AN ANALYSIS OF VALUE-ADDED AGRICULTURAL EXPORTS TO MIDDLE-INCOME DEVELOPING COUNTRIES: THE CASE OF WHEAT AND BEEF PRODUCTS

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Abstract

This study determined probable future directions in U.S. value-added agricultural exports to middle-income developing countries (MIDCs) under the assumption of continued income growth. Import share equations for U.S. bulk, semi-processed and value-added wheat or beef products, as a percent of total U.S. wheat or beef product exports to each MIDC, were econometrically estimated using the ordinary least squares (OLS) technique. The empirical results indicate that in most MIDCs, increases in real per capita income have negative effects on the import share of processed wheat products while having positive effects on the import share of bulk wheat. However, import shares of U.S. processed beef products are likely to increase with income growth in most MIDCs.

Key words: value-added agricultural exports, middle-income developing countries (MIDCs), processed and semi-processed products

The term "value-added agricultural exports" denotes both processed products, because they have added value through some processing, and unprocessed high-value commodities. Table 1 classifies agricultural commodities in bulk and value-added form. Nuts, fresh fruits, and vegetables are categorized as unprocessed high-value commodities. Processed products can include both semi-processed and highly processed products.

Because value-added agricultural products involve a larger scope of economic activity than bulk commodities, the promotion of value-added agricultural exports is likely to stimulate the economy. Schluter and Clayton argue that

> ... exporting processed commodities instead of their bulk agricultural components provides an export market for those domestic goods and services required to assemble, process, and distribute the processed commodities. Three measures of the potential increase in economic activity associated with processed commodities are appropriate for consideration: (1) direct plus indirect plus induced output or business activity; (2) the employment associated with this increased business activity; and (3) the personal income generated by the increased business activity.

Schluter and Edmondson estimated that if one million dollars-worth of wheat exported as bulk form were exported as wheat flour instead, an additional $9 million of business activity, employment for 109 workers, $1.9 million of personal income, $160,000 of federal personal income taxes, and $199,000 of federal corporate income taxes would be generated. If so, then prospects for expanding value-added agricultural exports, in addition to bulk exports, should be of great interest to policy makers.

The United States has recently become one of the largest exporters of value-added agricultural products. Historically, the United States has exported low-value primary products because it has had a comparative advantage in producing bulk commodities such as wheat, cotton, corn, and soybeans (Nuttall). Since 1981, the value of total U.S. agricultural exports had decreased until the slight recovery in 1987. The principal factor causing the sharp drop in exports of bulk commodities was a substantial production increase in both major exporting and importing countries. Other factors include the strong value of the U.S. dollar, the impact of global debt, and increased food self-sufficiency in many developing country markets. However, value-added exports have shown relatively little decline despite these circumstances, and the value of value-added exports has increased over the past four years. In 1988, value-added exports were 42.5 percent of total agricultural exports, up from 29.5 percent in 1980 (Table 2).

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Table 1. Classification of Agricultural Commodities

Commodity Groups	Bulk	Value-Added[a]
Grains and Feeds	Unmilled Wheat Feed Grains Rice, Milled	Wheat Flour Bulgur Wheat Feeds and Fodders Other Grain Products Other Wheat Products
Oilseeds and Products	Oilseeds	Oilcake and Meal Vegetable Oils
Animals and Animal Products	Animals, Live (Including Poultry, Live)	Meats Dairy Products Fats, Oils, Greases Hides and Skins Wool and Mohair Sausage Casings Bull Semen Misc. Animal Products
Horticultural and Tropical Products	Hops, Including Extract Rubber-Crude, Natural Pulses Fibers except Cotton	Fruits and Prep. Fruit Juices Wine Nuts and Prep. Vegetables and Prep. (Excluding Pulses, Hops) Sugar and Tropical Products
Cotton, Tobacco, Seeds, and Others	Cotton Tobacco-Unmtg. Seeds	Beverages (Excluding Juices) Nursery and Greenhouse Products Essential Oils

[a] Includes semi-processed and processed products (because it has added value through some processing) as well as some unprocessed high value products such as fresh fruits, vegetables, and nuts.

Source: *Foreign Agricultural Trade of the United States* (FATUS), USDA

Table 2. U.S. Agricultural Exports

Year	Bulk	Value-Added	Total	Percentage[a]
	million dollars			
1980	29,073	12,160	41,233	29.5
1981	30,545	12,792	43,337	29.5
1982	25,425	11,198	36,623	30.6
1983	24,925	11,174	36,099	31.0
1984	26,357	11,447	37,804	30.3
1985	18,506	10,520	29,026	36.2
1986	14,436	11,781	26,217	44.9
1987	15,813	12,825	28,638	44.8
1988	21,341	15,752	37,093	42.5

[a] Value-added as a percent of total exports.

Source: USDA, *Foreign Agricultural Trade of the United States,* Calendar Year, 1980-1988.

A significant proportion of the increase in both world and U.S. exports of value-added products since 1970 results from the rapid income growth in both developing and developed economies. The growth in U.S. value-added exports has occurred in spite of many trade barriers. Subsidized sales from competitors such as the European Community (EC) and Brazil have diminished the level of U.S. exports (Rahe and Collie).

The central objective of this study was to determine probable future directions in value-added exports to middle-income developing countries under the assumption of continued income growth. Wheat and beef products were selected. Beef products were disaggregated into live cattle, fresh or frozen beef, and prepared beef. Wheat products were disaggregated into unmilled wheat, wheat flour, and other wheat products (Table 3).

Most U.S. exports of wheat have been in bulk form. In 1988, 4.6 percent of all wheat exports were in value-added form. The majority of beef exports, however, have been in processed form. In 1988, 84.6 percent of all beef product exports were value-added (Table 4).

Table 3. Selected Agricultural Commodity Groups

Group/Product	Beef	Wheat
Bulk	Live Cattle	Unmilled Wheat
Semi-Processed	Fresh or Frozen Beef	Wheat Flour
Value-Added	Preserved or Prepared Beef	Wheat Products

As middle-income developing countries have emerged as large agricultural importers in world markets, the importance of further studies on these countries has increased. Table 5 shows total U.S. agricultural exports and U.S. agricultural exports to middle-income developing countries (MIDCs). As shown in the table, the U.S. agricultural export share to these countries has increased in the 1980s. U.S. agricultural exports to these countries were 14.1 percent of total U.S. agricultural exports in 1982, but has increased to 21.3 percent in 1988. Hence, these markets have become more important for U.S. agricultural exports.

Middle-income developing countries (MIDCs) are usually classified on the basis of income levels. In this study, MIDCs are defined by the following three criteria:

Table 4. Total U.S. Wheat and Beef Exports: 1980-1988

	Bulk		Value-Added		Total			
Year	Wheat	Beef	Wheat	Beef	Wheat	Beef	Wheat%[a]	Beef %[a]
	million dollars							
1980	6,375	55	283	249	6,658	304	4.3	82.0
1981	7,844	65	309	300	8,153	365	3.8	82.1
1982	6,676	50	252	373	6,928	423	3.6	88.2
1983	6,235	44	325	392	6,560	436	5.0	89.9
1984	6,473	56	267	470	6,740	526	4.0	89.3
1985	3,607	122	291	467	3,898	589	7.5	79.3
1986	3,007	109	273	622	3,280	731	8.3	85.1
1987	3,043	105	236	771	3,280	876	7.2	88.0
1988	4,888	202	236	1,109	5,124	1,311	4.6	84.6

[a] Value-added as a percent of total.

Source: USDA, *Foreign Agricultural Trade of the United States*, Calendar Year, 1980 - 1988.

Table 5. U.S. Agricultural Exports to MIDCs

Countries	1982	1983	1984	1985	1986	1987	1988
	million dollars						
Singapore	157	153	145	113	118	127	147
Hong Kong	392	357	412	389	400	466	489
Korea	1,581	1,840	1,650	1,413	1,306	1,833	2,274
Taiwan	1,155	1,308	1,458	1,231	1,171	1,285	1,661
Algeria	167	211	199	227	287	310	596
Malaysia	144	131	123	94	78	90	99
Israel	353	306	334	277	255	271	329
Jordan	73	79	98	48	45	44	83
Mexico	1,156	1,942	1,993	1,439	1,080	1,202	2,234
Sub Total	5,177	6,327	6,411	5,231	4,741	5,629	7,911
Total U.S. Agricultural Exports	36,627	36,099	37,804	29,041	26,222	28,709	37,093
Percentage[a]	14.13	17.53	16.96	18.01	18.08	19.61	21.33

[a] U.S. agricultural exports to MIDCs as percent of U.S. total agricultural exports.

Source: USDA, *Foreign Agricultural Trade of the United States*, Calendar Year, various issues.

(1) GNP per capita in constant 1985 U.S. dollars ranging from $1,500 to $8,000,
(2) A positive annual average growth rate of GNP per capita during 1980-1985,
(3) Population greater than 2.5 million in mid-1988.

On the basis of the above criteria, MIDCs include Singapore, Hong Kong, Korea, Taiwan, Algeria, Malaysia, Israel, Jordan, and Mexico.

In the past decade, the majority of U.S. wheat exports to MIDCs have been in bulk form. The value-added share of wheat exports to MIDCs since 1980 has been less than 1 percent. However, the value-added share of total U.S. wheat exports to all world destinations has averaged 5.4 percent since 1980 (Tables 4 and 6). In world value-added wheat markets, the European Community (EC) has had a lion's share. Recently, Japan is emerging as a strong value-added wheat exporter, especially in the Asian market.

Compared to wheat, U.S. value-added beef exports to MIDCs have been relatively high. Again, the value-added share of U.S. beef exports to MIDCs has been much less than the level of total U.S. value-added beef exports. In 1988, the value-added share of U.S. beef exports to all foreign countries was 84.6 percent of the total dollar amount. The value-added share of U.S. beef exports to MIDCs was only 39.5 percent of the total dollar amount. The reason for the lower percentage to MIDCs centers around Mexico, which is an MIDC. An examination of U.S. beef exports to Mexico shows that Mexico tends to import much more live cattle than processed beef. Mexico imported 140.6 million dollars worth of U.S. live cattle in 1988, but only 40 million dollars of value-added beef. Mexico is an isolated case. All the other MIDCs tend to import value-added beef rather than live cattle. However, Mexico's lower share was significant enough to reduce the average share of U.S. value-added beef exports to MIDCs.

MODEL FORMULATION

Data limitations prohibited the estimation of import demand functions for value-added agricultural products in MIDCs. Data for U.S. exports to these countries were available, but unfortunately, proper estimation of an import demand function for U.S. products requires all the data necessary for a traditional import demand function or some specific import demand model such as Armington's demand model (a world trade model that differentiates products imported in a country by kind and origin). However, if share equations are estimated instead, then all factors that affect the general level of beef and wheat product imports, but that do not affect the allocation of imports among product classes, can be dismissed.

Armington developed a trade allocation model based on the two-stage budgeting procedure. Armington's model differentiates commodity supplies by kind and origin. In the model, a "good" is a commodity differentiated by kind (e.g. beef vs. pork). A "product" is differentiated by both kind and origin (e.g. U.S. beef vs. Australian beef).

In the first stage, an importer's total import of commodity i derived from maximizing weakly separable utility subject to a budget constraint is expressed as:

(1) $M_i = M_i(P_1, \ldots, P_i, \ldots, P_n, Y), \quad i = 1, \ldots, n$

where P_i is import price for the i^{th} good and Y is total expenditure.

In the second stage, total expenditure for each good is allocated among m different products (of the i^{th} good) that are differentiated by origin. Minimiz-

Table 6. U.S. Wheat and Beef Exports to MIDCs: 1980-1988

Year	Bulk		Value-Added		Total			
	Wheat	Beef[a]	Wheat	Beef[b]	Wheat	Beef	Wheat %[c]	Beef %[c]
	million dollars							
1980	729	15	3	18	732	32	0.4	54.3
1981	968	24	4	21	972	46	0.4	47.1
1982	726	22	2	27	728	49	0.3	55.0
1983	673	23	3	23	677	46	0.5	49.2
1984	688	31	3	26	692	57	0.5	45.4
1985	606	95	4	25	609	120	0.6	20.9
1986	646	55	1	22	647	77	0.2	28.5
1987	614	35	11	34	625	68	1.7	49.1
1988	795	144	5	94	800	238	0.7	39.5

[a] Beef in bulk: Live cattle.

[b] Value-added beef: Fresh or frozen and preserved or prepared beef.

[c] Value-added as percent of total.

Source: USDA, *Foreign Agricultural Trade of the United States,* Calendar Year, 1980-1988.

ing the cost of purchasing total imports of the i^{th} good subject to the total import demand for the i^{th} good, M_i, yields an import demand differentiated by the origin of the i^{th} good as follows:

(2) $M_{ij} = M_{ij}(M_i, P_{i1}, \ldots, P_{ij}, \ldots, P_{im}), \quad j = 1, \ldots, m$

where M_{ij} is the "product" belonging to good i and imported from origin j and P_{ij} is price of product i from origin j.

Unfortunately, limitations in data for MIDCs' value-added agricultural imports and the import prices of major value-added agricultural exports other than the U.S. (based on the classification in this study) prevented value-added import demand and trade flow analyses. For this reason, the share equation model was used to analyze changes in the value-added import share of total imports by MIDCs of U.S. wheat and beef products, in response to changes in import prices and per capita incomes.

Let $M_{ij} = q_{ij}$. If an importer's expenditure for a group of U.S. products is fully utilized, then

$$(3) \quad S_{ij} = \frac{P_{ij}\, q_{ij}}{\sum_{i}^{n} P_{ij}\, q_{ij}}, \quad i = 1, \ldots, n$$

where S_{ij} = the import share of the i^{th} U.S. product (e.g., bulk wheat, flour, or other wheat products) of total U.S. products (e.g., the sum of bulk wheat and wheat flour and other wheat products) within a product class,

j = the U.S.,

q_{ij} = quantity of product i imported from the U.S. (j = the U.S.), and

$\sum_{i}^{n} P_{ij}\, q_{ij}$ = the importer's total expenditure for the import of U.S. products within a product class $(q_{1j}, \ldots, q_{nj})$.

In the equation for M_{ij} ((2) above), it was assumed that the import prices except for product i from origin j (i.e. the U.S.) were constant. Then

$$(4) \quad M_{ij} = M_{ij}\,[M_i(P, Y), P_{ij}] = q_{ij}\,.$$

Therefore, the share, S_{ij}, is a function of U.S. prices and an importer's income, as follows:

$$(5) \quad S_{ij} = \frac{P_{ij}\, q_{ij}}{\sum_{i}^{n} P_{ij}\, q_{ij}} = S_{ij}(P_{ij}, Y), \; i = 1, \ldots, n\,.$$

Note that subscript h introduced below identifies the destination country, while subscript j identifies the country of product origin. In this paper, the only country of origin was the United States, and for simplification the subscript j has been dropped from the following equations.

For each country, U.S. beef imports were divided into three categories corresponding to various degrees of processing. These categories were live cattle, fresh or frozen beef, and prepared beef. The category of prepared beef included preserved or prepared beef and veal. Imports of U.S. wheat were divided into the three categories of bulk wheat, wheat flour, and other wheat products. Other wheat products included items such as macaroni, spaghetti, wheat cereal, rolled wheat, and bulgur wheat.

The empirical models of beef import share equations were as follows:

(6) Live Cattle:

$$SCV_h = \alpha_0 + \alpha_1 RPC_h + \alpha_2 RPBF_h + \alpha_3 RPBP_h + \alpha_4 IY_h + \varepsilon_{b1},$$

(7) Fresh or Frozen Beef:

$$SBFV_h = \beta_0 + \beta_1 RPC_h + \beta_2 RPBF_h + \beta_3 RPBP_h + \beta_4 IY_h + \varepsilon_{b2},$$

(8) Prepared Beef:

$$SBPV_h = \gamma_0 + \gamma_1 RPC_h + \gamma_2 RPBF_h + \gamma_3 RPBP_h + \gamma_4 IY_h + \varepsilon_{b2},$$

where:

SCV_h = Live cattle imports as a share of total cattle, beef, and beef product imports from the U.S. in country h,

$SBFV_h$ = Fresh or frozen beef imports as a share of total cattle, beef, and beef product imports from the U. S. in country h,

$SBPV_h$ = Prepared or preserved beef imports as a share of total cattle, beef, and beef product imports from the U.S. in country h,

RPC_h = Real import price of live cattle in country h's currency (1985 = 100),

$RPBF_h$ = Real import price of fresh or frozen beef in country h's currency (1985 = 100),

$RPBP_h$ = Real import price of preserved or prepared beef in country h's currency (1985 = 100),

IY_h = Real per capita income in deflated domestic currency (1985 = 100) in country h,

$\varepsilon_{b1}, \varepsilon_{b2}, \varepsilon_{b3}$ = Random error terms that were assumed to be normally distributed with zero expectation and scalar-diagonal covariance matrix.

The empirical models of wheat import share equations were as follows:

(9) Unmilled Wheat:

$$SWV_h = \alpha_o + \alpha_1 RPW_h + \alpha_2 RPWF_h + \alpha_3 RPWP_h + \alpha_4 IY_h + \varepsilon_{w1},$$

(10) Wheat Flour:

$$SWFV_h = \beta_0 + \beta_1 RPW_h + \beta_2 RPWF_h + \beta_3 RPWP_h + \beta_4 IY_h + \varepsilon_{w2},$$

(11) Other Wheat Products:

$$SWPV_h = \gamma_0 + \gamma_1 RPW_h + \gamma_2 RPWF_h + \gamma_3 RPWP_h + \gamma_4 IY_h + \varepsilon_{w3},$$

where:

$SWVh$ = Wheat imports as a share of total wheat and wheat product imports from the U.S. in country h,

$SWFV_h$ = Wheat flour imports as a share of total wheat and wheat product imports from the U.S. in country h,

$SWPV_h$ = Other wheat product imports as a share of total wheat and wheat product imports from the U.S. in country h,

RPW_h = Real import price of wheat in country h's currency (1985 = 100),

$RPWF_h$ = Real import price of wheat flour in country h's currency (1985 = 100),

$RPWP_h$ = Real import price of wheat products in country h's currency(1985 = 100),

$\varepsilon_{w1}, \varepsilon_{w2}, \varepsilon_{w3}$ = Random error terms that were assumed to be normally distributed with zero expectation and scalar-diagonal covariance matrix.

The import shares of each product were obtained as follows:

$$(12)\quad S_{ih} = \frac{P_{ih} q_{ih}}{\sum_j P_{jh} q_{jh}}$$

$$\sum_i S_{ih} = 1$$

where:

S_{ih} = The import share of the i^{th} U.S. product (e.g., bulk wheat, flour, and other wheat products) of total U.S. products (e.g., total bulk wheat and wheat products) within a product class (e.g., wheat product) in country h,

P_{ih} = Price of the i^{th} U.S. product in a product class to country h in U.S. dollars,

q_{ih} = Quantity of the i^{th} U.S. product in a product class imported to country h,

$P_{ih}q_{ih}$ = Import expenditure for the i^{th} U.S. product within a product class in country h.

In the share equations, the import budget shares sum to one. This adding-up condition is satisfied if Sum $(\alpha_o, \beta_o, \gamma_o) = 1$, Sum(j: $\alpha_j, \beta_j, \gamma_j$, for j = 1,2,3,4) = 0. The share model in which all independent variables are exogenous is linear in all parameters in the model, and it can be estimated (at least without cross-equation restrictions such as symmetry) equation by equation by OLS given normally distributed errors. Moreover the OLS estimates satisfy the adding-up condition and are equivalent to maximum likelihood estimates for the system as a whole (Deaton and Muellbauer).

Real per capita gross domestic product (GDP) for each country was used as a proxy for consumers' personal disposable income. This proxy was expressed in domestic currency and deflated by the domestic consumer price index (1985=100).

$$(13)\quad IY_h = \frac{\dfrac{GDP_h}{POP_h}}{\dfrac{CPI_h}{100}}$$

where:

IY_h = Real per capita income in deflated domestric currency (1985=100) in country h,

GDP_h = Gross domestic product (GDP) in the domestic currency of country h,

POP_h = Population in country h,

CPI_h = Consumer price index (1985=100) in country h.

U.S. export unit values of wheat and beef products to MIDCs were used to calculate real import prices in MIDCs. These unit values were computed by dividing the U.S. export value by the number of exported units as follows:

$$(14)\quad P_{ih} = \frac{XUSV_{ih}}{XUSQ_{ih}}$$

where:

P_{ih} = U.S. export unit value of product i to country h (a proxy for price of the i^{th} U.S. product in a product class to country h in U.S. dollars),

$XUSV_{ih}$ = Value of U.S. exports of product i to country h in U.S. dollars,

$XUSQ_{ih}$ = Quantity of U.S. exports of product i to country h.

The unit values of the imported products were transformed into a particular country's domestic currency and then deflated by the domestic consumer price index (1985=100) of the country as follows:

$$(15)\quad RP_{ih} = \frac{P_{ih} \bullet EXR_h}{\dfrac{CPI_h}{100}}$$

where:

RP_{ih} = Real import unit value for U.S. product i in deflated domestic currency (1985=100) in country h,

EXR_h = Exchange rate of country h's currency per U.S. dollar,

CPI_h = Domestic consumer price index of country h (1985=100).

Annual time series data from 1970 to 1988 were used for wheat. The analysis for live cattle and beef products covered the period 1978 to 1988 because data for preserved or prepared beef from 1970 to 1977 were not compatible with data from 1978 to 1988.

U.S. export data for live cattle, fresh or frozen beef, and preserved or prepared beef by destinations were obtained from USDA/FAS. The data for wheat, wheat flour, and other wheat products were obtained from *Foreign Agricultural Trade of the United States.* All data were based on calendar years.

Gross domestic product (GDP), population, consumer price index (CPI), and exchange rates were reported in various issues of *International Financial Statistics* of the International Monetary Fund (IMF). However, macroeconomic indicators for Hong Kong and Taiwan could not be obtained from the IMF since these countries were not official members. Therefore, data for Taiwan were obtained from the Economic Research Service of the U.S. Department of Agriculture. The original source for the GDP, population, and CPI data was the Council for Economic Planning and Development of the Republic of China, while the exchange rate data came from *Financial Statistics* of the Central Bank of China. Reliable data for Hong Kong and Algeria were not available; consequently they were dropped from the study.

EMPIRICAL RESULTS

The import share equations were estimated using an ordinary least squares (OLS) technique. The equations were estimated for each country and product. When the share model is estimated in the form of a system, the disturbances must sum to zero because the budget shares sum to one. This problem causes the covariance matrix to be singular. In this case, one of the equations must be deleted from the system for estimation and Zellner's iterative seemingly unrelated regressor (ITSUR) method is often used. The SUR estimates have the same asymptotic properties as maximum likelihood estimators (Alston et al.). However, if the regressors are exogenous and all the same across the equations, and no cross-equation restrictions such as the symmetry condition are imposed, the OLS estimators are equivalent to the maximum likelihood estimators for the system as a whole (Deaton and Muellbauer). Moreover, the adding-up condition is automatically satisfied by the OLS.

The impact of own-price upon import share is largely determined by the elasticity of import demand. If import demand is inelastic, an increase in price will result in greater import expenditures. If import demand is elastic, price increases result in reduced import expenditures. Because the numerator of the import share for a particular product is equal to import expenditures for the product, the effect of a price increase upon the numerator may be completely inferred from the elasticity of import demand. On the other hand, the impact upon the denominator is not so clear. To measure this effect, it is necessary to know the complement and substitute relationships between the products entering the calculation of the share. However, if the cross-price elasticities are small relative to the own-price elasticities, then changes in numerators will be proportionally greater than changes in the denominators, in which event, the direction of the effect of increases in own-price upon the shares may also be inferred from the elasticities of import demand. There will be a tendency for inelastic products to have import shares that are positively related to own-price, and for elastic products to have import shares that are negatively related to own-price.

Wheat Products

The wheat product category included unmilled wheat, wheat flour, and other wheat products. These correspond to bulk, semi-processed, and highly processed products, respectively.

Unmilled Wheat

In most of the selected countries, the import share of U.S. bulk wheat has been large compared with shares from other major wheat exporters. In these countries the import share of U.S. bulk wheat has generally been more than 90 percent of total U.S. wheat and wheat product imports.

Coefficients on per capita income were statistically significant except for Mexico and Israel (Table 7). For Jordan, Malaysia, Singapore, and Korea, the regression coefficients had positive signs. As the countries' per capita incomes increased, the import share for U.S. bulk wheat increased, while the share for processed U.S. wheat products decreased.

In Taiwan, the import share of U.S. bulk wheat had a negative relationship to per capita income over the period studied (Table 7). However, in terms of quantity imported from the U.S., imports have generally increased since 1980. Taiwan imported 550 thousand metric tons (MT) of U.S. unmilled wheat in 1980, and about 829 thousand MT in 1988. Therefore, because income in Taiwan increased over this period, it is likely that total imports of bulk wheat were positively related to income, even though their share of imports of all wheat products has decreased.

For Mexico and Taiwan, the regression coefficients for own-price of wheat were statistically significant with a negative sign. The negative sign suggests that in Mexico and Taiwan, import demands for U.S. bulk wheat were elastic with respect to U.S. wheat prices. However, for the other countries, except Malaysia, the own-price coefficients had positive signs but were insignificant. The own-price coefficient for Malaysia was statistically significant and positive; that is, increases in the own-price of U.S. wheat had positive effects on the import share of U.S. wheat.

Wheat Flour

Because of lack of data, wheat flour and other wheat products were aggregated to one category for Taiwan and Malaysia. An analysis of this product category appears in the next section.

Coefficients on per capita income in Jordan and Korea were statistically significant and negative for the import shares of wheat flour (Table 8). These results suggest that as MIDCs' personal disposable incomes grew, they developed their own flour milling industries. This is not surprising since these industries do not require high technology. The results are not encouraging for U.S. firms wishing to promote wheat flour exports to middle-income developing countries.

For all countries except Mexico and Jordan, the regression coefficients for own-price of wheat flour were not statistically significant. For Mexico and Jordan the coefficients were statistically significant with a positive sign for Mexico and a negative sign for Jordan. These results suggest that the import demand for U.S. wheat flour was inelastic to U.S. flour prices in Mexico, but elastic in Jordan.

Other Wheat Products

For all countries except Taiwan and Malaysia, other wheat products included only highly processed wheat products. Coefficients on per capita income were statistically significant in all countries except Mexico (Table 9). For four of the six countries, the regression coefficients had negative signs in the import share equations. As per capita incomes in Jordan, Malaysia, Singapore, and Korea increased, the import share of other wheat products fell while increasing for Israel and Taiwan. This suggests that highly processed U.S. wheat products lost share relative to bulk wheat for five of the countries as income increased. In contrast, for Taiwan and Israel, highly processed wheat products had shares that increased with income. With the exception of these two countries, the results were generally discouraging for the promotion of highly processed wheat products.

Coefficients on own-price were statistically significant in Israel and Korea. For Korea, there was a negative relation between own-price of wheat products and import share. For Israel, however, there was a positive relation. This suggests that in Korea, import demands for U.S. highly processed wheat products were elastic to U.S. prices, whereas in Israel they were inelastic.

Table 7. OLS Estimates of U.S. Unmilled Wheat Export Shares as a Percent of Total U.S. Wheat and Wheat Product Exports to Selected MIDCs, 1970-1988[a]

		Independent Variables				
Country	Intercept	RPW	RPWF	RPWP	IY	R^2
Mexico	1.0831 (4.155)	-8.688D-6 (-4.502)	-5.380D-6 (-3.183)	1.113D-6 (3.516)	5.465D-7 (1.184)	0.76
Israel	0.8645 (5.176)	0.022953 (0.454)	-0.034541 (-0.936)	0.000222 (0.032)	0.004482 (0.848)	0.30
Jordan	-0.8675 (-2.429)	0.000205 (0.901)	0.000517 (1.935)	2.333D-5 (0.352)	0.002919 (3.97)	0.71
Malaysia[c]	0.3668 (2.933)	0.000459 (2.734)	NI[b]	9.082D-6 (0.958)	9.126D-5 (4.498)	0.67
Singapore	0.6503 (4.273)	0.000310 (1.541)	1.347D-5 (0.262)	1.114D-5 (1.63)	1.244D-5 (1.899)	0.37
Korea	0.9059 (40.015)	5.659D-8 (0.576)	4.840D-8 (0.44)	1.456D-8 (0.597)	4.054D-8 (2.972)	0.67
Taiwan[c]	1.0035 (916.9)	-2.647D-7 (-3.869)	NI[b]	-5.088D-9 (-1.306)	-1.573D-8 (-2.972)	0.62

[a] The t-values are in parentheses.

[b] Not included; the variable was not included in the regression model.

[c] Unmilled wheat and value-added wheat products.

Table 8. OLS Estimates of U.S. Wheat Flour Export Shares as a Percent of Total U.S. Wheat and Wheat Product Exports to Selected MIDCs, 1970-1988[a]

		Independent Variables				
Country	Intercept	RPW	RPWF	RPWP	IY	R^2
Mexico	-0.1283 (-0.522)	8.587D-6 (4.72)	4.978D-6 (3.125)	-1.082D-6 (-3.627)	-4.547D-7 (-1.045)	0.77
Israel	0.1843 (1.114)	-0.034364 (-0.686)	0.044051 (1.206)	-0.002799 (-0.41)	-0.006114 (-1.169)	0.32
Jordan	1.8502 (5.256)	-0.000208 (-0.927)	-0.000518 (-1.969)	-2.411D-5 (-0.37)	-0.002876 (-3.968)	0.71
Singapore	0.1147 (1.724)	-0.000120 (-1.359)	-1.139D-8 (-0.001)	-3.839D-6 (-1.285)	-3.275D-6 (-1.143)	0.22
Korea	0.0932 (4.141)	-5.343D-8 (-0.548)	-5.189D-8 (-0.475)	-1.37D-8 (-0.566)	-4.023D-8 (-2.969)	0.67

[a]The t-values are in parentheses.

Table 9. OLS Estimates of U.S. Other Wheat Product Export Shares as a Percent of Total U.S. Wheat and Wheat Product Exports to Selected MIDCs, 1970-1988[a]

		Independent Variables				
Country	Intercept	RPW	RPWF	RPWP	IY	R^2
Mexico	0.0452 (1.387)	1.010D-7 (0.418)	4.013D-7 (1.899)	-3.068D-8 (-0.775)	-9.180D-8 (-1.59)	0.36
Israel	-0.0488 (-5.519)	0.011412 (4.259)	-0.009510 (-4.867)	0.002576 (7.049)	0.001632 (5.834)	0.91
Jordan	0.0173 (2.577)	2.921D-6 (0.681)	1.494D-6 (0.297)	7.860D-7 (0.631)	-4.298D-5 (-3.105)	0.67
Malaysia[c]	0.6332 (5.064)	-0.000459 (-2.734)	NI[b]	-9.082D-6 (-0.958)	-9.126D-5 (-4.498)	0.67
Singapore	0.2349 (2.388)	-0.000191 (-1.464)	-1.346D-5 (-0.404)	-7.300D-6 (-1.652)	-9.168D-6 (-2.164)	0.44
Korea	0.0009 (3.898)	-3.165D-9 (-3.117)	3.484D-9 (3.066)	-8.317D-10 (-3.298)	-3.017D-10 (-2.139)	0.68
Taiwan[c]	-0.0035 (-3.197)	2.647D-7 (3.868)	NI[b]	5.090D-9 (1.306)	1.573D-8 (2.973)	0.62

[a]The t-vales are in parentheses.

[b]Not included; the variable was not included in the regression model.

[c]Unmilled wheat and wheat products.

Beef Products

The beef product category consisted of live cattle, fresh or frozen beef, and preserved or prepared beef, corresponding to bulk, semi-processed, and highly processed products, respectively. The selected countries, except for Mexico, Korea, and Taiwan, have maintained imports of U.S. live cattle at very low levels. Consequently, the import share of U.S. live cattle of the total U.S. beef category was estimated only for Mexico, Korea, and Taiwan. Import shares for the other countries represent a percentage of the sum of fresh or frozen beef and preserved or prepared beef. In general, the t-statistics for several of the estimated coefficients were low. One of the reasons may be the short time series used.

Live Cattle

Coefficients on per capita income were statistically significant at the 20 percent or higher level in Mexico, Korea, and Taiwan. Income in Mexico and Korea had a negative relationship with the import share of U.S. live cattle. Mexico has historically been a major importer of U.S. live cattle, with its import share of the total U.S. beef category being over 90 percent in the 1970s (Table 10). In the 1980s, the live cattle import share for Mexico has been around 80 percent. The econometric results indicated that decreases in the import share of U.S. live cattle are likely to occur with increasing personal disposable income in Mexico. For Korea, the import share also decreased with increasing personal dis-

Table 10. OLS Estimates of U.S. Live Cattle Export Shares as a Percent of Total U.S. Live Cattle and Beef Product Exports to Selected MIDCs, 1978-1988[a]

		Independent Variables				
Country	Intercept	RPC	RPBF	RPBP	IY	R^2
Mexico	1.3599	5.803D-7	-1.269D-7	-3.552D-8	-7.510D-7	0.62
	(4.399)	(1.274)	(-1.08)	(-0.212)	(-1.835)	
Israel	-0.0488	0.011412	-0.009510	0.002576	0.001632	0.91
	(-5.519)	(4.259)	(-4.867)	(7.049)	(5.834)	
Jordan	0.0173	2.921D-6	1.494D-6	7.860D-7	-4.298D-5	0.67
	(2.577)	(0.681)	(0.297)	(0.631)	(-3.105)	
Malaysia[c]	0.6332	-0.000459	NI[b]	-9.082D-6	-9.126D-5	0.67
	(5.064)	(-2.734)		(-0.958)	(-4.498)	
Singapore	0.2349	-0.000191	-1.346D-5	-7.300D-6	-9.168D-6	0.44
	(2.388)	(-1.464)	(-0.404)	(-1.652)	(-2.164)	
Korea	2.4800	1.594D-7	-1.499D-7	4.285D-8	-9.739D-7	0.81
	(4.544)	(1.705)	(-1.685)	(0.979)	(-3.975)	
Taiwan	-1.5248	2.625D-6	3.488D-6	1.041D-6	6.418D-6	0.72
	(-2.048)	(0.544)	(2.193)	(0.941)	(1.846)	

[a]The t-values are in parentheses.

[b]Not included; the variable was not included in the regression model.

[c]Unmilled wheat and wheat products.

posal income. In contrast, for Taiwan, import share was positively related to income. In Korea, the coefficient on own-price was statistically significant at the 20 percent level with a positive sign. This suggests that Korean import demand for U.S. live cattle was inelastic with respect to U.S. cattle prices. The own-price coefficients were not significant in Mexico and Taiwan.

Fresh or Frozen Beef

For fresh or frozen beef, the regression coefficients for per capita income were statistically significant at the 10 percent or higher level of significance, with positive signs for Mexico and Korea, and negative signs for Israel and Jordan (Table 11). These results are encouraging for the prospects of promoting fresh or frozen beef to all countries except Israel and Jordan.

The denominators in the shares for all countries except Mexico, Korea, and Taiwan did not include live cattle. Therefore, the signs on the income coefficients for all countries except these show the relative effect that income should have upon fresh or frozen beef and preserved or prepared beef import

Table 11. OLS Estimates of U.S. Fresh or Frozen Beef Export Shares as a Percent of Total U.S. Live Cattle and Beef Product Exports to Selected MIDCs, 1978-1988[a]

		Independent Variables				
Country	Intercept	RPC	RPBF	RPBP	IY	R^2
Mexico	-0.1910	-1.881D-7	4.539D-8	9.572D-9	4.054D-7	0.59
	(-1.246)	(-0.833)	(0.779)	(0.115)	(1.998)	
Israel	7.3695	NI[b]	0.000641	-0.016188	-0.214538	0.68
	(2.18)		(0.114)	(-1.411)	(-2.083)	
Jordan	5.5791	NI[b]	-3.344D-7	-1.041D-5	-0.010286	0.59
	(1.936)		(-0.028)	(-1.782)	(-1.602)	
Malaysia	-0.5120	NI[b]	1.115D-5	6.730D-6	0.000199	0.25
	(-0.548)		(0.730)	(0.670)	(1.185)	
Singapore	-0.3517	NI[b]	2.296D-5	-1.224D-6	4.770D-5	0.23
	(-0.332)		(1.329)	(-0.102)	(1.041)	
Korea	-1.3958	-1.431D-7	1.044D-7	-3.179D-8	9.464D-7	0.84
	(-3.109)	(-1.86)	(1.427)	(-0.883)	(4.695)	
Taiwan	2.1706	-7.529D-7	-3.764D-6	-6.781D-7	-5.073D-6	0.82
	(3.853)	(-0.206)	(-3.127)	(-0.81)	(-1.928)	

[a]The t-values are in parentheses.

[b]Not included; the variable was not included in the regression model.

Table 12. OLS Estimates of U.S. Prepared Beef Export Shares as a Percent of Total U.S. Live Cattle and Beef Product Exports to Selected MIDCs, 1978-1988[a]

		Independent Variables				
Country	Intercept	RPC	RPBF	RPBP	IY	R^2
Mexico	-0.1689 (-1.078)	-3.922D-7 (-1.699)	8.153D-8 (1.368)	2.595D-8 (0.306)	3.456D-7 (1.666)	0.66
Israel	-0.6395 (-1.884)	NI[b]	-0.000641 (-0.114)	0.016188 (1.411)	0.214537 (2.083)	0.68
Jordan	-4.5791 (-1.589)	NI[b]	3.344D-7 (0.028)	1.041D-5 (1.782)	0.010286 (1.602)	0.59
Malaysia	1.5120 (1.657)	NI[b]	-1.115D-5 (-0.731)	-6.730D-6 (-0.682)	-0.000199 (-1.222)	0.25
Singapore	1.3517 (1.274)	NI[b]	-2.296D-5 (-1.329)	1.224D-6 (0.102)	-4.770D-5 (-1.041)	0.23
Korea	-0.0843 (-0.678)	-1.640D-8 (-0.77)	4.551D-8 (2.249)	-1.106D-8 (-1.109)	2.754D-8 (0.494)	0.63
Taiwan	0.3542 (1.498)	-1.873D-6 (-1.222)	2.767D-7 (0.548)	-3.624D-7 (-1.032)	-1.345D-6 (-1.219)	0.45

[a]The t-values are in parentheses.

[b]Not included; the variable was not included in the regression model.

shares. A negative sign indicates that the share of fresh or frozen beef will be lost to preserved or prepared beef as income increases. A negative sign was estimated for Israel and Jordan.

The regression coefficient on per capita income was not significantly different from zero at the 10 percent level in Taiwan. Taiwan's imports of U.S. fresh or frozen beef have not changed much since 1979. The quantity of fresh beef imports from the U.S. has shown a moderate increase since 1985. The regression coefficient on own-price in Taiwan was statistically significant for Taiwan. The import share of U.S. semi-processed beef products in Taiwan was negatively related to own price.

Preserved or Prepared Beef

Coefficients on per capita income were statistically significant at the 20 percent level and positive for Mexico, Israel, and Jordan (Table 12). In Mexico, per capita income had a statistically significant positive relationship with the import share of U.S. preserved or prepared beef. The other countries import only fresh or frozen beef and preserved or prepared beef in significant quantities. For these countries, the empirical results for highly processed beef products were simply the negative of those found for semi-processed beef products.

SUMMARY AND CONCLUSION

This study analyzed the import shares of U.S. value-added wheat and beef products in MIDCs (Singapore, Hong Kong, Korea, Taiwan, Algeria, Malaysia, Israel, Jordan, and Mexico). However, Hong Kong and Algeria were excluded from the empirical estimations because of data limitations. In estimating the import share equations for U.S. wheat, wheat flour, and other wheat products, and for live cattle, fresh or frozen beef, and preserved or prepared beef, the ordinary least squares (OLS) technique was applied to annual data from 1970 to 1988. A linear functional form of the import share equation was estimated.

The empirical results from the estimated import share of bulk wheat and wheat products indicated that in all selected MIDCs except Taiwan, U.S. bulk wheat exports will respond favorably to income growth relative to U.S. processed wheat product exports. The results showed that increases in real income growth had negative impacts on U.S. processed wheat products in all MIDCs except Taiwan.

International wheat flour trade has declined since 1980. In 1980/81, total world wheat flour trade was 9.48 million tons, but decreased to 5.72 million tons in 1985/86 (Table 13). In the world wheat flour market, major exporters have been developed countries, while major importers have been developing countries in Asia and Africa (Tables 13 and 14). In 1985/86, developed country exports accounted for over 94 percent of world wheat flour trade, and developing countries of Asia and Africa accounted for 90.6 percent of world wheat flour imports (Table 13). In most of the Asian countries, wheat flour imports have decreased since 1979/80. Japan, which has been a large bulk wheat importer, turned out to be a large net exporter of wheat flour in 1985/86 (Table 15). This indicates that the Asian countries

Table 13. Total World Trade in Wheat Flour and Imports by Asia and Africa, 1970/71 to 1985/86

Year[a]	Asia	World Percentage[b]	Africa	World Percentage[c]	Total
	(1,000 MT)		(1,000 MT)		(1,000 MT)
1970/71	2830	50.9	1360	24.5	5559
1971/72	2300	41.6	1590	28.8	5530
1972/73	2472	44.1	1633	29.2	5602
1973/74	2325	47.0	1344	27.2	4948
1974/75	2178	45.9	1615	34.1	4743
1975/76	2325	44.0	2024	38.3	5285
1976/77	2933	46.3	1870	29.6	6328
1977/78	3003	42.2	2295	32.3	7108
1978/79	2518	34.6	2537	34.9	7279
1979/80	3197	38.9	2650	32.3	8209
1980/81	1914	20.2	4175	44.0	9480
1981/82	1530	17.9	3541	41.5	8532
1982/83	1887	26.7	3950	55.9	7065
1983/84	2141	26.7	4334	54.1	8006
1984/85	1317	20.7	4293	67.6	6348
1985/86	1264	22.1	3914	68.5	5718

[a]The crop year, July/June.

[b]Asia as a percent of world total.

[c]Africa as a percent of world total.

Source: International Wheat Council, *World Wheat Statistics*, various issues.

tended to develop their milling industries as their economies grew. However, there has been a tendency for African countries to increase wheat flour imports (Table 13).

On the other hand, the empirical results from the estimated import shares of U.S. live cattle and processed beef products indicated that U.S. processed beef products will respond favorably to income growth relative to U.S. cattle exports in Mexico and Korea under the assumption of continued income growth. The results showed that imports of U.S. fresh or frozen beef are likely to increase with income growth in Mexico and Korea, while decreasing in Taiwan. In Israel and Jordan, the share of fresh or frozen beef is likely to decrease with income growth, but the share of prepared beef is likely to increase.

Table 14. Major World Exporters of Wheat Flour to Asia: Exports to Asia

Year[a]	EC[b]	U.S.	Canada	Japan	USSR	Australia	Total[c]
	1,000 MT						
1980/81	732	606	38	NA[d]	110	291	914
MS[e]	(0.38)	0.32	0.02		0.06	0.02	1
1981/82	889	328	27	NA[d]	90	27	1530
MS[e]	(0.58)	0.21	0.02		0.06	0.02	1
1982/83	954	325	76	149	200	35	1887
MS[e]	0.51	0.17	0.04	0.08	0.11	0.02	1
1983/84	1001	341	93	305	300	21	2141
MS[e]	0.47	0.16	0.04	0.14	0.14	0.01	1
1984/85	832	88	80	202	80	8	1317
MS[e]	0.63	0.07	0.06	0.15	0.06	0.01	1
1985/86	514	199	97	306	100	12	1264
MS[e]	0.41	0.16	0.08	0.24	0.08	0.01	1

[a]The crop year, July/June.

[b]European Community.

[c]World total exports to Asia.

[d]Not available.

[e]Market share.

Source: International Wheat Council, *World Wheat Statistics*, various issues.

Table 15. Major World Wheat Flour Exporters

Year[a]	EC[b]	U.S.	Canada	Japan	USSR	Australia	Total[c]
	1,000 MT						
1980/81	4331	1705	638	NA[d]	200	137	9480
MS[e]	0.46	0.18	0.07		0.02	0.01	1
1981/82	4381	1320	536	NA[d]	200	130	8532
MS[e]	0.51	0.15	0.06		0.02	0.02	1
1982/83	3690	1825	401	149	200	124	7065
MS[e]	0.52	0.26	0.06	0.02	0.03	0.02	1
1983/84	4190	2166	730	319	300	78	8006
MS[e]	0.52	0.27	0.09	0.04	0.04	0.01	1
1984/85	4088	1087	428	210	200	81	6348
MS[e]	0.64	0.17	0.07	0.03	0.03	0.01	1
1985/86	3609	1103	355	308	100	50	5718
MS[e]	0.63	0.19	0.06	0.05	0.02	0.01	1

[a]The crop year, July/June.

[b]European Community.

[c]World Total Exports to Asia.

[d]Not available.

[e]Market share.

Source: International Wheat Council, *World Wheat Statistics*, various issues.

In short, if the U.S. wishes to increase exports, value-added beef product exports to MIDCs should be emphasized more than value-added wheat product exports. This implies that future government programs should focus more on value-added beef product exports.

In this study, analysis of import demand for value-added agricultural exports was conducted using share equations. This approach was taken because extreme limitations in data availability and quality prevented estimation of ordinary import demand functions. Unfortunately, share equations cannot be used to explain or predict absolute movements in exported quantities or revenues. Absolute measures would be more valuable in assessing potential markets for value-added products. Were high quality data to become available, significant improvements could be made to this study by estimating and analyzing the ordinary import demands.

The empirical models in this paper do not include variables such as political and sociological factors. Improvements to this study could be made by the quantification of institutional variables.

REFERENCES

Ackerman, Karen, Stephen MacDonald, and Steve Milmoe. "International Trade." Nat. Food Rev., 12(1989):44.

Alston, Julian M., Colin A. Carter, Richard Green, and Daniel Pick. "Whither Armington Trade Models?" *Am. J. Agr. Econ.*, 72(1990):455-467.

Armington, Paul S. "A Theory of Demand for Products Distinguished by Place of Production." *IMF Staff Papers*, 16.1(1969):159-178.

Central Bank of China. *Financial Statistics*. The Republic of China, various issues.

Council for Economic Planning and Development. *Industry of Free China*. The Republic of China, Vol. L12, No. 1, July 1989.

Deaton, Angus and John Muellbauer. "An Almost Ideal Demand System." *Am. Econ. Rev.*, 70.3(1980):312-326.

International Wheat Council. *World Wheat Statistics*. London, various issues.

Lee, Jung-Hee, David Henneberry, and David Pyles. "Value-Added Agricultural Exports: An Overview for Oklahoma and the United States." *Current Farm Econ.*, 63.1, Ag. Exp. Sta., Div. of Ag., Oklahoma State University, March 1990.

Nuttall, John. "U.S. Farm Exports: The Value-Added Factors." Washington DC: U.S. Department of Agriculture, FAS, January 1983.

Rahe, Dewain H. and Willis G. Collie. "Value-added Exports Around the World." *1985 Yearbook of Agriculture*, Washington DC: U.S. Department of Agriculture.

Schluter, Gerald and Kenneth C. Clayton. "Expanding the Processed Product Share of U.S. Agricultural Exports." Washington DC:U.S. Department of Agriculture, Econ. Res. Svc., Nat. Econ. Div., Staff Rep. No. AGES8 10701,July 1981.

Schluter, Gerald and William Edmondson. "Exporting Processed Instead of Raw Agricultural Products." Washington DC : U.S. Dept. of Agr., Econ. Res. Svc., Agr. and Rur. Econ. Dev., Staff Rep. No. AGES89-58, November 1989.

United Nations, Food and Agriculture Organization. *FAO Production Yearbook*. Rome, various issues.

United Nations, Food and Agriculture Organization. *FAO Trade Yearbook*. Rome, various issues.

United Nations, International Monetary Fund. *International Financial Statistics*. Washington DC, various issues.

U.S. Department of Agriculture, Economic Research Services. *Foreign Agricultural Trade of the United States*. Washington DC, various issues.