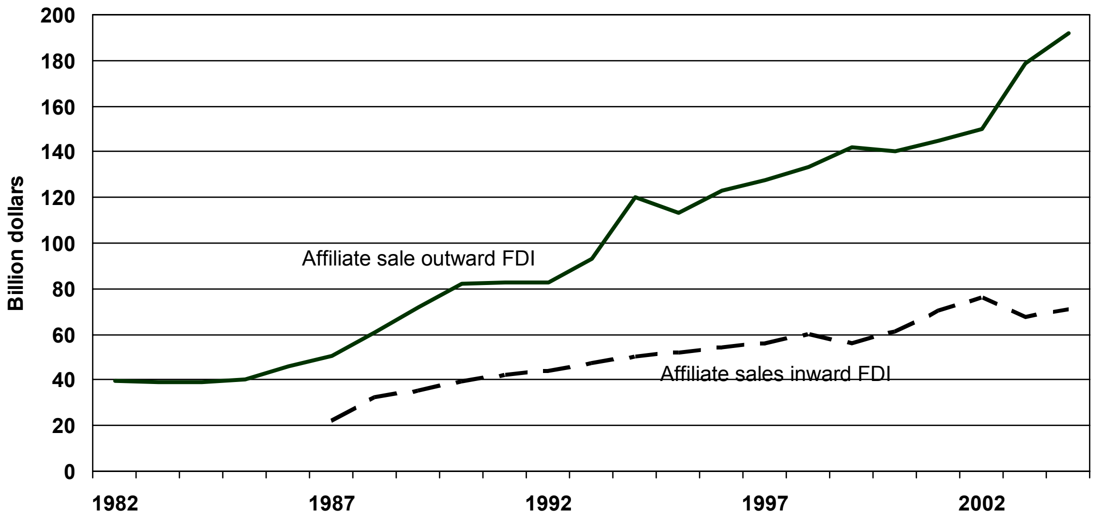

Figure 3. Processed Food Sales from Outward U.S. FDI Exceed U.S. Inward FDI Sales

Note: 1999 and 2000 FDI sales are estimates.

Source: Bureau of Economic Analysis (2007a) and Harris et al. (2002, Appendix Tables 42 and 43).

Table 1. Top Countries for U.S. Agricultural Exports and Affiliate Sales ($ billion 2004)

Country	U.S. Ag'l. Exports	Country	U.S. Affiliate Sales
Canada	8.7	Germany	31.4
Japan	8.4	U.K.	23.0
Mexico	7.2	Canada	21.0
South Korea	2.7	Netherlands	18.4
China	2.1	France	13.3
Taiwan	2.0	Mexico	10.9
Netherlands	1.2	Brazil	10.4
Hong Kong	1.1	Japan	8.9
U.K.	1.0	Australia	6.8
Germany	1.0	China	5.4
Egypt	0.9	Argentina*	5.1
Indonesia	0.8	Spain	4.0
Philippines	0.8	Belgium	3.6
Turkey	0.7	Italy	2.5
Spain	0.7	Venezuela*	2.4
Thailand	0.6	Poland	2.2
Belgium	0.6	Portugal	2.0
Russia	0.6	Austria*	1.2
Italy	0.5	South Korea*	1.0
Colombia	0.5	Philippines*	1.0

Note: * implies food only; otherwise, food and beverages and tobacco.

Source: Economic Research Service (2007) and Bureau of Economic Analysis (2007a).

The Choice to Produce Abroad

Using the theory of the firm, we demonstrate how a company decides the mix of what to produce at home and what to produce abroad. Suppose a company has two production facilities, one in its home country and one in a country abroad. At the heart of the decision of where to produce is where it will allocate its capital stock. Foreign direct investment is the physical capital that is allocated abroad.[6]

The simplified model (Figure 5) demonstrates that the firm will locate its capital stock between its domestic and foreign plants depending on relative output prices in the United States and abroad. The exchange rate comes into play immediately, as product prices defined in terms of foreign country currencies are translated into dollars in an environment of flexible exchange rates. As the dollar appreciates in comparison to the other currency, it becomes advantageous for the company to produce abroad and to shift capital to its foreign affiliate. When the dollar depre-

[6] The authors use the definition of U.S. FDI developed by the Bureau of Economic Analysis, U.S. Department of Commerce, where it is defined as the stock of FDI at the close of each year.

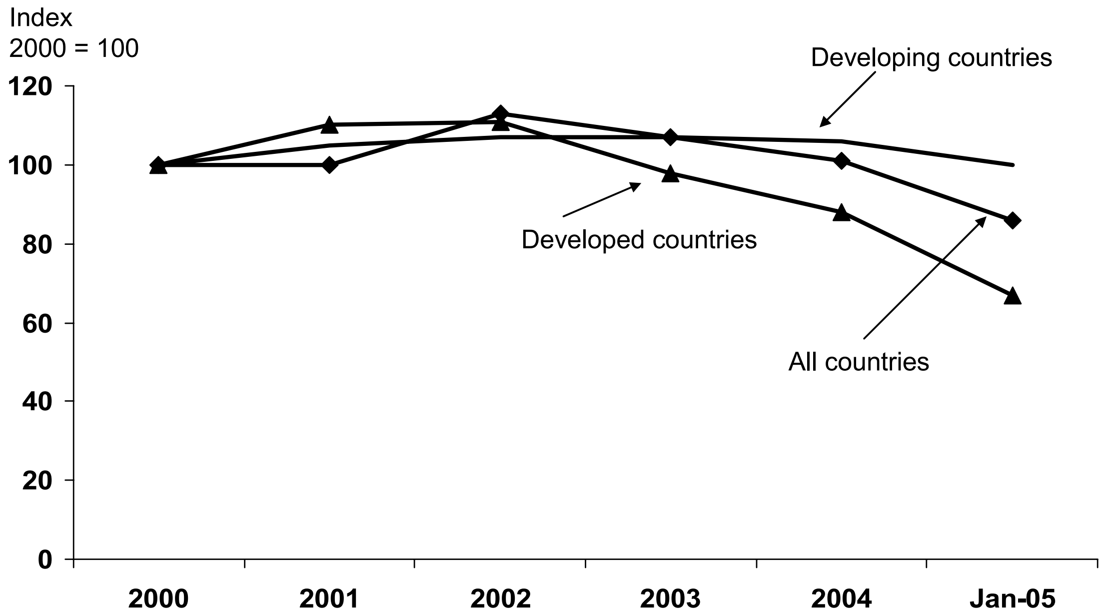

Figure 4. FDI-Weighted Exchange Rate Index

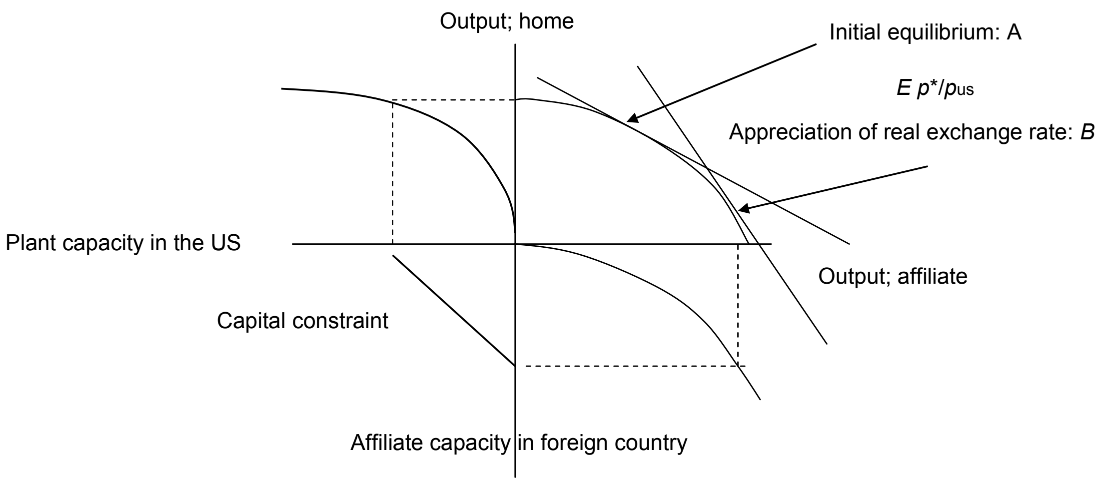

Figure 5. Production Possibility Frontier of a Multinational Enterprise with Home and Affiliate Plants

ciates, more production shifts to the domestic U.S. company. The depreciation of the dollar may portend a drop in the stock of U.S. FDI abroad, relative to what is held in the United States. In the next section, we present the formal model of how a firm allocates its capital stock between a domestic production unit and a foreign one.

The Framework

A production possibility framework demonstrates the shift of production between countries on the basis of exchange rate fluctuations in a straightforward way. With production functions representing a U.S. operation in the northeast quadrant and its foreign affiliate in the southwest quadrant of Figure 5, we can draw out the direct effects of an exchange rate change on production and investment in each firm. Figure 5 shows the production possibility frontier in the northwest quadrant given a capital market equilibrium that is expressed by the firm's capital constraint in the southeast quadrant. The appreciation of the dollar causes the point of tangency between the price line of Ep^*/p_{US} and the production possibility curve between a U.S. firm and the foreign affiliate to shift from *A* to *B*. The exchange rate, *E*, expressed as local currency/$, becomes larger with dollar appreciation, indicating that one gets more product for the dollar even when the price in local currency remains unchanged. With p^* remaining constant, the ratio of Ep^*/p_{US} becomes steeper, reaching a point of tangency at *B*. This translates to more production in the U.S. foreign affiliate and less production in the domestic U.S. firm. Given the capital constraint, the firm has an incentive to increase the capacity of the foreign affiliate and to lessen the capacity of the domestic U.S. plants. This is a direct effect. The indirect effect is to increase the shadow value of capital to the enterprise, which depending on the capital market can "pivot" the capital constraint, resulting in a further increase in capacity of the foreign affiliate. A new equilibrium is established at point *B*. This structure is stated in analytical terms in the next section, which serves to derive our key estimating equation.

The Mathematical Model

Assume that the firm has two locations, a U.S. operation and a foreign affiliate. It uses the same technology and it has a fixed company-wide resource that it can allocate to the two locations. This can be some firm-specific resource or firm-specific capital. This resource is $X = x_{US} + x_{FDI}$. The problem is to maximize production from the two operations given the constraint on capital. The model assumes a profit-maximizing firm with Cobb-Douglas production functions. Any combination of the fixed input can be used along the input line. The price line tangency in the output market defines the profit-maximizing solution.

The problem is to choose x_{US} and x_{FDI} to maximize the value of production subject to a capital constraint:

$$\text{(1)} \quad \text{Max} : \pi = p_{US} x_{US}{}^{\alpha} T_{US}{}^{1-\alpha} + Ep^*(X - x_{US})^{\alpha} T_{FDI}{}^{1-\alpha},$$

where $X = x_{US} + x_{FDI}$, x_i = capital investment in country *i*, T_i = other input(s) used in production of the product in country *i*, *E* = exchange rate = *LC*/$, and p_i = real food price in country *i*.

The first-order conditions from the implied Lagrangian function are

$$\text{(2)} \quad d\pi / dx_{US} = \alpha p_{US} x_{US}{}^{\alpha-1} T_{US}{}^{1-\alpha} - \alpha Ep^*(X - x_{US})^{\alpha-1} T_{FDI}{}^{1-\alpha} = 0.$$

By rearranging (2), we get

$$\text{(3)} \quad \alpha p_{US} x_{US}{}^{\alpha-1} T_{US}{}^{1-\alpha} = \alpha Ep^*(X - x_{US})^{\alpha-1} T_{FDI}{}^{1-\alpha}.$$

By substitution:

$$\text{(4)} \quad \frac{x_{FDI}{}^{\alpha-1} = p_{US} x_{US}{}^{\alpha-1} T_{US}{}^{1-\alpha}}{Ep^* T_{FDI}{}^{1-\alpha}}.$$

Solving for x_{FDI}:

$$\text{(5)} \quad \frac{x_{FDI} = [p_{US} x_{US}{}^{\alpha-1} T_{US}{}^{1-\alpha}]^{1/\alpha-1}}{Ep^* T_{FDI}{}^{1-\alpha}}.$$

Rearranging terms yields the direct effects of the exchange rate on resource allocation between the domestic and the affiliate plant:

$$\text{(6)} \quad x_{FDI} = \frac{[Ep^*]^{\alpha-1}}{p_{US}} \frac{T_{FDI}}{T_{US}} x_{US}.$$

Notice the apparent complementarity between x_{FDI} and x_{US}. An incentive to increase inputs in home plants (T_{US}) implies an incentive, all else remaining constant, to decrease foreign direct investment (x_{FDI}).

The Empirical Model

Given a Cobb-Douglas specification, the following estimating equation is derived from equation (6):

$$(7)\quad \text{Ln}(x_{\text{FDI}}) = \alpha + \beta_1 \ln(E) + \beta_2 \ln(p^*) + \beta_3 \ln(p_{\text{US}}) + \beta_4 \ln(T_{\text{FDI}}) + \beta_5 \ln(T_{\text{US}}) + \beta_6 \ln(x_{\text{US}}) + \varepsilon.$$

The dependent variable is the stock of U.S. foreign direct investment in the global food and beverage industry (x_{FDI}) (see Appendix for data sources). Relative prices of the output of the U.S. food industry (p_{US}) and the global food industry (Ep^*, where E is the FDI-weighted exchange rate and p^* the FDI-weighted prices in the FDI host countries) were used as independent variables to explain U.S. foreign direct investment in the global processed food industry, as were other inputs, T_{FDI} and T_{US}, here expressed as the real cost of goods sold from the U.S. food industry and the real cost of goods sold from the foreign affiliates of the U.S. food industry. The term x_{US} represents the amount of fixed capital used in the U.S. food and beverage industry. Consumer prices for food in the United States are deflated by the U.S. Consumer Price Index (CPI). The FDI-weighted consumer prices for food that pertain to affiliates in other countries are also adjusted by the FDI-weighted real exchange rates and the FDI-weighted CPI's of the host countries. The term x_{US} was deflated by the U.S. CPI. The error term is initially assumed to be normal with independent and identically distributed error terms that have a zero mean and constant variance. Equation (6) suggests the following expected signs on the coefficients:

$$\beta_1 > 0,\ \beta_2 > 0,\ \beta_3 < 0,\ \beta_4 > 0,\ \beta_5 < 0,\ \beta_6 > 0.$$

The Empirical Results

A multiple regression was initially used to fit equation (7) for the years 1983 to 2002. Because of autocorrelation in the error term, we adjusted the equation with the maximum likelihood GARCH method. The empirical model results closely follow the expected results of the theoretical model (Table 2). All the coefficients have the expected sign and only the coefficients associated with both domestic and foreign prices are not significantly different from zero. The lagged exchange rate variable indicates that the FDI-weighted exchange rate is significant in explaining changes in FDI. Thus, an appreciation of the dollar results in increased FDI abroad, while a depreciation of the dollar implies the reverse. The exchange rate variable is lagged to allow for the adjustments that occur in commerce, since trade and FDI are not instantaneous. The exchange rate converts local currencies into dollars, to be consistent with other independent variables in the equation.

The ratio of real food prices in the FDI countries (fixed FDI-weighted real CPI's for food) to real food prices in the United States represents the real relative price of product output in the two markets. The coefficients are positive for FDI countries and negative for the United States. These results suggest the expected effect that FDI is responsive to relative food prices. The ratio of the real cost of materials in the FDI countries and the United States represents the ratio of physical inputs.

A rise in domestic material costs provides an incentive to invest abroad. This result can also be interpreted as follows. An increase in economic growth in other sectors of the U.S. economy that cause an increase in costs to domestic food processing provides an incentive to invest in affiliate plants in other countries. The base of fixed capital in the U.S. processed food industry is also significant and indicates that an increase in fixed capital in the U.S. processed food industry provides a base for generating FDI abroad. An overall implication of these empirical results is that countries such as China that tend to maintain an undervalued exchange rate will experience increased amounts of FDI, while countries that maintain overvalued currencies discourage FDI. Consequently, countries with overvalued exchange rates incur costs from lost export opportunities for domestic firms as well as discouraging FDI. They lose the benefits of technical transfer and lost employment opportunities implied in FDI and reduced export industries.

Table 2. Regression Results of Equation (7)

Independent Variables	Coefficient	Standard Error	Two-Tailed Test of Probability of Significance
Intercept	-37.448	12.092	0.002
Exchange rate lagged (β_1)	0.714	0.323	0.027
Food prices FDI (β_2)	1.636	1.906	0.39
Food prices U.S. (β_3)	-1.42	2.208	0.52
Cost of materials—affiliate (β_4)	0.403	0.137	0.003
Cost of materials—U.S. (β_5)	-2.316	1.218	0.057
U.S. fixed capital (β_6)	9.508	3.005	0.002
Corrected R^2	0.844	F-test	11.318
Durbin-Watson	2.383	Prob (F-statistic)	0.001

Conclusions

The results in this paper highlight the importance of the exchange rate in determining a firm's decision to embark on foreign direct investment. As the dollar appreciates, the firm will seek to increase production in other countries because prices in dollars decline in other countries, making it more profitable to produce abroad. As the dollar depreciates, the opposite prevails so that FDI abroad may actually decline. Since a strong currency represents myriad things, such as a strong domestic economy, the reasons for FDI are many. Firms may have excellent profits and capital available for investment to invest elsewhere, and they may see assets abroad as being undervalued in comparison to assets at home, for example. Because of the way that exchange rates translate local currency prices into dollars, the exchange rate effect is apparent. This relationship is borne out empirically. Given the constraints to decision making, it takes time for the exchange rate effect to work through commerce. Because of the emerging patterns of exchange rates, it is possible to make inferences about the future of the U.S. FDI in the global processed food industry. The recent 15 percent decline in the dollar was mostly devaluations against the yen and the euro. The devaluation against the currencies of most developing countries was much less. This implies that U.S. FDI is likely to be geared more to developing countries than to developed countries in the near future. The continued growth in FDI despite the recent depreciation of the dollar may also indicate that other factors may contribute to increased FDI, such as possibly the continued growth in the fixed capital of the domestic U.S. processed food industry that continues to generate more financial capital for investments both in the United States and abroad, as well as the relative costs of inputs in the food industries of other countries.

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APPENDIX

Data Sources

Data for x_{FDI} was derived from the U.S. Direct Investment Position Abroad on a Historical Cost Basis (adjusted to include beverages) of the Bureau of Economic Analysis (Bureau of Economic Analysis 2007a). The CPI for food and CPI data in other countries was obtained from the International Labour Organization (2006). The real country exchange rate series was taken from the Economic Research Service's exchange rate data set (Economic Research Serivce 2006b) and weighted by the average U.S. FDI by country between 1998 and 2000. Cost of materials data for the U.S. food industry was obtained from the Annual Survey of Manufactures (U.S. Census Bureau, various issues). The number of employees was obtained from the Bureau of Economic Analysis (2007a) and from the Economic Research Service (1991, 1992, 1996). Data on U.S. fixed capital investment was obtained from the Bureau of Economic Analysis (2007b). The U.S. CPI for food and overall index is the U.S. city average, not seasonally adjusted, for the base period 1982–84 = 100, adjusted to a 2000 base. These series can be obtained from Department of Labor (2007). Data for FDI cost of goods sold is derived from Bureau of Economic Analysis (2007a). These data were deflated by the appropriate CPI deflators.