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International Trade and Foreign Direct Investment: Substitutes or Complements?

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International agricultural trade has evolved over time. Processed foods and developing countries have become major growth markets for U.S. agricultural exports, and foreign direct investment (FDI) has become even more important than exports as a means of accessing foreign markets. The critical question is whether FDI is a substitute for or a complement of exports. This research builds upon an existing theoretical FDI model and contributes to the literature through the development of a simultaneous equation system for FDI and exports, which is estimated using two-stage least squares. Empirical analyses were used to examine the relationship between U.S. FDI and exports of processed foods into East Asian countries–China, Japan, Singapore, South Korea, and Taiwan–from 1989 to 1998. The results indicated a complementary relationship between FDI and exports. Additionally, these results indicated that interest rates, exchange rates, gross domestic product (GDP), and compensation rates are important variables that influence U.S. FDI in East Asian countries, while GDP, exchange rates, and export prices are important export determinants.

Key Words: East Asia, exports, foreign direct investment, international trade, processed foods

JEL Classifications: F47, Q17, C3, F17

The evolution of international agricultural trade encompasses many facets. From a product perspective, processed foods have become the major growth market for U.S. exports. From a country perspective, developing countries, particularly East Asian countries, are the major growth markets for U.S. exports. From a market access perspective, foreign direct investment (FDI) has become even more important than exports as a means of accessing foreign markets. Thus, to increase U.S. competitiveness in entering foreign markets, it is important to examine the relationship between exports and FDI. The critical question is whether FDI is a substitute for or a complement of exports. Does an increase in FDI lead to an increase in exports? Alternatively, does an increase in FDI lead to a decrease in exports? This article begins by presenting the evolution of agricultural trade and then focuses on the determinants of and relationship between U.S. exports and FDI through a literature review, model development, and empirical estimation of a simultaneous equation system.

Recent Trends in Exports and FDI

U.S. agriculture has become more dependent on the export market. As shown in Figure 1, the volume and value of U.S. agricultural ex-

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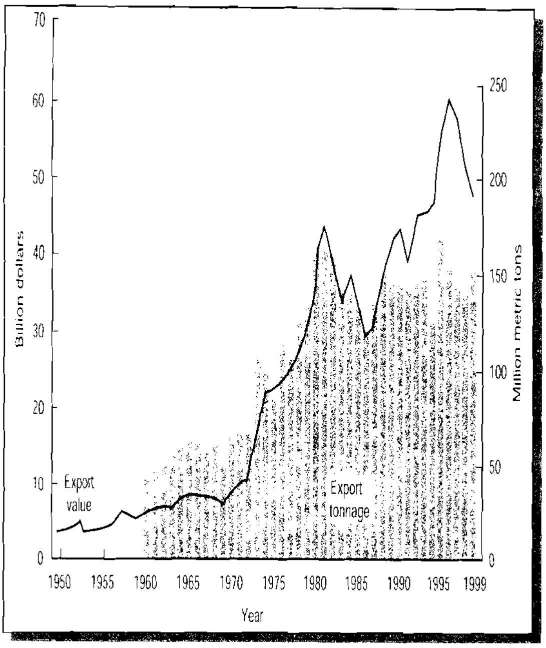

Figure 1. U.S. Agricultural Export Value and Volume, 1950–1999 (Source: Penson, Capps, and Rosson)

ports has dramatically risen. In 1998, over 30% of U.S. agricultural output was exported, accounting for 25% of U.S. farm income (Penson, Capps, and Rosson). For certain commodities, the export market is even more important (e.g., rice, cotton, and wheat, for which over 40% of production is exported).

Historically, bulk commodities have accounted for most of the United States's agricultural exports. Now bulk commodities have become less important in global trade in terms of export value (Figure 2). For example, bulk commodities accounted for nearly 70% of total U.S. agricultural exports in 1980 but declined to 40% in 1998 (Regmi and Gehlhar). According to the U.S. Department of Commerce, the food-processing industry is the largest manufacturing sector in the U.S. economy, accounting for about 14% of total U.S. manufacturing output (Henderson, Handy, and Neff). In 2000, U.S. exports of processed foods and beverages totaled $30 billion, up 4% following 2 years of small declines (Edmondson and Jones).

International trade has historically occurred between developed (high-income) countries. However, developing countries have become key participants in world trade. According to the International Monetary Fund (IMF) (2001), developing countries now account for 33% of world trade, up from 25% in the 1970s. Developing countries are the major growth market for U.S. agricultural products, having purchased 51% of all U.S. agricultural exports in 1999 (Figure 3). In the last decade, 7 of the top 10 U.S. export destinations—Mexico, South Korea, Taiwan, China, Hong Kong, Egypt, and Russia—have been devel-

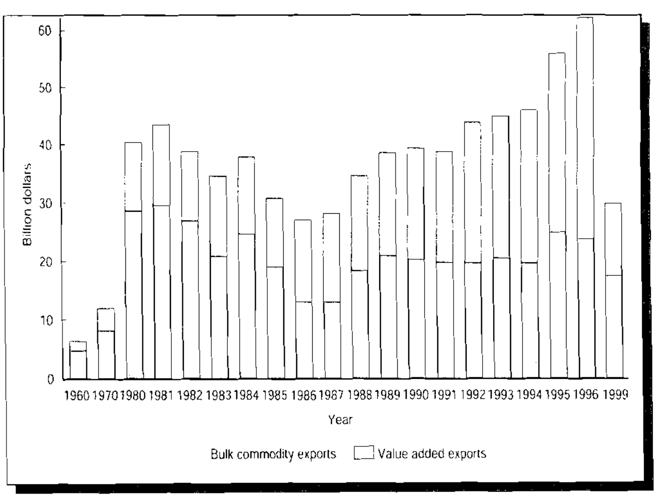

Figure 2. U.S. Agricultural Exports of Value-Added and Bulk Commodities, 1960–1999 (Source: Penson, Capps, and Rosson)

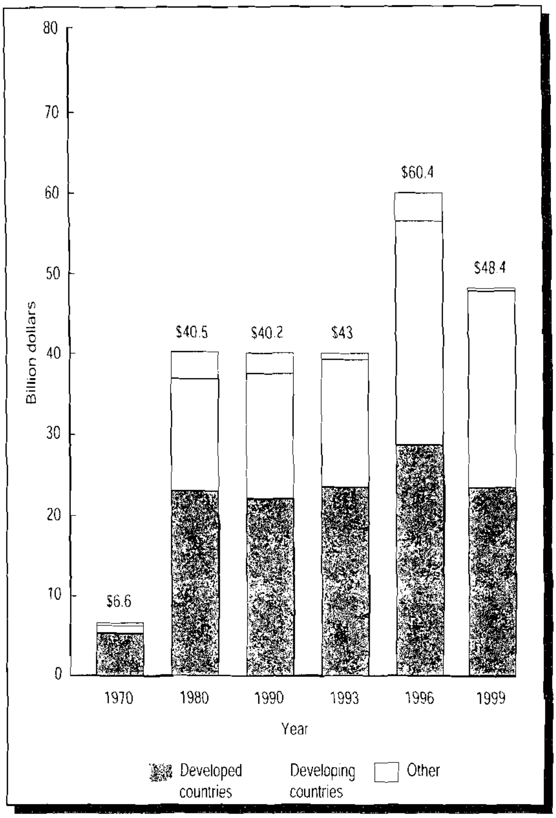

Figure 3. Major Markets for U.S. Agricultural Exports (Source: Penson, Capps, and Rosson)

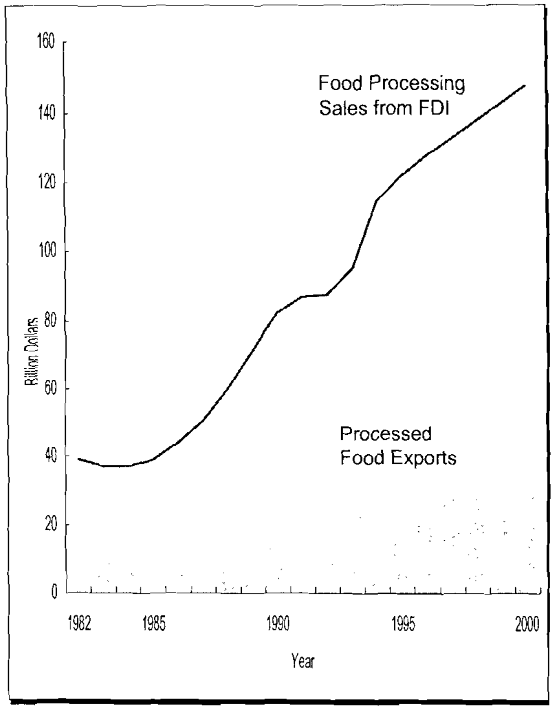

Figure 4. Processed-Food Sales from Foreign Direct Investment Exceed U.S. Exports (Note: 1999 and 2000 sales are estimates; Source: U.S. Department of Commerce, Bureau of Economic Analysis)

oping countries (U.S. Department of Agriculture, Economic Research Service [USDA-ERS] 2002b). Changes in population, rapid economic growth, liberalization of severe agricultural import restrictions, and adoption of a Western diet promote the future growth of East Asian markets.

East Asian countries (i.e., Japan, South Korea, Taiwan, China, and Hong Kong) have accounted for one third of total U.S. agricultural exports over the last decade (USDA-ERS 2002b). Additionally, Asian growth economies have also attracted FDI. According to the IMF (2001), FDI to developing countries, including Asian countries, rose steadily from $18 billion in 1990 to $138 billion in 1997. Even in the wake of the Asian currency crises (1997–1998), FDI has been noted for its stability compared with other forms of capital flows (IMF 2001). Thus, East Asian countries are an important component in analyzing processed foods.

Another facet in the evolution of international trade is the way agribusinesses access foreign markets (Figure 4). Historically, the export market has been the primary means of accessing foreign markets. FDI by U.S. agribusinesses provides a market access alternative that can be viewed as "tariff jumping." Foreign affiliate sales that stem from FDI are not subject to import tariffs or other trade barriers, in contrast to U.S. exports of similar products. In 2000, FDI sales of U.S. processed food were five times the amount of U.S. exports—$150 billion versus $30 billion (Bolling and Somwaru 2001).

Research Objectives

The purpose of this paper is to analyze the relationship between FDI and exports. Specifically, we (1) identify the determinants of U.S.

exports to and FDI in East Asian countries for the processed-food industry and (2) investigate the relationship between U.S. exports and FDI for the processed-food industry in East Asia; that is, whether they are substitutes or complements. Additionally, this article provides a review of trade and FDI literature, builds upon an existing theoretical FDI model, and contributes to the literature through the development of a simultaneous equation system for FDI and exports, which is estimated using two-stage least squares. Empirical analyses were used to examine the relationship between U.S. FDI and exports of processed foods into East Asian countries—China, Japan, Singapore, South Korea, and Taiwan—from 1989 to 1998.

Literature Review

Determinants of FDI

A large body of literature has been devoted to FDI in the manufacturing sector, but the literature has only recently begun to cover FDI as it applies to agriculture. Key literature includes work by Vernon (who focused on the product life cycle) and Hymer (who analyzed multinational enterprises [MNEs] on the basis of industrial organization theory) and the seminal book by Dunning (who introduced an ownership-location-internalization paradigm to explain FDI by multinational enterprises).

From a broad perspective, Dunning's ownership advantage explains *why* MNEs invest in foreign countries, location advantage explains *where* MNEs locate a foreign plant, and internalization advantage explains *how* MNEs enter a foreign country. Dunning's location advantage theory provides a framework to identify important variables that influence FDI in foreign countries using three main categories: (1) economic factors, (2) social or cultural factors, and (3) the political environment. Overall, Dunning concludes that foreign countries that attract investments by multinational firms have a large and growing market, a high gross domestic product (GDP), low production costs, and political stability. Other authors have built upon Dunning's framework to empirically assess factors that influence FDI (Gopinath, Pick, and Vasavada 1998, 1999; Graham; Lipsey and Weiss 1981, 1984; Malanoski, Handy, and Henderson; Ning and Reed; Pompelli; Somwaru and Bolling).

With regard to theoretical models, Bajo-Rubio and Sosvilla-Rivero developed a conceptual FDI model for Spain using cost minimization theory. They found a positive relationship between GDP and FDI, implying that multinational enterprises tend to invest in large-market economies. Trade barriers were found to positively influence FDI inflows, indicating tariff jumping. Additionally, inflation rates and the lagged capital stock were found to negatively influence FDI. However, results for unit labor and capital costs were not significant. Barrell and Pain developed a model using profit maximization theory, focused on U.S. investment, and found that gross national product, corporate profits, the effective exchange rate, relative wages, and capital costs positively influenced U.S. FDI abroad. In the short term, exports negatively influenced FDI, while in the long term, exports had a positive influence.

Determinants of Exports

Export determinants, like FDI determinants, include GDP and exchange rates. Additionally, the export price is an important factor influencing the quantity of exports. Ruppel evaluated the determinants of exports in the U.S. processed-food industry and found that exchange rates negatively affected exports, while a positive relationship existed between exports and both per capita GDP and foreign exchange reserves. Gopinath, Pick, and Vasavada's (1999) empirical results showed a negative relationship among exports and wages, interest rates, agricultural prices, and producer subsidy equivalents (PSEs, a proxy variable to capture trade barriers), while a positive relationship among export prices, per capita GDP, and exchange rates. Marchant, Saghaian, and Vickner, extending earlier research on U.S. exports to Canada (Munirathinam, Marchant, and Reed), examined exchange rates, GDP, and export prices as important factors in determining

Table 1. Determinants of Exports to and FDI in Foreign Countries

Indicator	Direction of Impact	
	FDI	Exports
Economic Advantages		
Market Size (GDP)	+	+
Degree of Development (GDP per capita)	+	+
Economic Growth (growth rate of GDP)	+	n/a
Exchange Rates	+	−
Exchange Rate Volatility	−	n/a
Wages	−	+
Interest Rates	−	−
Social and Cultural Advantages		
Language	+	n/a
Membership of EEC or OECD	+	n/a
Stage of Development (developing vs. developed)	+/−	n/a
Distance	−	n/a
Political Advantages		
Foreign Income Tax	−	n/a
Protection (PSE)	+	−
Export Prices	n/a	−

Notes: n/a indicates not used in empirical studies; + indicates positive impacts; − indicates negative impacts.

U.S. exports of processed foods to China. Both studies found a positive relationship between GDP and exports, while export prices were found to negatively influence exports. Table 1 summarizes the determinants of FDI and exports and their respective impacts on FDI and exports based on the above trade and FDI literature.

Exports and FDI Models—Substitutes or Complements?

One of two possible relationships—substitutive or complementary—describes FDI and exports. A substitutive relationship indicates that an increase in FDI will decrease exports to foreign countries and vice versa. In contrast, a complementary relationship indicates that FDI and exports move in the same direction.

Seminal work by Robert Mundell introduced a substitutive relationship between FDI and international trade. This relationship originated from the neoclassical Heckscher-Ohlin-Samuelson assumptions, whereby international trade is driven by differences in factor endowments and factor prices for homogenous products. These differences become smaller when international factors become mobile between countries and international trade flows decrease. Thus, Mundell concludes that capital movements, driven by FDI, are the perfect substitute for exports. Mundell also stated that import tariffs reduce exports and encourage FDI. Alternatively, Kojima described FDI as complementary to trade if FDI capital outflows create or expand the opportunity to export products. Lipsey and Weiss (1981) and Rugman stated that the production of one product by foreign affiliates may increase total demand for their entire product line, making FDI and exports complementary.

Empirical results appear to be mixed (Connor; Overend, Connor, and Salin; Pagoulatos). However, when empirical studies are viewed from a developed-versus-developing-country perspective, their results indicate that the relationship between FDI and exports tends to be substitutive between developed countries (Gopinath, Pick, and Vasavada 1999) and complementary between developed and developing countries (Bolling and Somwaru 2000; Carter and Yilmaz; Malanoski, Handy, and

Henderson; Marchant, Saghaian, and Vickner).

Theoretical Model

The above literature review described a variety of approaches used to model FDI and exports. Barrell and Pain developed a theoretical model that focused solely on FDI using profit maximization theory, while Bajo-Rubio and Sosvilla-Rivero used cost minimization theory for their FDI model. Gopinath, Pick, and Vasavada (1999) developed a theoretical model for both FDI and exports using profit maximization theory and estimated exports and FDI separately. Alternatively, Pfaffermayr (1994); Carter and Yilmaz; and Marchant, Saghaian, and Vickner estimated both FDI and exports simultaneously, but they did not develop an explicit theoretical model. This article contributes to the literature by building upon an existing theoretical FDI model (Bajo-Rubio and Sosvilla-Rivero) and developing a simultaneous equation system for FDI and exports. Estimation of this simultaneous system assesses the respective determinants of exports and FDI, in addition to determining whether these market access strategies are substitutes or complements.

As described above, multinational agribusinesses use both exports and FDI for market access strategies. Since exports and FDI are both included in a firm's strategy to maximize its profits, we develop two behavioral models—an FDI and an export model—that are ultimately linked on the basis of firms' simultaneous market access strategies for each of these endogenous variables.

FDI Model

The structure of the FDI model follows that of Bajo-Rubio and Sosvilla-Rivero, whose derivation is summarized in this section. We begin with a cost function faced by a firm with both domestic and foreign production plants. The firm must decide whether to produce domestically and export to the foreign market or implement FDI in the foreign market. Both scenarios require the firm to choose cost-minimizing output levels. The firm's objective is to minimize the total cost in both plants,

$$(1)\quad C = \alpha_d(Q_d)Q_d + \alpha_f(Q_f)Q_f,$$

where C denotes the total cost, α_d and α_f are unit costs in domestic and foreign plants, respectively, and Q_d and Q_f are respective quantities produced in each plant. Unit costs in both plants are a function of the quantity produced. The firm would minimize equation (1) subject to the constraint that output should equal total demand ($\bar{D}$):

$$(2)\quad Q_d + Q_f = \bar{D}.$$

Then, the Lagrangean function is obtained by combining equations (1) and (2) as follows:

$$(3)\quad L = \alpha_d(Q_d)Q_d + \alpha_f(Q_f)Q_f + \lambda(\bar{D} - Q_d - Q_f).$$

Differentiating equation (3) with respect to Q_d, Q_f, and λ yields

$$(4)\quad \frac{\partial L}{\partial Q_d} = \alpha_d' Q_d + \alpha_d(Q_d) - \lambda$$

$$(5)\quad \frac{\partial L}{\partial Q_f} = \alpha_f' Q_f + \alpha_f(Q_f) - \lambda$$

$$(6)\quad \frac{\partial L}{\partial \lambda} = \bar{D} - Q_d - Q_f,$$

where $\alpha_d' = d\alpha_d/dQ_d$ and $\alpha_f' = d\alpha_f/dQ_f$. Setting equations (4), (5), and (6) to zero and solving for Q_f gives

$$(7)\quad Q_f = \gamma_1\bar{D} + \gamma_2(\alpha_d - \alpha_f),$$

where $\gamma_1 = \alpha_d'/(\alpha_d' + \alpha_f')$ and $\gamma_2 = 1/(\alpha_d' + \alpha_f')$, and both are assumed to be positive. Equation (7) indicates that the output produced in the foreign plant is positively related to total demand ($\bar{D}$) and differences in unit costs. If $\alpha_d > \alpha_f$, the foreign plant increases its production. If $\alpha_d < \alpha_f$, the firm expands production in its domestic plant, resulting in a reduction in the output produced in its foreign plant.

Following microeconomic theory, Bajo-

Rubio and Sosvilla-Rivero then state that in addition to choosing the quantity of foreign production, Q_f, the cost-minimizing firm must also choose the quantity of inputs used to produce Q_f units. Assuming that the firm uses two inputs, labor and capital, the firm's total production cost in the foreign plant is

$$(8) \quad C_f = w_f L_f + k_f K_f,$$

where w and k denote the wage and the cost of capital. The firm minimizes the cost function expressed in equation (8) subject to the constraint given by the Cobb-Douglas production function

$$(9) \quad Q_f = L_f^a K_f^b.$$

The Lagrangean function is

$$(10) \quad L = w_f L_f - k_f K_f + \lambda(Q_f - L_f^a K_f^b),$$

with first-order conditions

$$(11) \quad \frac{\partial L}{\partial L_f} = w_f - \lambda a\left(\frac{Q_f}{L_f}\right)$$

$$(12) \quad \frac{\partial L}{\partial K_f} = k_f - \lambda b\left(\frac{Q_f}{K_f}\right)$$

$$(13) \quad \frac{\partial L}{\partial \lambda} = Q_f - L_f^a K_f^b.$$

Solving the first-order conditions in equations (11), (12), and (13) for K_f gives

$$(14) \quad K_f = \left[\left(\frac{b}{a}\right)\left(\frac{w_f}{k_f}\right)\right]^{a/(a+b)} Q_f^{1/(a+b)}.$$

Replacing Q_f from equation (7), we obtain

$$(15) \quad K_f = \left[\left(\frac{b}{a}\right)\left(\frac{w_f}{k_f}\right)\right]^{a/(a+b)} [\gamma_1 \bar{D} + \gamma_2(\alpha_d - \alpha_f)]^{1/(a+b)}.$$

In equation (15), desired capital stock is positively related to total demand ($\bar{D}$) and negatively related to the hosting country's unit costs relative to those of the home country. Unit costs in both the home and the foreign plants depend on the quantities of labor and capital used. Assuming substitution between labor and capital, the quantity of capital used depends on labor and capital costs.

Bajo-Rubio and Sosvilla-Rivero state that equation (15) might be augmented by adding the effect of trade barriers in the host country with an additional term in the cost function. The firm may increase capital investment in the foreign plant to increase production as a way to gain market access when trade barriers are high, consistent with tariff jumping. This implies that K_f is positively related to trade barriers. Thus, according to Bajo-Rubio and Sosvilla-Rivero, the capital stock in the foreign plant is a function of total demand (D), unit production costs (UC), and trade barriers (TB). Since FDI is determined on the basis of K_f, FDI is expressed as

$$(16) \quad \text{FDI} = \Phi(K_f) = f(D, \text{UC}, \text{TB}).$$

The host country's GDP is used as a proxy for its market size and reflects aggregate demand (D). Following Bajo-Rubio and Sosvilla-Rivero, we augment this equation by adding the exchange rate (ER). Also, unit costs are further divided into unit labor compensation costs (C) and capital costs (IR). Additionally, we extend Bajo-Rubio and Sosvilla-Rivero's model by including exports (XQ) to capture simultaneity with FDI as firms access foreign markets. Thus, the stylized FDI equation used in our model for selected Asian countries (China, Japan, Singapore, South Korea, and Taiwan) is expressed as

$$(17) \quad \text{FDI}_{it} = f(\text{GDP}_{it}, C_{it}, \text{IR}_{it}, \text{TB}_{it}, \text{ER}_{it}, \text{XQ}_{it}),$$

where i represents the importing country and t represents time. The hypotheses to be tested in the FDI model are as follows:

(1) GDP is positively related to FDI; as income increases, the demand for variety and quality of goods also increases.
(2) Compensation rates are negatively related to FDI; multinational firms tend to invest in countries with low compensation rates, thereby reducing production costs.
(3) Interest rates are negatively related to FDI;

a lower interest rate increases U.S. FDI in foreign countries.

(4) Trade barriers are positively related to FDI; the greater the foreign protection, the more likely a U.S. firm will invest in a host country instead of using exports to enter its market.

(5) Exchange rates positively influence FDI; an appreciation of the U.S. dollar (the U.S. dollar gets stronger relative to a foreign currency) causes an increase in U.S. FDI in foreign countries, since it is relatively cheaper for U.S. firms to buy foreign assets or to build plants in foreign countries.

(6) Exports could negatively or positively influence FDI. The sign of the parameter estimate on exports is important in determining whether FDI and exports are complements or substitutes. A positive parameter for exports indicates a complementary relationship between FDI and exports, while a negative parameter indicates a substitutive relationship.

Export Model

Since exports are known to be endogenous (Gopinath, Pick, and Vasavada 1999), we specified the U.S. export equation using consumer demand theory. Foreign demand in importing country i at time t for processed foods manufactured by U.S. firms is specified by

$$(18)\quad XQ_{it} = g(GDP_{it}, XP_{it}, ER_{it}, FDI_{it}),$$

where XQ denotes U.S. exports to foreign countries (China, Japan, Singapore, South Korea, and Taiwan) and XP denotes the U.S. export price for processed foods in foreign countries. Additionally, the endogenous FDI variable is included to capture simultaneity between export and FDI market access strategies. Hypotheses to be tested for the export model are as follows:

(1) GDP positively influences exports, implying that an increase in GDP causes an increase in exports; the demand for variety and quality of goods tends to increase as income rises.

(2) Export prices negatively influence exports, implying that a decrease in the export price causes an increase in the volume of U.S. exports, following the law of demand.

(3) Exchange rates (foreign currency per U.S. dollar) negatively influence exports; as the U.S. dollar appreciates, it becomes more expensive for foreign consumers to purchase U.S. imports, and U.S. exports decline.

(4) Finally, FDI could negatively or positively influence exports, depending on whether exports and FDI are complements or substitutes.

Data Description

Data fit by the above models were collected for the processed-food industry for 1989–1998 for the East Asian countries China, Japan, Singapore, South Korea, and Taiwan. Processed-food data were obtained using the Standard Industrial Classification level of aggregation for "Food and Kindred Products" (SIC-20), which includes meat, fish and dairy products, processed fruits and vegetables, grain mill and bakery products, sugar and confectionary products, fats and oils, beverages (including soft drinks and beer and wine), and other processed foods.

Annual data on U.S. affiliate sales (FDI) in China, Japan, Singapore, South Korea, and Taiwan were collected from *U.S. Direct Investment Abroad: Operations of Parent Companies and Their Affiliates* (U.S. Department of Commerce, Bureau of Economic Analysis [BEA]) for 1989–1997 and from the BEA Web site for 1998. Consistent with the FDI literature, foreign affiliate sales were used to capture FDI, with both sales and exports being flow variables and FDI being a stock variable.

Because export quantity and price data were not available, both were calculated from data provided by the USDA-ERS (Spring 2001). The primary source for raw export statistics was the U.S. Department of Commerce, Bureau of Census, and the USDA-ERS aggregated this data to the SIC-20 level. The above FDI data were reported at the two-digit SIC-

20 level, while USDA-ERS export quantity data were reported at the four-digit level and in various measurement units (e.g., kilograms, liters, metric tons, pieces). Thus, we calculated export quantities by first converting various units of data to metric tons and then aggregating all product categories within the SIC-20 four-digit code to the two-digit level. Analogous calculations were conducted for export prices.

Interest rate data for the United States and all host countries were obtained from the *International Financial Statistics Yearbook* (IMF 2000). The FDI empirical model includes relative interest rates between the host country and the United States. The GDPs of host countries were represented in millions of U.S. dollars and were obtained from the IMF (2002). The exchange rate is expressed in foreign currency units per U.S. dollar and was obtained from the USDA (2002a).

Compensation data include wages, salaries, and benefits received by employees in the processed-food industry in the United States and foreign countries from 1989 to 1998. Total employee compensation data for U.S. affiliates in host countries were collected from *U.S. Direct Investment Abroad: Operations of Parent Companies and Their Affiliates* (U.S. Department of Commerce, BEA) and from the BEA website. Data on total compensation for U.S. employees was collected from the U.S. Department of Labor's Bureau of Labor Statistics Web site.

Empirical Model and Results

Assuming a double log functional form, equations (17) and (18) are expressed as a simultaneous equation system that captures the endogeneity of the FDI and export variables:

$$(19)\quad \ln FDI_{it} = \alpha_0 + \alpha_1 \ln XQ_{it} + \alpha_2 \ln IR_{it} + \alpha_3 \ln C_{it} + \alpha_4 \ln ER_{it} + \alpha_5 \ln GDP_{it} + \alpha_6 \ln D + \mu_{1it}$$

$$(20)\quad \ln XQ_{it} = \beta_0 + \beta_1 \ln FDI_{it} + \beta_2 \ln XP_{it} + \beta_3 \ln ER_{it} + \beta_4 \ln GDP_{it} + \beta_5 \ln D + \mu_{2it},$$

where FDI is U.S. affiliate sales in each foreign country; XQ is the volume of exports of processed foods (SIC-20); IR is the interest rate, measured as a ratio of the foreign interest rate relative to the U.S. interest rate; C is the compensation rate, measured as a ratio of the foreign compensation rate relative to the U.S. compensation rate; ER is the exchange rate, measured as foreign currency per U.S. dollar; GDP is the gross domestic product in the foreign country; and XP is the export price for processed foods (SIC-20). Unfortunately, PSE trade barrier data are not available for Southeast Asian countries. Additionally, D denotes dummy variables for the countries, α_j and β_k are parameter estimates ($j = 0, \ldots, 6$; $k = 0, \ldots, 5$), i denotes the foreign country (China, Japan, Singapore, South Korea, and Taiwan), and t denotes the year (1989–1998). All data are expressed in nominal values. Parameter estimates are elasticities, since all variables are log transformed.

The Durbin-Wu-Hausman (D-W-H) test for endogeneity (Davidson and Mackinnon) was conducted, and empirical results verified that a simultaneous model was the proper specification. Thus, both the FDI and the export equations were regressed simultaneously using two-stage least squares with SAS software. Additionally, we required the exchange rate and export price coefficients to be equal in the export equation, consistent with the law of one price (Reed).

This simultaneous-equation model system was estimated with cross-section and time series data (e.g., five countries over 10 years). The Park test for heteroscedasticity and the Durbin-Watson test for autocorrelation were conducted. The Park test rejected heteroscedasticity for both the FDI and the export equations. The Durbin-Watson test rejected autocorrelation for both equations. Empirical results for FDI and exports are reported in Table 2.

FDI Empirical Results

Empirical FDI results show that exports positively influence FDI and are highly significant at the 5% level. The parameter estimate indicates that a 1% increase in exports causes FDI

Table 2. Parameter Estimates of Foreign Affiliate Sales and Exports

Variable	Foreign Affiliate Sales (*FDI*)	Exports (*XQ*)
Intercept	−2.15	7.30
	(−0.82)	(1.23)
Export Quantity (XQ) (metric tons)	0.26**	—
	(1.94)	
Foreign Affiliate Sales (FDI) (millions of U.S. dollars)	—	0.96***
		(6.89)
Interest Rates (IR) (foreign IR/U.S. IR)	−0.44***	—
	(−3.84)	
Exchange Rates (ER) (foreign currency/U.S. dollar)	0.55**	−0.59*
	(2.10)	(−1.68)
GDP (millions of U.S. dollars)	0.36***	0.47*
	(2.72)	(1.71)
Compensation Rates (C) (Foreign C/U.S. C)	0.36***	—
	(3.11)	
Export Prices (XP) (U.S. dollars/metric ton)	—	−0.59*
		(−1.68)
Model Diagnostics		
Adjusted R^2	0.98	0.92
Dummy Variables		
China	0.93	−0.80
	(1.18)	(−0.60)
Korea	−0.78	2.49***
	(−1.45)	(2.65)
Singapore	1.69	0.68
	(1.06)	(0.22)
Taiwan	1.10**	0.61
	(2.11)	(0.66)

Notes: All variables are log transformed; therefore, the parameter estimates are elasticities. Values in parentheses are t-ratios; *** is 1% significance level; ** is 5% significance level, and * is 10% significance level.

to increase by 0.26%. Therefore, we found a complementary relationship between U.S. FDI and exports for all five Southeast Asian countries (i.e., China, Japan, Singapore, South Korea, and Taiwan). Malanoski, Handy, and Henderson and Bolling and Somwaru (2000) suggested a complementary relationship between FDI and exports in developing countries. As four of the five countries examined are developing countries (e.g., China, Singapore, South Korea, and Taiwan), this empirical result is consistent with their findings.

Interest rates were found to negatively influence U.S. FDI and were also highly significant at the 1% level. This finding was consistent with our expectation that an increase in interest rates causes a decrease in FDI. The empirical result shows that a 1% increase in interest rates causes FDI to decreases by 0.44%. This result supports the empirical findings of Gopinath, Pick, and Vasavada (1999) and Marchant, Saghaian, and Vickner.

Exchange rates (foreign currency per U.S. dollar) were found to positively influence FDI and were highly significant at the 5% level. A 1% increase in exchange rates causes a 0.55% increase in FDI. This finding is consistent with our hypothesis that as the U.S. dollar appreciates, it will be cheaper for U.S. firms to invest in foreign countries.

Additionally, a 1% increase in foreign GDP causes a 0.36% increase in U.S. FDI (see Table 2). This parameter estimate was highly significant at the 1% level, and these results imply that U.S. agribusinesses invest in high-income countries. The importance of GDP has been verified by Gopinath, Pick, and Vasavada (1999); Marchant, Saghaian, and Vickner; Lipsey and Weiss (1981); and Ning and Reed.

Empirical results indicate that relative compensation rates (foreign compensation rate relative to U.S. compensation rate) positively affect FDI. Similar results were obtained by Barrell and Pain and by Gopinath, Pick, and Vasavada (1999). This finding was not consistent with our hypothesis that U.S. firms tend to invest in countries with low compensation rates. There are two possible explanations for this positive relationship between FDI and compensation rates. First, U.S. FDI flows into developed countries—which have high compensation rates—are higher than U.S. FDI flows into developing countries. This may indicate that relative productivity, rather than compensation rates, is a key in FDI flows. Second, this research focused on U.S. foreign affiliate sales in foreign countries rather than on capital flows into foreign countries since both endogenous variables, sales and exports, are flow variables. Thus, compensation rates and sales may not be related. Also, high U.S. affiliate sales may stimulate higher compensation rates by U.S. affiliates in foreign countries.

Additionally, dummy variables were used to capture the effects of cross-section data for specific countries. Japan is represented by the overall intercept term, so the parameter estimates on the four dummy variables indicate country-specific differences between Japan and the other four countries (i.e., China, Singapore, Taiwan, and South Korea). Only Taiwan's parameter estimate was significantly different from zero. The parameter estimate for Taiwan indicates that the average U.S. affiliate sales in Taiwan are higher than U.S. affiliate sales in Japan. Also, the adjusted R^2 for the FDI equation indicates that 98% of the variation of the dependent variable (FDI) is explained by the model.

Empirical Results for Exports

Table 2 also presents empirical results for the export equation. With regard to the FDI-export relationship, empirical results for the export equation reinforce FDI results. Specifically, empirical results for the export equation show that FDI positively influences exports and is highly significant at the 1% level. The parameter estimate indicates that a 1% increase in FDI causes a 0.96% increase in exports. Thus, although a complementary relationship exists, exports appear to stimulate FDI to a greater extent.

Empirical results show that exchange rates and export prices negatively influence exports, and these results were significant at the 10% level. These results are consistent with our above hypotheses. Additionally, we required the exchange rate and export price parameter estimates to be equal on the basis of the law of one price. Thus, as shown in Table 2, a 1% increase in either exchange rates or export prices causes a 0.59% decrease in U.S. exports to East Asian countries.

Empirical findings indicate that GDP in foreign countries positively influences U.S. exports, as expected, and these results were significant at the 10% level. These empirical results show that a 1% increase in foreign GDP leads to a 0.47% increase in exports. These results are consistent with the hypothesis that U.S. exports increase as income in foreign countries increases.

As with the FDI equation, dummy variables were used for China, South Korea, Singapore, and Taiwan, while Japan was represented in the overall intercept term. Only for South Korea was the parameter estimate significant at the 1% level. This parameter estimate indicates that the average quantity of U.S. exports to Korea was higher than that of U.S. exports to Japan. Additionally, the adjusted R^2 for the export equation indicates that 92% of the variation of the dependent variable (exports) is explained by the model.

Summary and Conclusions

This research examined the relationship between U.S. FDI in and exports to foreign countries for the processed-food industry (SIC-20) by estimating a simultaneous equation system for FDI and exports. The analysis focused on East Asian countries—China, Japan, Singapore, South Korea, and Taiwan—from 1989 to 1998. Additionally, variables that influence FDI and exports were identified.

Empirical results for the FDI equation indicated that interest rates, exchange rates, GDP, and compensation rates are important variables that influence U.S. FDI. Interest rates were found to negatively influence U.S. FDI in East Asian countries, consistent with our hypothesis that an increase in interest rates (the cost of financing) causes a decrease in investment. Exchange rates were found to positively influence FDI, supporting our hypothesis that as the dollar appreciates, it becomes relatively cheaper for U.S. firms to invest in foreign countries; thus, FDI increases. Additionally, GDP was found to positively influence FDI, indicating that an increase in foreign GDP causes an increase in U.S. FDI in East Asian countries. However, our finding for compensation rates was not consistent with our hypothesis. This may indicate that relative productivity is a more important variable than compensation rates in influencing FDI in developing countries. Also, this may indicate that there was no relationship between U.S. foreign sales (our measure for FDI) and compensation rates. Similar results were obtained by Gopinath, Pick, and Vasavada (1999).

Empirical results for the export equation indicate that GDP, export prices, and exchange rates are important determinants of U.S. exports to East Asian countries. Empirical results indicate that an increase in foreign GDP resulted in an increase in U.S. exports. These results are consistent with the hypothesis that the demand for goods increases as income increases. Empirical results indicate that an increase in export prices causes a decrease in U.S. exports to East Asian countries. This indicates that when the export price of processed foods increases, it will be more expensive for foreign consumers to purchase goods from the United States. Similarly, empirical results indicate that an increase in the exchange rate caused a decrease in U.S. exports, indicating that when the U.S. dollar appreciates, it will be more expensive for consumers in foreign countries to purchase goods from the United States.

Empirical results indicate a bidirectional complementary relationship between FDI in and exports to East Asian countries. This finding implies that FDI influences exports and that exports influence FDI. Four of the five countries examined are developing countries. Thus, this finding was consistent with the empirical results of Malanoski, Handy, and Henderson and Somwaru and Bolling, which suggest a complementary relationship between FDI and exports in developing countries.

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