Demand Determinants for U.S. Processed Food Exports to Emerging/Low and Middle-Income Countries

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Abstract

Because processed foods are the fastest growing segment of U.S. agricultural exports, it is imperative to understand the underlying factors behind this growth. The overall objective of this research is to examine demand for processed foods by low and middle-income countries and assess demand determinants and potential import growth. To achieve this objective, a "modified gravity model" is estimated for U.S. exports of processed foods to 10 low and middle-income countries from 1980-2002 using both classical linear regression and fixed effects approaches. Results indicate that population, income, level of urbanization and an open trade regime have a positive effect on demand for processed foods by low and middle-income countries. As expected, exchange rates and distance have an inverse relationship with imports. Empirical results from the fixed-effects model are similar, with the exception of population. A cross-country comparative analysis of leading potential markets for U.S. processed food exports over the years 2003-2012 concluded that Mexico, China and Brazil respectively are likely to be the three largest future markets for U.S. processed foods among the 10 emerging countries.

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The United States is the world's largest food exporting country and processed foods are the fastest growing sector of both U.S. agricultural exports and global food trade. Historically, bulk commodities accounted for the majority of U.S. agricultural exports. However, U.S. processed foods surpassed bulk goods in export value in 1991 (figure 1). This growth in processed food exports can be ascribed to growing demands in East Asia and North America, where incomes are rising, diets are diversifying, and, in the case of some East Asian markets, production capacity is constrained (USDA). Bulk commodity exports comprised nearly 70 % ($28 billion) of the total value of U.S. agricultural exports in 1980 but steadily declined to 35 % ($19 billion) in 2002 (USDA-ERS, 2003). During the same period, processed foods' share of total agricultural exports climbed to 65 %. Thus, processed food products[1] are the growth market for U.S. agricultural exports.

The global population is projected to increase by more than 1.2 billion between 1998 and 2018, and almost all of this growth will occur in low and middle-income countries (Regmi, et al., 2001). In terms of potential U.S. export markets, low and middle-income countries (see appendix A for the definition of low and middle-income countries) like China, India, Indonesia, Brazil, Mexico, Thailand, Turkey, Egypt, Argentina and Malaysia are among the most populous countries in the world, and many

[1] The food processing industry includes firms and their establishments that manufacture or process foods and beverages for human consumption and other related products. Examples of processed and consumer-ready foods used in this analysis include meats and meat products; poultry meats; dairy products; fats, oils, and greases; fresh fruits; dried, canned, and frozen fruits; fruit juice including frozen; nuts and nut preparations; fresh vegetables; frozen and canned vegetables; and oilseed products.

of their economies are among the fastest growing. Figure 2 describes U.S. agricultural exports by region. Asia, followed by Latin America, is the largest market for U.S. agricultural exports. China, Mexico, Thailand, Indonesia, Turkey and Egypt (ERS, 2003) also ranked among the top twelve markets for U.S. agricultural exports in 2003.

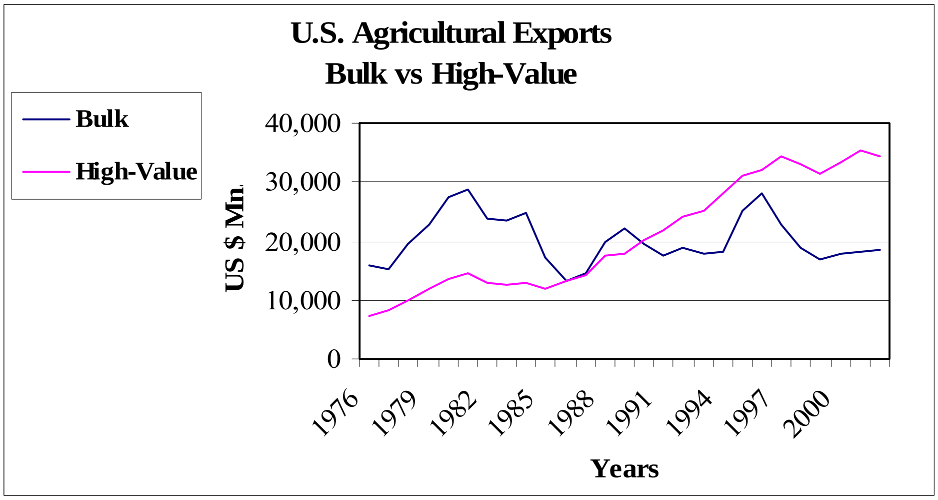


Figure 1. Value of U.S. agricultural exports in million U.S. $ for bulk and high value commodities, 1975-2000 (USDA-ERS, 2003).

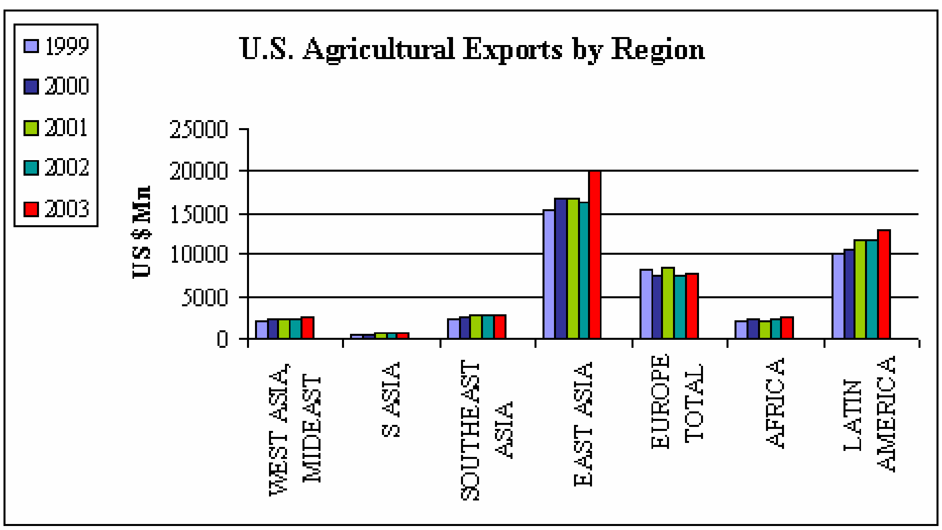
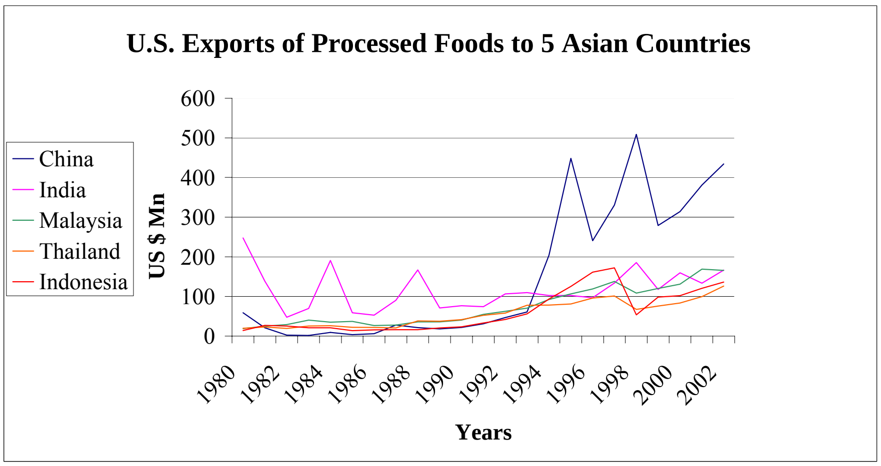


Figure 2. U.S. Agricultural Exports in million U.S. $ to 7 World Regions for 1999-2003 (FATUS, 2003).

A new research report prepared for the Goldman Sachs predicts that the combined economies of Brazil, Russia, China and India could be larger than the G-6 economies in less than 40 years (Wilson and Purushothaman). Furthermore, multinational food giant Nestle expects that by 2010 an additional 935 million Asians, many of them Chinese, will attain a purchasing power of nearly U.S. $1,800 a year. Many of these Asians will move to urban areas and their “protein’s source will be processed foods” (Hilsenrath).



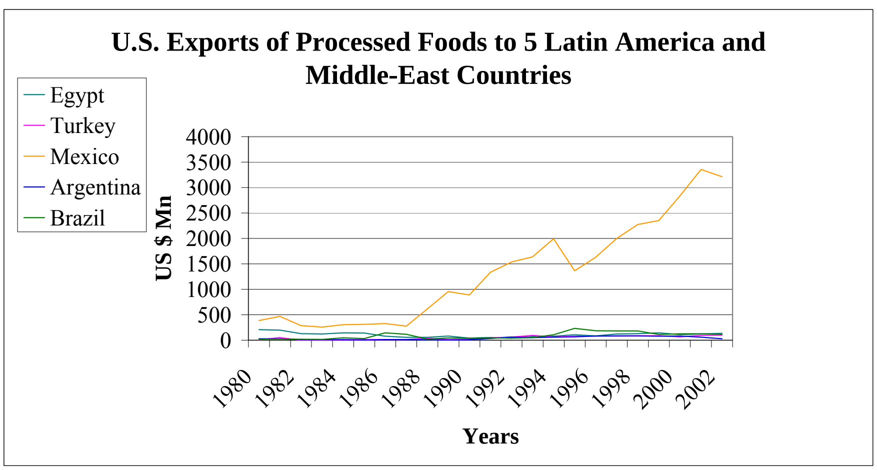


Figure 3. U.S. Processed Food Exports in Million U.S. $ to 10 Emerging Markets for years 1980-2002 (FATUS, 2003).

Research Objectives

The overall objective of this research is to examine demand for processed foods by low and middle-income countries, seeking to assess demand determinants and potential import growth for U.S. processed food exports. In addition to size and distance (the usual gravity variables), the impact of tariffs, urbanization and exchange rates on import demand for processed foods will be analyzed using an augmented gravity model. The overall objective was achieved by completing the following tasks:

1. Collect data on demand determinants for processed foods by the ten countries. Examples of consumption data include income, tastes and preferences, population and level of urbanization. Countries examined include Brazil, Argentina, Mexico, Thailand, Indonesia, Malaysia, China, India, Egypt and Turkey.
2. Analyze the trade regimes of these countries, e.g., degree of trade liberalization.
3. Develop an import demand model for U.S. exports of processed foods.
4. Conduct cross-country comparisons by using the results of the above model to map out potential future demand by these countries and rank the potentially lucrative markets for U.S. processed food exports.

Literature Review

Recent Trends in Processed Food Trade

Global food consumption patterns were transformed during the past decade due to increased urbanization, demographic shifts, higher incomes, improved transportation facilities, and consumer awareness of food quality and safety (Regmi, 2001). In developing countries, better retail facilities, paucity of time, and higher purchasing power among urban dwellers have changed eating habits and spurred demand for processed foods. In addition, the urban population in developing countries is expected to double to nearly 4 billion people by 2020 (Regmi and Dyck, 2001). This population growth will create a huge potential market for U.S. exports of processed foods (Regmi, 2001).

Consumers in middle-income and, especially, low-income countries spend a greater portion of their budget on staple food products (e.g. cereals) and are more responsive to changes in food prices and incomes (Gelhar and Coyle, 2001). However, this response differs across food items. For example, when prices and incomes change, consumers in low and middle-income countries make few adjustments to their staple food budgets relative to higher value food items (e.g. dairy and meat). Such changes have spurred global agricultural trade and altered its composition between bulk and processed foods. However, the impact of income growth in developed and developing countries on trade patterns is not similar (Regmi, 2001).

The Gravity Model

One of the most popular models used to estimate international trade flows is the gravity model. This model, developed by Tinbergen and Poyhonen in the early 1960s, is described as the "workhorse for empirical studies of the pattern of trade" (Bayoumi and Eichengreen, p. 142, 1997) and the "standard empirical framework used to predict how countries match up in international trade" (Rauch, p.10, 1999). The "formal theoretical foundations" of the gravity model for empirical studies of international trade are provided by Anderson, Krugman, Helpman and Bergstrand, and "are now well-established" (Baier and Bergstrand, 2001).

Gravity equations are log-linear, cross-sectional specifications that estimate nominal bilateral trade flow values between two countries (Baier and Bergstrand, 2001).

Bilateral trade flows follow the "physical principles of gravity" where two opposite forces - income and impediments to trade – determine the volume of bilateral trade (Fontagné and Pasteels). Impediments to trade include transportation costs, trade policies, uncertainty, cultural differences, and limited overlap in consumer preferences (Fontagné and Pasteels). The standard gravity model predicts that "countries with similar levels of output per capita will trade more than countries will dissimilar levels" (Frankel, 1997).

Krugman states that gravity equations successfully explain the volume of trade between two countries using few variables like the GDPs of the two trading countries and the distance between them. Krugman describes a typical gravity equation as follows:

$$T_{ij} = kY_i^{\alpha} Y_j^{\beta} D_{ij}^{-\gamma} \qquad (1)$$

where T_{ij} is the volume of trade between countries i and j; Y_i and Y_j are their respective GDPs; D_{ij} is the distance between the two countries; and k is a parameter. According to Krugman, estimation of equation (1) typically results in values of α and β that are one and a value of γ that is statistically different from zero (i.e. distance has a strong effect on trade). Frankel, Stein and Wei (1996) also found the effect of log distance on bilateral trade to be statistically significant.

It is common to add other variables to the basic gravity model. Frankel (1997) states that other explanatory variables[2], such as population to control for the size of the country and dummy variables representing trading blocks (to evaluate the effect of preferential trading agreements), are often added. Bergstrand (1985) and Fontagné and Pasteels also modify the theoretical model to control for various factors such as regional

[2] According to Frankel (1997), the effects of economic size (GDP) and population are independent.

trade integration and preferential arrangements. Baier and Bergstrand (2001) included variables representing trade barriers (e.g. transport costs and tariffs) to their model. Bougheas, Demetriades, and Morgenroth added infrastructure variables to their model because transport costs are not only a function of distance but also roads, ports, and telecommunication networks. Exchange rates (ER) are also included to proxy price and inflation (Bergstrand, 1985; Fontagné and Pasteels).

A modified gravity model, therefore, estimates the value of bilateral trade using variables representing GDP, population as a measure of the size of the market, trade impediments, and enhancement factors. Generally, a gravity equation estimates bilateral trade flows, but it may also be used to estimate the determinants of the volume of trade (Fontagné and Pasteels). Likewise, this research seeks to estimate the determinants of the volume of U.S. exports using a gravity equation.

Determinants of Food Trade

Coyle et al. (1998) examined the major determinants of changes in the structure of global food trade and identified income growth, food expenditures, factors of production, transport costs, and trade policy changes as key economic factors that explain shifts in trade patterns. They concluded that growth in income impacts food consumption more than any other factor. Gehlhar and Coyle (2001) found that that improved diet in developing countries, resulting from income growth, has contributed to changes in global trade patterns. However, the connection between changes in food consumption patterns and changes in world agricultural trade goes beyond income growth and dietary changes.

The global population is expected to increase by 1.2 billion people between 1998 and 2018. This expected growth in population (SZ) and rising incomes in developing countries are likely to account for most of the increase in global food demand over the next twenty years (Regmi, Deepak, Seale, and Bernstein, 2001). Lifestyle improvements are concurrent to rising levels of urbanization and result in greater emphasis on convenience and higher food consumption away from home.

Transport costs (DIS) are barriers to trade that vary by commodity. Transportation costs for processed foods are high owing to the perishable nature of many commodities (Gehlhar and Coyle, 2001). A reduction in overall transportation costs owing to better transportation technology will increase trade in processed foods (Regmi and Gelhar, 2001). Feenstra found that about two-fifths of trade growth relative to income is explained by the combined effect of declining transport costs and falling tariffs: the latter accounting for twice as much as the former. Transport costs are usually proxied by the distance between importing and exporting countries.

Trade Policy, Tariffs and Openness Index

High protection of agricultural commodities in the form of tariffs continues to be a barrier to world trade. Some countries provide unfair protection for certain domestic products by imposing high duties on comparable imported goods that result in higher prices for imported goods. The global average tariff on agricultural products is 62 % (Gibson et al.) and accounts for 52 % of the increase in world prices (Burfisher et al.). Although both developed and developing countries impose high tariffs, average agricultural tariffs in developing countries are much higher. Average commodity tariffs range from 50 to 91 %, with tobacco, meats, dairy, sugar, and sweeteners subject to the highest tariff rates (Gibson et al.). Reduction in tariffs will make certain food items more affordable in developing countries (Gehlhar and Coyle, 2001) and expand agricultural trade. The average tariff for the U.S. (12 %) is one of the lowest in the world. Therefore, U.S. agriculture stands to gain from global tariff reductions (Gibson et al.).

Membership in the World Trade Organization (WTO) is crucial in determining the tariff levels of importing countries. Two significant accomplishments of the WTO are the extension of trading concessions by member states to one another and market access for agricultural goods by introducing "tariffication" (dell'Aquila, Sarker and Meilke). Identification of potentially lucrative markets for U.S. processed food exports depends crucially on the prospects of trade liberalization by WTO members.

Krugman attributes the growth in world trade since 1950 to political causes. Specifically, recent growth is a response to the removal of protectionist measures and the lowering of tariffs that have restricted trade since 1913. Growth is not due to the commonly held journalistic view of technology-led reductions in transportation costs. Baier and Bergstrand (2001) concur with Krugman and concluded that income growth contributed 67 %, tariff-rate reductions 25 %, and transport-cost reductions 8 % to the real growth of world merchandise trade among several OECD countries between the late 1950s and late 1980s. According to Athukorala and Sen, inter-country differences in processed food exports' growth rates are influenced more by trade policy regime (TRAD) than by resource endowments. While resource availability is essential, exports of processed foods depend crucially on the "openness" of domestic trade policy.

Clearly, tariff rates and trade policies have a significant impact on international trade. Given the importance of trade policy to a country's propensity to import, trade regimes are significant in identifying the most lucrative future markets for U.S. exports of processed foods. However, it is difficult to quantify protectionism owing to different tariff rates applied to different commodities (Krugman) and the complex nature of commercial policies.

Edwards states that many variables, including tariffs, licenses, quotas, prohibitions and exchange controls, impact international trade. Attempts to measure trade orientation by a single indicator may be an exercise in futility or result in omitted variable error. Comparative measures of openness are also imperfect. Edwards cites other authors who state that South Korea is an open and outward-oriented economy for some, but for others it is semi-closed and government-controlled.

Sachs and Warner conducted a comprehensive study of the process of global integration and assessed its effects on the economic growth of reforming countries. They used cross-country indicators of trade openness or liberalization to classify each country's orientation to the global economy as "open" or "closed" and determined the year of trade liberalization, if at all. However, Edwards points out that this categorization of a trade regime as "open" or "closed" is a binary classification, which does not account for varying degrees of government intervention.

Theoretical Model

This research employs a variation of the cross-sectional gravity methodology discussed above to model the relationship between U.S. exports of processed foods and the variables that determine demand for such foods. Following Frankel (1997) and Bergstrand (1985), variables other than the "usual gravity variables" have been included to capture the impact of trade regime and urbanization on demand for U.S. exports. Following Summary, the theoretical model for our research is a gravity-type equation that estimates "one-way" trade, in our case, U.S. exports. The gravity model used in this investigation is defined as equation (2).

$$(2) \qquad EXP_{it}^{us} = f\,(SZ_{it}, GDP_{it}, ER_{it}, DIS_{i}, TRAD_{it}, URB_{it}) + \varepsilon_{it}$$

In equation (2), EXP_{it}^{us} is U.S. exports of processed foods to importing country i in time t, SZ is the population of importing country i, GDP is the gross domestic product of country i, ER is the exchange rate of country i in local currency per U.S. dollar, DIS is the distance between the U.S. and the importing country i, $TRAD$ is the trade regime of country i, URB is the level of urbanization in country i, and ε is a stochastic error term. Using equation (2), the following hypotheses are tested:

1) Population is positively related to imports (i.e., as population increases, demand for processed foods increases);
2) GDP is positively related to imports (i.e., as GDP increases, demand for processed foods also increases);
3) Exchange rates are negatively related to imports (i.e., an appreciation of the U.S. dollar, which occurs when more of a local currency is needed to buy a U.S. dollar, causes a decrease in demand for U.S. exports of processed foods by the importing country);
4) Distance is negatively related to imports (i.e., as distance between exporting and importing countries increases, demand for U.S. processed foods decreases);
5) Trade regime is positively related to imports (i.e., as a trade regime becomes "open," demand for U.S. processed foods increases); and

6) Urbanization is positively related to imports (i.e., as the importing country's level of urbanization increases, demand for U.S. processed foods increases).

Data Description and Methodology

Data on U.S. exports of processed foods (see footnote 1 for a complete list of processed foods) from 1980 to 2002 (23 years) for ten low and middle-income countries (China, India, Indonesia, Brazil, Mexico, Thailand, Turkey, Egypt, Argentina and Malaysia) were obtained from the Foreign Agricultural Trade of the U.S. (FATUS). Macroeconomic data on GDP and exchange rates for these countries were obtained from the USDA-ERS website. Following Fontagné and Pasteels, and Bergstrand (2001), nominal GDP at current exchange rates was used to proxy income of the importing country. Data on the levels of urbanization were compiled from the United Nations Population Division's 2001 World Urbanization Prospects. The shortest navigable distance between the U.S. and an importing country was measured in nautical miles (see www.distances.com for details).

Consumer profiles for each importing country's purchases of processed foods were constructed based on the following factors: size of urban population, age structure, percentage of women employed, consumer tastes and preferences, and perceptiveness to Western foods. However, because the process used to create the profile is ad hoc and lacks a standard scale of measurement, it was decided that is more appropriate to use level of urbanization as a proxy for consumer profile.

The variable representing trade regime for each of the ten countries is best constructed on the basis of a country's import policy and tariff structure. Unfortunately, data on tariff rates for processed foods for each of the ten countries over the period studied are not available. Furthermore, tariff rates are not the best measure of a trade regime's liberalization. Instead, a method proposed by Sachs and Warner to measure trade liberalization is used. Sachs and Warner categorized a trade regime as "closed" if at least one of the following was true:

1) Non-tariff barriers (NTBs) covering 40 % or more of trade;
2) Average tariff rates of 40 % or more;
3) A black market exchange rate that is depreciated by 20 % or more relative to the official exchange rate, on an average, during the 1970s or the 1980s;
4) A socialist economic system (as defined by Kornai); and
5) A state monopoly of major exports, defined by a score of 4 on the export-marketing index in a 1994 World Bank study.

Table 1. Year of trade liberalization of each country included in the study, if the country has an open trade policy, and the year that trade regime was opened, based on Sachs-Warner (1995).

Country	Trade Policy	Year Opened
China	Closed	Never Open
India	Open	1994
Indonesia	Open	1970
Thailand	Open	Always Open
Malaysia	Open	1963
Egypt	Closed	Never Open
Turkey	Open	1989
Brazil	Open	1991
Argentina	Open	1991
Mexico	Open	1986

Table 1 reports the results of Sachs and Warner for each of the ten countries used in this study. Note that the results of Sachs and Warner were established in 1994. Also note that the average tariff levied by the ten countries is not identical. Indonesia, Thailand, and Malaysia are not as "open" as the U.S., but they are more liberalized than most developing countries (Sachs and Warner). Given that each of the ten countries is now a member of the WTO, it is assumed that the "open" economies remained so through the end of the sample period. For Egypt and China, which were they are assigned a "closed" trade regime for the entire period of the study. Developing countries are not required to bring their tariff rates into full compliance with WTO regulations until 2005.

Empirical Results

Equation (2) is estimated as a classical linear regression model and also as a fixed-effects model. Following Frankel (1997), the gravity model is first estimated using ordinary least-squares (OLS) regression analysis. Frankel (1997) states that trade data usually contain enough information to obtain reliable estimates for country size, proximity, and the other variables in the gravity model. Next, the gravity model is modified to account for country specific fixed-effects. The fixed-effects model is also estimated using OLS.

The Classical Linear Regression Model

The data used in this study are arranged into a pooled, cross-section and time-series panel (NT= 230; N= 10 countries and T= 23 years). Following Baier and Bergstrand (2001), and Frankel (1997), equation (2) is estimated in natural log specification. The semi-log expression for equation (2), using the relevant independent variables previously discussed, yields equation (3). Note that in equation (3), all variables are transformed except the dummy variable for trade regime (TRAD).

(3) $$lnEXP_{it}^{us} = \beta_0 + \beta_1 lnSZ_{it} + \beta_2 lnGDP_{it} + \beta_3 lnER_{it} + \beta_4 lnDIS_i + \beta_5 TRAD_{it} + \beta_6 lnURB_{it} + \varepsilon_{it}$$

All variables and the *i* and *t* subscripts are identical to those defined in equation (2). The difference is that all continuous variables are now natural log transformations. Recall that

i = country 1,…….,10 (China, India, Indonesia, Malaysia, Thailand, Brazil, Argentina, Mexico, Egypt and Turkey respectively); and

t = years 1,2,………..23 (1980 through 2003).

Equation (3) was estimated using the STATA statistical computer program (www.stata.com/support/faqs/stat). No multicollinearity was detected among the variables. The Durbin-Watson test for autocorrelation was conducted and AR (1) was found to be present. The modified Wald test detected group-wise heteroskedasticity. The Breusch-Pagan Lagrange Multiplier (LM) test of independence was conducted and cross-sectional correlation was detected. This equation was then re-estimated using feasible generalized least-squares (FGLS) regression (Greene; Kmenta) with corrections for group-wise heteroscedasticity, cross-sectional correlation and panel-specific first-order autocorrelation.

Empirical results reported in table 2 indicate that all coefficients have the correct signs and are statistically significant at the 5 % level (or better). Population, GDP, trade regime, and the level of urbanization have a positive effect on import demand for U.S. processed foods, whereas distance and exchange rates have a negative impact. Keeping in mind that the parameter estimates represent elasticities, a 1 % increase in the population of the importing country increases U.S. exports by 0.31 %. A 1 % increase in GDP increases imports by 0.16 %. The opening of a hitherto closed trade regime leads to

Table 2. Parameter Estimates and t-values from estimation of U.S. Exports of Processed Foods (equation 3) to 10 developing countries from 1980 to 2002, plus variable means and standard deviations.

Variable	Coefficients	Std. Error	*t*-value	Std. Dev.	Mean
Intercept	10.65***	3.59	2.96		
Population (SZ)	0.31***	0.09	3.4	1.28	18.51
Income (GDP)	0.16***	0.02	7.02	5.01	23.12
Exchange Rates (ER)	-0.09***	0.01	-5.34	6.44	1.19
Distance (DIS)	-0.50***	0.18	-2.79	0.84	8.58
Trade Regime (TRAD)	0.30***	0.11	-2.59	0.49	0.58
Urbanization (URB)	0.58**	0.27	-2.11	0.5	3.77
Model Diagnostics					
Adjusted R2	0.55				

Note: *** is 1% significance level; ** is 5% significance level. All coefficients represent elasticities.

a 30 % increase in imports. A 1 % increase in the level of urbanization increases imports by 0.58 %. A decline in the value of a local currency by 1 % decreases import demand by 0.09 %. As distance gets shorter by 1 %, imports increase by 0.50 %.

The Fixed Effects Model

Finally, equation (2) is modified to allow for estimation using a panel data model for fixed-effects. The "fixed-effects" model is also known as the Least Squares Dummy Variable (LSDV) Model or the Covariance Model. The error terms satisfy all assumptions of the classical linear regression model (Greene). A country dummy is added to indicate the *i*th unit (D = 1, for country i, 0 otherwise), which forms the unique intercept for each country. Differences across countries are captured in differences in the intercept (Greene). The fixed effects model is expressed as follows:

$$(4) \qquad lnEXP_{it}^{us} = \alpha_{1.}d_{1it} + \alpha_{2.}d_{2it} + \ldots\ldots + \alpha_{10.}d_{10it} + \beta_1 lnSZ_{it} + \beta_2 lnGDP_{it} + \beta_3 lnER_{it} + \beta_4 lnDIS_i + \beta_5 TRADit + \beta_6 lnURB_{it} + \varepsilon_{it}$$

where the earlier definitions for the variables hold. d_{jit}s are country dummies, equal to 1 if $j = i$, 0 otherwise.

First, tests for autocorrelation within the country-groups were conducted. Autocorrelation was detected and corrected. Cross-sectional heteroskedasticity was also detected and corrected. This equation was then estimated using the SAS statistical computer program (SAS OnlineDoc, v. 8). Because distance is constant over time, it is collinear with the country dummy variables and, is removed from estimation. Although the exclusion of distance implies that this model is not the standard form of a "full gravity equation" as stated by Frankel (1997), the effect of distance is captured by the country dummy variable. The results are shown in table 3.

Table 3. Parameter Estimates and t-values from Fixed Effects estimation of U.S. Exports of Processed Foods to 10 Developing Countries for 1980 to 2002.

Variable	Coefficient	Std. Error	*t*-value
Population (SZ)	-0.46***	0.09	-5.13
Income (GDP)	0.81***	0.08	10.14
Exchange Rate (ER)	-0.76***	0.08	-8.96
Trade Regime (TRAD)	0.40***	0.46	2.84
Urbanization (URB)	3.30***	0.14	7.14
Estimated Fixed Effects			
China	-5.56***	1.57	-3.54
India	-3.93	2.88	-1.37
Malaysia	-65.02***	8.56	-7.59
Thailand	-13.53*	7.89	-1.71
Indonesia	2.53	3.12	0.81
Turkey	2.04	1.81	1.13
Egypt	-20.48***	4.14	-4.94
Mexico	-37.98***	7.44	-5.1
Argentina	-10.20***	1.06	-9.57
Brazil	-17.05***	2.09	-8.12
Model Diagnostics			
Adjusted R^2	0.99		

Notes: *** is 1% significance level; ** is 5% significance level; * is 10% significance level. All parameters represent elasticities.

Empirical results indicate that fixed effects for countries are statistically significant at the 10 % level except for India, Indonesia and Turkey. The *F*-test for group effects (Ho: $d_1 = d_2 = \ldots = d_{10} = 0$) indicates that country-effects are present and the relationship of U.S. exports of processed foods to each of these 10 countries is unique due to country variations. Coefficients for all variables except population have the correct signs and are statistically significant at the 1 % level. Income, an open trade regime and the level of urbanization have a positive effect on import demand. A 1 % increase in GDP causes imports to go up by 0.81 %. The opening of a hitherto closed trade regime leads to a 40 % increase in imports. A 1 % increase in the level of urbanization causes imports to increase by 3.30 %. Exchange rates have a negative impact on import demand. A 1 % decline in the value of local currency causes demand for imports to contract by 0.76 %.

Population, contrary to our hypothesis, was found to have a negative effect on demand for U.S. processed foods. The parameter estimate indicates that a 1 % increase in population causes exports to decrease by 0.46 %. This result is consistent with the conclusion of Frankel (1997) that population may have a negative impact on trade. Large countries are less open to trade as a percentage of GDP than smaller countries, which are more dependent on trade. To test this phenomenon, we estimated our gravity equation with income, population and the level of urbanization as quadratic variables and found that the effect of population on import demand increases at a decreasing rate, indicating a non-linear relationship. After the maximum population level for this quadratic variable was reached, an increase in population had a negative effect on import demand. Since China and India's populations are over one billion respectively, they skew the overall effect of population in our model.

Cross-Country Comparison and Predictions

Notwithstanding the empirical success of the classical gravity equation in explaining bilateral trade flows, its predictive potential is limited (Bergstrand, 1985). The predictive potential of the model, estimated in this investigation, is also limited given an R^2 value of 0.55. Nonetheless, a cross-country comparison was conducted to rank the ten low and middle-income countries as future markets for U.S. exports of processed foods. Countries were ranked on the basis of predictions for the period 2003-2012 using the parameter estimates of the above classical regression model and variable forecasts. Data on future projections of macroeconomic variables such as GDP, exchange rates, and population for each country were compiled from the USDA-ERS. China and Egypt were assigned an "open" trade regime from 2006 onwards. We assume that these two countries will become sufficiently open by 2005 (when all developing countries, who are WTO members, become fully compliant with WTO tariffs regulations), even though they may not qualify as "open" trade regimes under the Sachs-Warner methodology. These projections are shown in table 4.

Table 5 sums the yearly projections reported in table 4 and ranks the ten studied countries according to total projected U.S. exports. Mexico is predicted to be the largest importer of U.S. processed foods, followed by China and Brazil. Despite being only the fifth largest among the ten studied countries, Mexico is projected as the largest potential market for U.S. processed food exports due to the significant impact of distance on the volume of trade. Mexico shares a common border with the U.S. and the estimation of the classical gravity model returns a high coefficient of –0.50 on distance. Furthermore, the parameter estimates of an "open" trade regime are high both in the classical and fixed-effects models. Mexico is a member of NAFTA and U.S. exports are allowed unrestricted access to that country at very low or zero duty. In addition, Mexico's per capita income is relatively higher than most emerging markets. Malaysia, Thailand and Turkey are projected as the three smallest markets due to their lower population and longer distance from the U.S.

Table 4. Projected U.S. Exports of Processed Foods in million U.S. $ between 2003 and 2012.

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
China	286.9	295.4	304.3	425.8	440.5	455.2	470.5	485.9	501.2	516.9
India	219.9	224.3	229.0	234.2	239.5	244.9	250.4	256.0	261.8	267.8
Indonesia	83.7	87.2	90.8	94.5	98.2	102.0	105.9	109.8	113.7	117.7
Mexico	788.0	804.8	821.9	839.6	857.5	875.8	894.3	913.2	932.4	951.9
Argentina	163.7	171.5	179.6	187.6	195.1	202.2	209.5	217.0	224.8	232.8
Brazil	354.3	361.1	369.4	377.8	386.3	395.0	403.8	412.5	421.3	430.3
Egypt	86.8	88.6	90.5	125.3	128.1	131.1	134.0	137.0	140.2	143.4
Thailand	55.9	57.0	58.1	59.2	60.4	61.5	62.6	63.7	64.9	66.1
Malaysia	77.6	79.7	81.8	83.9	86.0	88.2	90.4	92.7	94.9	97.3
Turkey	53.3	55.9	58.8	61.7	64.7	67.9	71.1	74.6	78.1	81.9

Table 5. Country Ranking based on Total Projected U.S. Exports of Processed Foods in million U.S. $ from 2003 to 2012.

Rank	Country	Projected U.S. Exports
1	Mexico	8679
2	China	4182
3	Brazil	3912
4	India	2428
5	Argentina	1984
6	Egypt	1205
7	Indonesia	1003
8	Malaysia	872
9	Turkey	668
10	Thailand	609

Summary and Conclusions

This research examines the determinants of U.S. exports of processed foods to ten emerging markets from 1980 to 2002 using a gravity model. The ten low and middle-income countries analyzed included China, India, Indonesia, Brazil, Mexico, Thailand, Turkey, Egypt, Argentina and Malaysia.

The “modified gravity model” was estimated using two approaches. Empirical results from the classical linear regression analysis indicate that, consistent with our hypotheses, population, GDP, level of urbanization and an open trade regime positively impact U.S. exports of processed foods. As expected, exchange rates and distance were found to have a negative effect on U.S. exports. These empirical results are consistent with the findings of Coyle, Gehlhar, Hertel, and Wang (1998) and Regmi, Deepak, Seale, and Bernstein (2001).

Empirical results from the fixed-effects model are similar to those from the classical linear regression model, with the exception of population. Population, contrary to expectations, has a negative relationship with import demand for U.S. processed foods. However, this negative impact of population is consistent with the findings of Frankel (1997). Group-effects are present for all the 10 countries and 7 of these are statistically significant, indicating that the relationship of U.S. exports of processed foods to each of these 10 countries is unique.

A cross-country comparative analysis was conducted to rank the ten markets for U.S. exports of processed foods in the future. Countries were ranked on the basis of predictions for the period 2003-2012 using results from the classical regression model. Mexico is predicted to be the largest importer of U.S. processed foods, followed by China and Brazil. So, what do the empirical results of this research imply? Among the emerging markets, countries with open trade policies offer better opportunities to U.S. exporters of processed foods. Also, middle-income countries that are not too distant from the U.S. are projected as more lucrative markets.

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APPENDIX A

Definition of Low and Middle-Income countries:

Income group: Economies are divided according to 2002 GNI per capita, calculated using the World Bank Atlas method. The groups are: *low income*, $735 or less; *lower middle income*, $736 - $2,935; *upper middle income*, $2,936 - $9,075; and *high income*, $9,076 or more (The World Bank, 2004)

China	Lower-middle-income
India	Low-income
Indonesia	Low-income
Thailand	Lower-middle-income
Malaysia	Upper-middle-income
Egypt	Lower-middle-income
Turkey	Lower-middle-income
Brazil	Lower-middle-income
Argentina	Upper-middle-income
Mexico	Upper-middle-income