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Short-run and long-run industry-level estimates of U.S. Armington elasticities

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Abstract

The Armington substitution elasticity is a key parameter for trade-policy analysis. We estimate short- and long-run Armington elasticities for 309 manufacturing industries at the four-digit Standard Industrial Classification (SIC) level over the period 1989–1995. Our estimation results offer a comprehensive, disaggregated, and up-to-date set of Armington elasticities. On average, long-run estimates are approximately two times larger than the short-run estimates, which is important since long-run estimates are more appropriate for most trade-policy analysis. Also, statistically significant differences exist within most three-digit SIC categories, which highlights the importance of estimation at a disaggregated level.

JEL classification: F1; C1

Keywords: Applied modeling; Armington elasticities; International trade

1. Introduction

Using economic models to evaluate changes in trade policy generally requires the conversion of policy changes into price effects. Model analyses use these price shifts to determine how policy is expected to affect output, employment, trade flows, economic welfare, and other variables of interest. The direction and magnitude of a trade-policy change on individual variables depends on the size of the shock as well as the behavioral relationships present in the economy. When evaluating policy shifts within an economic model, these behavioral relationships largely take the form of elasticities reflecting the responsiveness

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of one set of variables to a change in a second set. For example, trade policy often takes the form of a change in the relative price of traded goods and domestic sales. As a result, a key relationship for model analysis is the degree of substitution between imported and domestic goods due to changes in the relative price of those two goods, commonly known as the Armington elasticity.[2]

The role of the Armington assumption is quite important in the international trade literature on a number of points. First, the magnitude of the trade-substitution elasticity is important in the debate regarding the "border effect." International borders are apparently reducing trade flows among countries (McCallum, 1995), but the extent depends on the degree of substitutability between domestic and imported goods.[3] Second, Armington elasticity estimates are a key variable in testing Grossman and Helpman's "Protection for Sale" model. In order to test whether this model yields predictions consistent with the data, Gawande and Bandyopadhyay (2000) and Goldberg and Maggi (1999) rely on import-demand elasticity estimates from the literature.

Finally, the Armington elasticity plays a key role in applied modeling that is often used to assess *ex ante* economy-wide impacts of policy changes, such as tariffs and taxes. Indeed, applied partial- and general-equilibrium models used to examine trade policy are almost universally sensitive to trade elasticities. While the Armington assumption considerably simplifies the task of parameterizing a multi-region trade model, the trade-substitution elasticity is a key behavioral parameter that drives the quantitative, and sometimes qualitative, results used by policymakers.[4] Knowledge of these elasticities is important for computable-general-equilibrium (CGE) policy modeling, because the degree to which a policy change will affect a country's trade balance, level of income, and employment depends on the magnitude of the elasticity used in the model.

Since results of trade-policy analysis using static computable models are generally interpreted as the long-run effects of policy changes, we attempt to extract the long-run estimates from the data. Of the 309 elasticity estimates obtained at the four-digit U.S. Standard Industrial Classification (SIC) level,[5] 277 short-run estimates were statistically significant and of the correct sign, and of the 118 long-run estimates, 83 were statistically significant and of the right sign. This paper provides the most comprehensive and disaggregated set of Armington elasticity estimates to date.

[2] The constant elasticity of substitution (CES) specification for the trade substitution elasticity is derived from Armington (1969).

[3] The "border effect" refers to border-induced changes in the volume of trade. This finding was reported by McCallum (1995) who calculated gravity-adjusted volume of trade among Canadian provinces to exceed provinces' trade with the U.S. states by more than a factor of 20. Recent empirical findings suggest that borders can also affect the composition of trade (Hillberry, 2002).

[4] The assumption of national product differentiation is a common feature in many CGE models used to evaluate trade policy. However, inferences about policy and welfare drawn from such models can be misrepresented because the results tend to be dominated by changes in the terms of trade. Brown (1987) was one of the first to evaluate how national product differentiation relates to terms-of-trade effects of a tariff. McDaniel and Balistreri (2001) discuss the inverse relationship between the optimal tariff and Armington elasticity, and demonstrate the importance of the trade elasticity in the welfare interpretations of trade liberalization for a small open economy. See also Francois and Shiells (1994) for an overview of the controversy over the Armington assumption.

[5] The 1987, SIC descriptions are provided in the *Standard Industrial Classification Manual 1987* found at http://www.osha.gov/oshstats/sicser.html.

The paper is organized as follows. The next section provides an overview of previous work in this area, Section 3 presents the empirical model, and Section 4 describes the data used in the estimations. The econometric methodology and results are presented in Section 5. Section 6 provides a discussion of the comparability of estimates in the literature and possible reasons for discrepancies, and offers directions for future research.

2. Context

Comprehensive industry-level estimates of Armington elasticities have appeared intermittently over the last few decades. Four well-known studies for U.S. imports include Stern, Francis, and Schumacher (1976), Shiells, Stern, and Deardorff (1986), Reinert and Roland-Holst (1992), and Shiells and Reinert (1993). These papers focus on industry-level detail at the two- or three-digit SIC level.

One of the first systematic studies to provide import-demand elasticities for the United States was carried out by Stern et al. (1976). This study offers "best estimates" of U.S. import-demand elasticities for 28 industries at the three-digit SIC level. Rubber products, wearing apparel, metal products excluding machinery, and transport equipment were among the sectors found to be "extremely import sensitive," while food, beverages, textiles, tobacco, machinery including electrical machinery, and iron and steel were classified as "moderately import sensitive." The wood and paper products industries were considered "import inelastic."

Shiells et al. (1986) estimated trade-substitution elasticities using a simple stock-adjustment model with annual data from 1962 to 1978 for 163 disaggregated industries. The authors obtained statistically significant Armington elasticities for 122 of the 163 sectors. Their estimates compared adequately with previous estimates from Stern et al.

Shiells and Reinert (1993) disaggregated U.S. imports into those from NAFTA members and those from the rest of the world (ROW). Using quarterly data over 1980–1988, they obtained estimates for 128 mining and manufacturing sectors. Elasticities were estimated according to three specifications: (i) generalized-least-squares using a Cobb–Douglas price aggregator; (ii) maximum-likelihood estimation using a CES price aggregator; and (iii) simultaneous equation estimation using a Cobb–Douglas price aggregator and a distributed lag model. Shiells and Reinert found the estimates to be relatively insensitive to shifts among the three estimation procedures.

Reinert and Roland-Holst (1992) estimated Armington elasticities for 163 U.S. mining and manufacturing sectors. They obtained significant estimates for approximately two-thirds of the three-digit SIC industries using quarterly data from 1980 to 1988. These elasticity estimates are among the most widely cited estimates in the literature; however, they are now over a decade old.

While the aforementioned papers provide valuable estimates of trade-substitution elasticities, they do not consider explicitly the long-run aspect of applied partial- and general-equilibrium modeling. In this paper, we estimate Armington elasticities for 309 industries at the four-digit SIC level over the period 1989–1995. Where appropriate, we employ techniques to extract the long-run estimates that are relevant to applied policy modeling.

3. The empirical model

A key feature of the Armington (1969) approach to demand is the assumption that consumers distinguish products by their source. The product-differentiation model is now widely used in empirical international trade studies, in which consumers are assumed to differentiate between domestic goods and their imported substitutes.[6] The Armington elasticity, estimated below, describes the ease of substitution between domestic goods and imports.

The elasticity of substitution between home goods and imports can be derived from a familiar two-stage budgeting process.[7] From an economy-wide perspective, a representative consumer has a well-behaved utility function defined over composite goods (C), which contains imported goods (M) and domestic goods (D). In the first stage, a representative consumer allocates total expenditures to different product categories. In the second stage, a representative consumer allocates expenditures within each group between D and M, taking relative prices as given. The Armington specification can be represented by the following CES functional form for the composite good:

$$C = \alpha[\beta M^{((\sigma-1)/\sigma)} + (1-\beta)D^{((\sigma-1)/\sigma)}]^{\sigma/(\sigma-1)} \tag{1}$$

where σ represents the constant elasticity of substitution between domestic and import goods, and α and β are calibrated parameters in the demand function. We follow the standard assumptions of a well-behaved utility function and continuous substitution between M and D. Also, the assumption of weak separability of product categories in the utility function means that the allocation of expenditures to goods within an industry group is conditional on the level of spending on this group. Then, an optimization of the second-stage, sub-utility function yields a ratio of imports to domestic goods that is a function of the ratio of domestic prices to import prices:[8]

$$\frac{M}{D} = \left[\frac{\beta}{1-\beta}\frac{p_{\mathrm{d}}}{p_{\mathrm{m}}}\right]^{\sigma} \tag{2}$$

where prices are multiplicative. This first-order condition equates the rates of substitution and relative prices, and the Armington elasticities can be estimated for disaggregated commodity categories.[9] This first-order condition can be conveniently rewritten as the base equation used in the estimations:

$$y = a_0 + a_1 x \tag{3}$$

[6] See Shiells et al. (1986).

[7] See Helpman and Krugman (1985), and Shiells et al. (1986).

[8] de Melo and Robinson (1989) provide a detailed discussion of CES import behavior in a general equilibrium model.

[9] Winters (1984) discusses the separability assumptions. The parameter σ is also seen as the compensated price elasticity of import demand.

where $y = \ln(M/D)$, $a_0 = \sigma \ln[\beta/(1-\beta)]$, a_1 is the elasticity of substitution between imports and domestic sales, and x represents $\ln(p_\mathrm{d}/p_\mathrm{m})$.[10]

4. Data

Four data series are required to operationalize Eq. (3): real imports, domestic sales of domestically produced goods, and the prices of those two groups of goods. The data are monthly, covering the period January 1989 to December 1995, and the analysis is generally defined at the four-digit level of the U.S. SIC.

4.1. Real import quantities and prices

Real import quantities and prices are constructed from Department of Commerce data defined at the 10-digit level of the U.S. Harmonized Tariff Schedule (HTS). One of the main difficulties associated with this level of detail is to aggregate these data to the four-digit SIC level. A concordance compiled by the U.S. Department of Commerce was used to match the detailed 10-digit HTS lines to 4-digit SIC categories. Both customs value (CV) data and units of quantity were collected to construct real import series. When the detailed trade series are grouped by four-digit SIC category, the quantity units across trade categories are often not identical. For those industries, we constructed real import series, using a Laspeyres index with a 1992 base year as follows.[11]

Let m_{it} represent the monthly import quantity of 10-digit HTS industry i in time period t and v_i represent the 1992 average monthly unit value of industry i. The real import series is calculated as: $M_t = \sum_i v_i \times m_{it}$. The price series were calculated by deflating this series by the customs values of the 10-digit import categories for which quantity data were available to construct the quantity series for each SIC category, $p_{m_{it}} = \left(\sum_i \mathrm{CV}_i\right)/M_{it}$.

The final step to calculate the real import series used in the estimation was to normalize the import quantity series so that the average monthly 1992 value of M_t equals 1.0. This series was then multiplied by the 1992 average monthly value of imports to obtain a series of the same magnitude in 1992 as the value of imports for that SIC category.

4.2. Domestic sales and price data

The more challenging series to construct were domestic sales of domestically produced goods (D_t). Domestic sales represent the net of total domestic production (Q_t) less exports (X_t), $D_t = Q_t - X_t$, and each of those variables was individually constructed.

Total domestic production was constructed using the following approach.[12] First, for each four-digit SIC category, 1992 average monthly shipment values were calculated from annual total shipments (s_t), obtained from the *Annual Survey of Manufacturers* published

[10] The log-linear equation is a standard specification used in the literature to estimate Armington elasticities. See, for instance, Shiells et al. (1986), Shiells and Reinert (1993), Ho and Jorgenson (1997), and Reinert and Roland-Holst (1992).

[11] Ten-digit tariff lines that were sparsely populated were dropped during the aggregation process.

[12] The technique we used to construct U.S. domestic sales is outlined in Reinert and Roland-Holst (1992).

by the U.S. Census Bureau (various years). Next, monthly industrial production indices at the four-digit SIC level were collected from the Federal Reserve Board of Governors (BOG)[13] and normalized so that the 1992 monthly average equals 1.0, called ip_t. Of the 309 SIC categories used for the estimations, 143 BOG industrial production series directly corresponded to the four-digit SIC categories and 166 series required mapping to an alternative SIC category.[14] Domestic production was calculated as the product of this normalized series and the 1992 monthly average value of production (s_t), that is, $Q_t = s_t ip_t$.

Real monthly exports were constructed using the same procedure as imports, a Laspeyres' index of usable 10-digit export categories. Let x_{it} represent the monthly export quantity of 10-digit HTS series i in time period t and let z_i represent the 1992 average monthly unit value of product i. The real export series is calculated as: $X_t = \sum_i x_i x_{it}$. As before, the order of magnitude is established by normalizing real exports so that the average monthly 1992 quantity is 1.0. This series is then multiplied by the 1992 average monthly value of exports for that SIC category to X_t.[15] Finally, real domestic sales of the domestically produced goods are calculated as the difference between the constructed monthly domestic production and monthly exports.

Prices of domestically produced goods were proxied using the producer price indices (PPI) available from the Bureau of Labor Statistics. Prices used in construction of the PPI are generally ex-factory which applies to the first significant commercial transaction in the United States. The classification system corresponds to commodity lines, and products were grouped by similarity of end-use or material composition and were seasonally adjusted. Price series were generally identifiable for four-digit SIC industry levels from January 1989 to December 1995. Out of the 309 SIC categories, 287 PPI series corresponded directly to the four-digit SIC. As with the industrial production data, the method used to select a replacement for the remaining series was to use the closest available product category at the five- or three-digit level.[16] A three-way concordance between SIC codes, industrial production series, and pricing proxies was constructed from the most disaggregated series available. In the event that data series were not available at the four-digit level, data were constructed from concorded data to the three- or four-digit level.

[13] Unpublished series were kindly provided by Charlie Gilbert of the BOG; public data were downloaded from http://www.bog.frb.fed.us/releases/download.htm.

[14] In instances where no four-digit SIC series were available, a three-digit SIC-coded BOG industrial series was substituted for the unavailable four-digit SIC series. For example, the BOG series I20300, 'canned and frozen foods,' corresponds to the three-digit SIC 203. Since no four-digit SIC disaggregation is available for BOG series I20300 from either published or unpublished data, we chose to match that BOG series for all SIC codes under 203 estimated at the four-digit level. For the following four-digit SIC codes, BOG series I20300, 'canned and frozen foods,' was used: 2032 'canned specialties,' 2033 'canned fruits and vegetables,' 2034 'dehydrated fruits, vegetables, and soups,' 2035 'pickles, sauces, and salad dressings,' and 2037 'frozen fruits and vegetables.'

[15] The average monthly export values were calculated using all 10-digit HTS lines, whether or not they were included to construct the index of real exports.

[16] A replacement series was used for the remaining 22 series. For example, for SIC 2273 'carpets and rugs,' no PPI series was available that corresponded at the four-digit SIC level. In this case, we used the PPI series corresponding to five-digit SIC 2273.1 'aircraft floor coverings except rubber or plastics.' For SIC 3492 'fluid power valves and hose fittings,' no close four- or five-digit PPI series was available, so the three-digit corresponding series for SIC 349 'miscellaneous fabricated metal products' was used. Of the 22 substituted series, 6, 7, and 9 series were substituted at the two-, three-, and five-digit level, respectively.

5. Econometric methodology

5.1. Specification

An assumption in comparative-static modeling is that prices and quantities adjust instantaneously to a given exogenous change. However, adjustment actually may take some time, perhaps due to factors such as consumption patterns, trade in intermediate goods, and existing inventory levels. Therefore, we attempt to allow for time of adjustment in the estimation procedure. Accordingly, the estimation technique of Eq. (3) was determined by the time-series properties of the quantity and pricing series.

The weighted symmetric test is used to determine the order of integration of the two series used in estimating Eq. (3), the ratio of domestic sales to imported goods, and the corresponding relative prices.[17] When series were found to be integrated of order one, or I(1), tests for second-order integration were easily rejected. Therefore, each series was either stationary [I(0)] in log-levels or in first-differenced form.

A group of non-stationary time series is cointegrated if a linear combination of them is stationary; that is, the combination does not have a stochastic trend. We tested for a long-run, stationary relationship between the ratio of domestic goods and imports, and the relative price ratio for each SIC series using the Engle–Granger technique. The Engle–Granger test is only valid if all the cointegrating variables are I(1). Accordingly, this test was performed only when both the ratio of domestic goods and imports, and the relative price ratio, were I(1). The cointegration results allowed us to determine whether a single-equation error–correction model would be an appropriate specification for each series.[18] A three-step procedure was used to select the model that would generate, when possible, long-run elasticity estimates.

First, for industries having stationary log-level data, a parsimonious geometric lag model was estimated because it can be used to easily extract both short- and long-run elasticity estimates.[19] In these cases, Eq. (3) was operationalized as:

$$y_t = a_0 + a_1 x_t + a_2 y_{t-1} + u_t \tag{4}$$

where y and x are the goods and price ratios, respectively, and u_t represents an *iid* error term. Long-run elasticity estimates can be estimated as $a_1/(1 - a_2)$ if $0 < a_2 < 1$; otherwise the reported elasticities are a_1.

Second, when the data for an SIC were both I(1) and cointegrated, a single-equation error–correction model of the following form was estimated to extract the long-run elasticity estimates:

$$\Delta y_t = a_0 + a_1\, \Delta x_t + a_2 y_{t-1} + a_3 x_{t-1} + u_t \tag{5}$$

where $\Delta y_t = y_t - y_{t-1}$ and u_t represents an *iid* error term. Eq. (5) is a form of the unrestricted version of the error–correction mechanism (ECM) model associated with Hendry, Pagan,

[17] The Weighted Symmetric test is recommended over the Dickey–Fuller test because it is more likely to reject the null hypothesis of a unit root when it is in fact false. The Weighted Symmetric test is a weighted double-length regression; this procedure has been found to have power uniformly higher than that of OLS. See Pantula, Gonzales-Farias, and Fuller (1994) for details.

[18] The theory is set forth in Engle and Granger (1987).

[19] See Pindyck and Rubinfeld (1981), pp. 269–270.

and Sargan (1984). This model allows the short- and long-run responses of demand with respect to price to be determined completely by the data.[20] Specifically, short-run elasticity estimates are (a_1) and long-run elasticity estimates are ($-a_3/a_2$).

Finally, when both series were I(1) and not cointegrated or when only one series was stationary, the variables were first-differenced for stationarity and the following model was estimated:

$$\Delta y_t = a_0 + a_1 \Delta x_t + u_t \tag{6}$$

where a_1 is the (short-run) Armington elasticity. Estimates from this equation do not yield long-run values. Monthly dummies are also added to each regression.

5.2. Results

Table 1 reports the estimation results with the short-run and, where possible, long-run elasticities. The estimated equation is reported in the second column.[21] Of the 309 sectors estimated, 277 had positive short-run elasticity estimates that were significant at the 10% level, and 83 of the 118 long-run estimates obtained were positive and significant. The average short-run elasticity estimate is 0.95, with a range between 0.15 and 4.85. The average long-run elasticity estimate is 1.55, with a range between 0.52 and 4.83. The long-run estimates were up to roughly five times larger than the short-run estimates, and on average, about twice as large as the short-run elasticities.

In reviewing the long-run estimation results, some of the most import-sensitive sectors appear to be luggage, plastic materials and resins, photographic equipment, paperboard boxes, malt beverages, and softwood veneer and plywood. A few of the least import-sensitive sectors included brooms and brushes, petroleum and coal products, house furnishings, in vitro and in vivo diagnostic substances, and food containers. We do not analyze formally the determinants of these elasticities in this paper.

Rough comparisons between these long-run estimates and those reported by Reinert and Roland-Holst reveal that the long-run estimates reported here are generally larger.[22] While the long-run estimates are larger than the short-run estimates, they are still smaller than those often used in applied modeling work (Harrison, Rutherford, & Tarr, 1996).

One possible concern with our elasticity estimates is that they are estimated with high-frequency monthly data. In order to consider whether lower frequency data more truly reflect long-run responses to trade-price changes, we aggregate our monthly data up to quarterly data and then re-estimate the elasticities.[23] The results show no systematic bias and we find that our estimates based on monthly data are not sensitive to the frequency of the data.

[20] Johnson et al. (1992) employ this error–correction modeling technique to estimate short- and long-run elasticities for Canadian consumption of alcoholic beverages.

[21] Note that the price series in Eq. (2) is inverted, thus, the elasticity estimates are positive.

[22] While Reinert and Roland-Holst estimated at the three-digit SIC level and we estimated at the four-digit SIC level, a rough comparison was plausible for 50 sectors. The long-run estimates reported here were greater in 42 of the 50 cases reported by Reinert and Roland-Holst. This suggests that the long-run estimates presented in this paper should be used in place of existing short-run estimates. A table of these comparisons is available upon request.

[23] We examined this point thanks to comments from an anonymous referee.

Table 1
Short- and long-run elasticity estimates

SIC	Description	Equation	Short-run elasticities			Long-run elasticities			Adjusted R^2	DW/DH	DW/DH P-value	Observed
			Elasticity	S.E.	P-value	Elasticity	S.E.	P-value				
2011	Meat packing plants	(4)	0.909	0.350	0.011	1.580	0.592	0.008	0.52	−1.126	0.260	83
2015	Poultry/egg processing	(4)	0.700	0.133	0.000	1.249	0.253	0.000	0.55	1.974	0.048	83
2021	Creamery butter	(4)	1.699	0.207	0.000	1.699	0.266	0.000	0.51	3.626	0.000	83
2022	Cheese, natural, processed	(4)	1.003	0.149	0.000	1.346	0.174	0.000	0.84	2.939	0.003	83
2023	Condensed, evaporated milk	(6)	0.590	0.280	0.038				0.22	2.722	1.000	83
2024	Ice cream, frozen desserts	(6)	0.496	0.146	0.001				0.14	2.612	1.000	70
2026	Fluid milk	(4)	−0.073	0.187	0.697	−0.131	0.341	0.701	0.17	−4.592	0.000	83
2032	Canned specialties	(6)	0.505	0.194	0.011				0.24	2.986	1.000	83
2033	Canned fruits, vegetables	(6)	1.190	0.208	0.000				0.59	2.304	0.998	83
2034	Dehydrated fruits and vegetables	(6)	0.958	0.087	0.000				0.63	2.898	1.000	83
2035	Pickles, sauces, dressings	(6)	0.925	0.189	0.000				0.61	2.175	0.988	83
2037	Frozen fruits, vegetables	(6)	1.362	0.162	0.000				0.46	2.750	1.000	83
2041	Flour, other grain mill products	(6)	1.390	0.079	0.000				0.86	2.463	1.000	83
2043	Cereal breakfast foods	(5)	0.642	0.170	0.000	0.794	0.281	0.005	0.31	2.264	0.998	83
2044	Rice milling	(6)	0.602	0.297	0.046				0.09	2.874	1.000	83
2045	Blended and prepared flour	(5)	0.967	0.221	0.000	2.885	0.250	0.000	0.54	2.084	0.983	83
2046	Wet corn milling	(6)	0.350	0.175	0.049				0.20	2.926	1.000	83
2047	Dog and cat food	(4)	0.607	0.194	0.003	1.397	0.420	0.001	0.58	−2.135	0.033	83
2048	Other prepared feeds	(6)	0.864	0.055	0.000				0.78	3.043	1.000	83
2051	Bread, cake, related products	(5)	0.404	0.221	0.072	1.745	0.245	0.000	0.80	2.233	0.997	83
2062	Cane sugar refining	(5)	0.932	0.095	0.000	1.005	0.025	0.000	0.81	1.931	0.921	83
2064	Candy, confectionery	(6)	0.925	0.186	0.000				0.61	2.938	1.000	83
2066	Chocolate and cocoa	(6)	0.376	0.373	0.317				0.29	2.797	1.000	83
2068	Salted, roasted nuts, seeds	(6)	0.090	0.248	0.716				0.51	2.603	1.000	83
2074	Cottonseed oil mills	(6)	2.351	0.179	0.000				0.63	2.960	1.000	83
2075	Soybean oil mills	(4)	1.076	0.077	0.000	1.436	0.073	0.000	0.88	4.974	0.000	83
2076	Other vegetable oil mills	(6)	2.105	0.176	0.000				0.60	2.351	0.999	83
2077	Animal, marine fats and oil	(6)	1.978	0.304	0.000				0.36	2.841	1.000	83
2079	Shortening, cooking oils	(6)	0.882	0.231	0.000				0.32	2.909	1.000	83
2082	Malt beverages	(4)	0.783	0.350	0.029	3.342	1.856	0.072	0.58	−2.000	0.046	83
2083	Malt	(6)	3.135	0.230	0.000				0.67	2.791	1.000	83
2085	Distilled liquor, except brandy	(6)	0.005	0.204	0.982				0.55	2.876	1.000	83
2086	Bottled, canned soft drinks	(6)	0.560	0.378	0.142				0.45	2.182	0.989	83
2087	Other flavoring extracts, syrups	(6)	0.973	0.135	0.000				0.46	2.565	1.000	83

Table 1 (*Continued*)

SIC	Description	Equation	Short-run elasticities			Long-run elasticities			Adjusted R^2	DW/DH	DW/DH *P*-value	Observed
			Elasticity	S.E.	*P*-value	Elasticity	S.E.	*P*-value				
2095	Roasted coffee	(6)	0.319	0.213	0.138				0.27	2.451	1.000	83
2111	Cigarettes	(6)	0.946	0.249	0.000				0.81	1.996	0.927	83
2121	Cigars	(5)	1.019	0.016	0.000	0.980	0.009	0.000	0.95	2.225	0.997	83
2131	Chewing, smoking tobacco	(5)	−0.275	0.281	0.333	−0.629	0.459	0.171	0.20	2.278	0.999	83
2231	Weaving and finishing mills	(6)	0.456	0.209	0.032				0.22	2.841	1.000	83
2241	Narrow fabric mills	(4)	0.481	0.130	0.000	1.335	0.463	0.004	0.50	−1.994	0.046	83
2252	Other hosiery	(6)	−0.381	0.103	0.000				0.25	2.610	1.000	83
2257	Circular knit fabric mills	(5)	1.465	0.148	0.000	2.873	0.367	0.000	0.77	2.730	1.000	83
2258	Lace and warp knit fabric mills	(5)	1.374	0.118	0.000	1.051	0.351	0.003	0.79	2.441	1.000	83
2273	Carpets and rugs	(6)	0.909	0.099	0.000				0.56	2.840	1.000	83
2281	Yarn spinning mills	(5)	1.611	0.234	0.000	0.881	1.053	0.403	0.60	2.571	1.000	83
2284	Thread mills	(6)	0.772	0.199	0.000				0.19	2.810	1.000	83
2295	Coated fabrics, not rubberized	(6)	0.871	0.089	0.000				0.66	2.847	1.000	83
2296	Tire cord and fabric	(6)	1.346	0.516	0.011				0.39	2.466	1.000	83
2297	Nonwoven fabrics	(6)	0.789	0.302	0.012				0.38	3.028	1.000	71
2299	Other textile goods	(6)	0.532	0.120	0.000				0.31	2.784	1.000	83
2311	Men’s, boy’s suits, coats	(5)	1.177	0.402	0.005	1.054	1.504	0.483	0.68	2.808	1.000	83
2321	Shirts, men’s and boy’s	(6)	1.183	0.476	0.015				0.68	2.654	1.000	83
2322	Men’s/boy’s underwear	(6)	0.368	0.411	0.374				0.14	2.887	1.000	83
2323	Men’s and boy’s neckware	(6)	0.849	0.150	0.000				0.66	2.906	1.000	83
2325	Men’s/boy’s trousers, slacks	(6)	0.040	0.484	0.934				0.56	2.667	1.000	83
2329	Men’s/boy’s clothing	(6)	0.861	0.160	0.000				0.85	2.444	1.000	83
2331	Women’s blouses and waists	(6)	−0.100	0.370	0.788				0.76	2.758	1.000	83
2335	Women’s dresses	(6)	0.622	0.252	0.016				0.79	2.667	1.000	83
2337	Women’s suits and coats	(6)	1.055	0.213	0.000				0.79	2.805	1.000	83
2339	Other women’s outerwear	(6)	1.063	0.180	0.000				0.74	1.959	0.901	83
2341	Women’s/children’s underwear	(6)	1.124	0.260	0.000				0.47	3.048	1.000	83
2342	Brassieres, allied garments	(4)	−0.588	0.234	0.014	−2.103	0.410	0.000	0.86	−5.725	0.000	83
2353	Hats and caps	(6)	0.368	0.188	0.054				0.11	2.869	1.000	83
2371	Fur goods	(6)	0.827	0.104	0.000				0.76	2.911	1.000	83
2384	Robes and dressing gowns	(5)	0.891	0.257	0.001	1.167	0.467	0.012	0.68	2.420	1.000	83
2385	Waterproof outergarments	(6)	0.881	0.059	0.000				0.82	2.276	0.997	83
2386	Leather/sheep lined clothing	(4)	1.356	0.309	0.000	2.059	0.383	0.000	0.80	1.828	0.861	73
2389	Other apparel, accessories	(4)	1.364	0.093	0.000	1.540	0.115	0.000	0.87	4.813	0.000	83
2391	Curtains, draperies	(6)	1.091	0.160	0.000				0.56	2.971	1.000	83
2392	Other house furnishings	(4)	0.086	0.085	0.315	0.119	0.120	0.321	0.39	2.083	0.982	83

2393	Textile bags	(6)	1.020	0.219	0.000				0.48	2.607	1.000	83
2394	Canvas and related products	(4)	0.998	0.161	0.000	2.130	0.291	0.000	0.88	0.062	0.951	83
2395	Pleating and stitching	(5)	0.983	0.042	0.000	0.841	0.082	0.000	0.93	2.239	0.998	83
2396	Automotive/apparel trimmings	(4)	0.735	0.140	0.000	1.033	0.169	0.000	0.55	−0.257	0.797	83
2399	Other fabricated textile products	(6)	1.184	0.186	0.000				0.20	3.123	1.000	83
2411	Logging	(6)	0.616	0.127	0.000				0.46	2.930	1.000	83
2426	Hardwood/flooring mills	(6)	0.799	0.183	0.000				0.07	2.980	1.000	83
2429	Other special product sawmills	(6)	−0.674	0.736	0.364				0.33	2.722	1.000	71
2431	Millwork	(6)	1.006	0.058	0.000				0.80	2.825	1.000	83
2436	Softwood veneer, plywood	(4)	0.839	0.302	0.007	3.195	0.925	0.001	0.80	−1.404	0.160	77
2452	Prefabricated wood buildings	(4)	1.033	0.052	0.000	1.109	0.071	0.000	0.87	3.091	0.002	83
2491	Wood preserving	(4)	0.581	0.124	0.000	1.088	0.110	0.000	0.87	0.041	0.968	83
2499	Other wood products	(6)	1.380	0.462	0.004				0.57	2.481	1.000	83
2514	Metal household furniture	(6)	1.326	0.135	0.000				0.83	3.001	1.000	71
2515	Mattresses and bedsprings	(6)	0.795	0.079	0.000				0.64	2.897	1.000	83
2591	Drapery hardware, shades	(6)	0.978	0.073	0.000				0.75	2.699	1.000	83
2611	Pulp mills	(6)	0.994	0.673	0.144				0.05	3.025	1.000	83
2621	Paper mills	(6)	1.055	0.062	0.000				0.90	2.561	1.000	83
2631	Paperboard mills	(6)	0.887	0.407	0.033				0.17	3.014	1.000	83
2652	Setup paperboard boxes	(6)	0.757	0.358	0.038				0.18	2.942	1.000	83
2653	Corrugated, solid fiber boxes	(6)	1.501	0.175	0.000				0.69	2.740	1.000	83
2656	Sanitary food containers	(5)	0.780	0.144	0.000	0.415	0.263	0.115	0.51	2.407	1.000	83
2657	Folding paperboard boxes	(4)	0.798	0.257	0.003	3.875	0.495	0.000	0.94	−1.421	0.155	83
2672	Other paper-coated boxes	(4)	0.974	0.129	0.000	1.480	0.475	0.002	0.75	7.093	0.000	83
2673	Bags-plastics, coated	(6)	0.960	0.101	0.000				0.76	2.871	1.000	83
2674	Bags, uncoated paper	(6)	1.006	0.185	0.000				0.47	2.730	1.000	83
2676	Sanitary paper products	(6)	0.393	0.156	0.014				0.15	2.704	1.000	83
2677	Envelopes	(6)	1.044	0.116	0.000				0.62	2.709	1.000	83
2678	Stationary products	(6)	1.542	0.244	0.000				0.45	2.685	1.000	83
2679	Converted paper products	(6)	1.074	0.192	0.000				0.49	2.763	1.000	83
2711	Newspapers	(6)	1.077	0.037	0.000				0.88	2.362	0.999	83
2721	Periodicals	(6)	1.119	0.114	0.000				0.63	2.755	1.000	83
2731	Book publishing	(6)	1.056	0.072	0.000				0.77	2.715	1.000	83
2741	Misc. publishing	(6)	1.124	0.077	0.000				0.81	2.732	1.000	83
2761	Manifold business forms	(6)	0.927	0.155	0.000				0.50	2.511	1.000	83
2782	Blank books/looseleaf binders	(6)	0.919	0.110	0.000				0.54	2.458	1.000	83

Table 1 (*Continued*)

SIC	Description	Equation	Short-run elasticities			Long-run elasticities			Adjusted R^2	DW/DH	DW/DH *P*-value	Observed
			Elasticity	S.E.	*P*-value	Elasticity	S.E.	*P*-value				
2796	Platemaking services	(6)	0.827	0.096	0.000				0.62	3.194	1.000	83
2812	Alkalis and chlorine	(6)	0.760	0.163	0.000				0.93	2.984	1.000	83
2813	Industrial gases	(4)	0.962	0.032	0.000	1.050	0.045	0.000	0.92	4.110	0.000	83
2816	Inorganic pigments	(4)	0.483	0.158	0.003	1.152	0.476	0.015	0.42	−3.935	0.000	83
2821	Plastics materials, resins	(4)	0.873	0.184	0.000	4.834	1.248	0.000	0.87	−0.172	0.864	83
2822	Synthetic rubber	(6)	−0.016	0.377	0.967				0.36	2.670	1.000	83
2823	Cellulosic manmade fibers	(4)	1.092	0.265	0.000	2.094	0.468	0.000	0.58	4.231	0.000	82
2824	Organic fibers, noncellulosic	(6)	1.117	0.261	0.000				0.53	3.058	1.000	83
2833	Medicinals and botanicals	(6)	0.881	0.048	0.000				0.88	2.692	1.000	83
2835	Diagnostic substances	(5)	0.492	0.187	0.011	0.001	0.606	0.999	0.44	2.376	1.000	83
2836	Biological products	(4)	0.298	0.155	0.060	0.675	0.454	0.137	0.29	−1.812	0.070	83
2841	Soap and other detergents	(4)	0.353	0.290	0.227	2.929	3.076	0.341	0.73	−1.104	0.270	83
2842	Polishes and sanitation goods	(6)	0.624	0.170	0.001				0.18	2.870	1.000	83
2843	Surface active agents	(6)	0.800	0.125	0.000				0.50	2.735	1.000	83
2844	Toilet preparations	(6)	0.692	0.100	0.000				0.53	3.064	1.000	83
2851	Paints, allied products	(5)	1.287	0.071	0.000	1.034	1.080	0.338	0.90	2.512	1.000	83
2874	Phosphatic fertilizers	(6)	1.215	0.386	0.002				0.38	1.700	0.542	83
2879	Agricultural chemical products	(4)	1.028	0.200	0.000	1.620	0.391	0.000	0.62	−0.120	0.905	83
2891	Adhesives and sealants	(4)	1.181	0.091	0.000	1.873	0.116	0.000	0.90	2.521	0.012	83
2892	Explosives	(6)	0.917	0.057	0.000				0.83	2.610	1.000	83
2893	Printing ink	(6)	0.709	0.126	0.000				0.46	2.672	1.000	83
2895	Carbon black	(6)	−0.242	0.204	0.241				0.23	2.844	1.000	83
2899	Chemical preparations	(4)	1.111	0.094	0.000	1.811	0.125	0.000	0.89	3.044	0.002	83
2911	Petroleum refining	(6)	0.849	0.376	0.027				0.03	2.608	1.000	83
2951	Asphalt paving mixtures	(4)	0.899	0.216	0.000	1.079	0.240	0.000	0.72	1.721	0.085	83
2999	Petroleum, coal products	(4)	0.148	0.153	0.339	0.121	0.130	0.350	0.10	1.925	0.917	83
3011	Tires and inner tubes	(6)	0.789	0.136	0.000				0.50	2.966	1.000	83
3021	Rubber/plastics footwear	(6)	0.380	0.346	0.277				0.53	2.522	1.000	83
3052	Rubber/plastics hose, belting	(6)	1.225	0.173	0.000				0.67	3.033	1.000	83
3053	Gaskets, sealing devices	(6)	1.073	0.105	0.000				0.62	2.034	0.948	83
3069	Fabricated rubber products	(6)	0.814	0.072	0.000				0.62	2.822	1.000	83
3081	Unsupported plastics film	(6)	0.951	0.149	0.000				0.53	2.952	1.000	83
3082	Unsupported plastics shapes	(6)	0.961	0.028	0.000				0.94	2.237	0.995	83
3089	Plastic products	(4)	0.694	0.150	0.000	1.223	0.302	0.000	0.34	1.090	0.276	83
3111	Leather tanning and finishing	(6)	0.961	0.168	0.000				0.52	2.751	1.000	83
3142	House slippers	(5)	0.344	0.189	0.072	−1.322	1.252	0.291	0.79	2.512	1.000	83

3143	Men’s footwear, except athletic	(6)	0.662	0.202	0.002				0.57	2.569	1.000	83
3144	Women’s footwear, except athletic	(6)	0.662	0.232	0.006				0.67	2.666	1.000	83
3149	Nonrubber footwear	(4)	0.364	0.223	0.108	0.725	0.371	0.050	0.41	2.305	0.999	81
3151	Leather gloves and mittens	(6)	0.402	0.161	0.015				0.51	2.552	1.000	83
3161	Luggage	(4)	0.350	0.143	0.017	8.517	7.127	0.232	0.92	−3.212	0.001	83
3171	Women’s handbags	(6)	1.120	0.183	0.000				0.81	2.727	1.000	83
3172	Personal leather goods	(6)	0.531	0.274	0.057				0.54	2.411	1.000	83
3211	Flat glass	(6)	0.889	0.062	0.000				0.80	2.582	1.000	83
3221	Glass containers	(6)	0.962	0.190	0.000				0.50	2.928	1.000	83
3229	Pressed and blown glass	(6)	4.847	0.777	0.000				0.26	3.020	1.000	83
3231	Glass produced from pur. glass	(6)	1.108	0.094	0.000				0.78	2.710	1.000	83
3241	Cement, hydraulic	(6)	0.729	0.067	0.000				0.75	2.680	1.000	83
3253	Ceramic wall and floor tile	(6)	0.529	0.484	0.277				0.34	2.865	1.000	83
3255	Clay refactories	(4)	0.950	0.246	0.000	1.463	0.315	0.000	0.64	2.349	1.000	81
3261	Vitreous plumbing fixtures	(6)	0.784	0.084	0.000				0.62	2.847	1.000	83
3264	Porcelain electrical supplies	(4)	0.949	0.033	0.000	1.023	0.036	0.000	0.93	4.409	0.000	83
3272	Concrete products	(6)	1.027	0.060	0.000				0.86	2.540	1.000	83
3274	Lime	(4)	0.392	0.233	0.096	1.814	1.308	0.166	0.70	0.166	0.868	83
3275	Gypsum products	(6)	−1.703	0.693	0.017				0.22	2.408	1.000	83
3281	Cut stone and stone products	(6)	0.874	0.049	0.000				0.79	2.689	1.000	83
3291	Abrasive products	(4)	1.164	0.124	0.000	2.382	0.305	0.000	0.72	−0.093	0.926	83
3295	Minerals, ground/treated	(4)	1.073	0.063	0.000	1.128	0.105	0.000	0.77	1.279	0.201	83
3297	Nonclay refractories	(6)	0.797	0.202	0.000				0.14	2.798	1.000	83
3299	Nonmetallic mineral products	(6)	1.211	0.094	0.000				0.63	3.018	1.000	83
3312	Steel works, blast furnaces	(6)	2.042	0.354	0.000				0.68	2.705	1.000	83
3315	Steel wire products	(6)	0.540	0.266	0.046				0.55	2.896	1.000	83
3321	Gray iron foundries	(4)	0.359	0.107	0.001	0.757	0.246	0.002	0.41	0.257	0.797	83
3334	Primary aluminum	(6)	0.648	0.369	0.084				0.23	2.765	1.000	83
3339	Primary nonferrous metals	(6)	2.757	0.706	0.000				0.29	2.633	1.000	80
3351	Copper rolling and drawing	(6)	1.935	0.423	0.000				0.31	2.920	1.000	83
3353	Aluminum sheet, plate, and foil	(6)	1.576	0.652	0.018				0.14	2.849	1.000	83
3354	Aluminum extruded products	(6)	1.643	0.348	0.000				0.49	3.099	1.000	83
3357	Nonferrous wire drawing	(6)	2.026	0.168	0.000				0.74	2.634	1.000	83
3365	Aluminum foundries	(4)	1.121	0.177	0.000	1.690	0.327	0.000	0.53	1.255	0.209	83
3399	Other primary metal products	(4)	1.342	0.126	0.000	1.232	0.115	0.000	0.68	4.806	0.000	83
3411	Metal cans	(6)	1.435	0.101	0.000				0.73	2.568	1.000	83

Table 1 (*Continued*)

SIC	Description	Equation	Short-run elasticities			Long-run elasticities			Adjusted R^2	DW/DH	DW/DH *P*-value	Observed
			Elasticity	S.E.	*P*-value	Elasticity	S.E.	*P*-value				
3412	Metal barrels, drums, pails	(4)	0.940	0.166	0.000	1.983	0.451	0.000	0.56	−1.463	0.143	83
3421	Cutlery	(4)	1.019	0.056	0.000	1.159	0.067	0.000	0.83	4.319	0.000	83
3423	Other hand and edge tools	(4)	0.842	0.112	0.000	1.140	0.138	0.000	0.66	−0.188	0.851	83
3429	Other hardware	(4)	0.839	0.122	0.000	1.519	0.324	0.000	0.62	0.074	0.941	71
3431	Metal sanitary ware	(6)	0.896	0.113	0.000				0.55	2.897	1.000	83
3432	Plumbing/heating, except electric	(4)	1.026	0.083	0.000	1.631	0.105	0.000	0.90	4.068	0.000	83
3433	Heating equipment, except electric	(4)	0.879	0.076	0.000	1.049	0.098	0.000	0.85	0.122	0.903	83
3441	Fabricated structural metal	(6)	−0.146	0.250	0.561				0.12	2.817	1.000	83
3442	Metal doors, sash, and trim	(6)	0.186	0.167	0.270				0.18	2.673	1.000	83
3443	Fabricated plate work	(6)	0.958	0.039	0.000				0.92	2.925	1.000	83
3444	Sheet metal work	(6)	0.769	0.161	0.000				0.27	2.534	1.000	83
3449	Miscellaneous metal work	(5)	0.833	0.190	0.000	1.059	0.248	0.000	0.43	2.033	0.970	83
3452	Fasteners	(6)	0.860	0.080	0.000				0.70	2.824	1.000	83
3469	Other metal stampings	(5)	0.921	0.046	0.000	1.202	0.235	0.000	0.86	2.450	1.000	83
3484	Small arms	(6)	1.020	0.340	0.004				0.32	2.969	1.000	77
3489	Other ordnance	(4)	0.494	0.082	0.000	0.568	0.131	0.000	0.41	1.907	0.939	64
3492	Fluid power valves, hose fittings	(6)	1.208	0.091	0.000				0.82	3.026	1.000	83
3493	Steel springs, except wire	(6)	0.735	0.291	0.014				0.72	2.942	1.000	83
3494	Valves and pipe fittings	(6)	0.741	0.908	0.417				0.07	2.490	1.000	81
3496	Misc. fabricated wire products	(6)	0.916	0.263	0.001				0.51	2.935	1.000	83
3497	Metal foil and leaf	(6)	0.980	0.116	0.000				0.46	2.675	1.000	83
3499	Fabricated metal products	(4)	1.339	0.230	0.000	1.962	0.367	0.000	0.57	0.957	0.339	83
3511	Turbines, generator sets	(6)	0.559	0.079	0.000				0.47	2.554	1.000	83
3519	Internal combustion engines	(6)	0.900	0.065	0.000				0.78	2.658	1.000	83
3523	Farm machinery and equipment	(6)	1.151	0.078	0.000				0.79	2.668	1.000	76
3531	Construction machinery	(4)	0.826	0.122	0.000	0.995	0.108	0.000	0.44	0.655	0.513	83
3532	Mining machinery	(6)	0.740	0.056	0.000				0.72	2.905	1.000	83
3534	Elevators and moving stairways	(4)	0.851	0.072	0.000	1.141	0.109	0.000	0.72	4.457	0.000	83
3535	Conveyers, equipment	(4)	0.823	0.063	0.000	0.967	0.098	0.000	0.78	2.209	0.996	79
3536	Hoists, cranes, monorails	(5)	0.507	0.058	0.000	0.529	0.068	0.000	0.74	1.837	0.838	83
3537	Industrial trucks/tractors	(5)	0.820	0.056	0.000	0.815	0.037	0.000	0.86	2.137	0.992	71
3541	Machine tools, metal cutting	(6)	0.583	0.108	0.000				0.31	3.314	1.000	83
3542	Machine tools, conveying equipment	(6)	0.493	0.105	0.000				0.34	3.029	1.000	83
3543	Industrial patterns	(4)	0.897	0.062	0.000	1.229	0.059	0.000	0.89	1.926	0.054	83
3544	Special dies, tools, fixtures	(6)	0.917	0.066	0.000				0.70	2.728	1.000	66
3545	Cutting tools accessories	(6)	0.525	0.130	0.000				0.36	2.806	1.000	83

3546	Power-driven handtools	(6)	0.422	0.167	0.014				0.50	3.030	1.000	83
3547	Rolling mill machinery	(4)	0.507	0.128	0.000	0.870	0.231	0.000	0.33	−2.364	0.018	83
3548	Welding apparatus	(6)	0.236	0.045	0.000				0.51	2.946	1.000	83
3552	Textile machinery	(6)	0.952	0.085	0.000				0.68	3.189	1.000	81
3553	Woodworking machinery	(6)	0.751	0.151	0.000				0.22	3.075	1.000	83
3556	Food products machinery	(6)	0.945	0.037	0.000				0.90	2.494	1.000	80
3559	Special industry machinery	(6)	1.021	0.026	0.000				0.94	2.938	1.000	83
3561	Pumps/pumping equipment	(5)	0.962	0.046	0.000	1.134	0.069	0.000	0.89	2.317	0.999	83
3562	Ball/roller bearings	(6)	0.437	0.259	0.096				0.14	2.963	1.000	83
3563	Air/gas compressors	(6)	0.799	0.296	0.009				0.05	2.904	1.000	76
3564	Blowers/fans	(6)	0.297	0.181	0.105				0.82	2.300	0.998	83
3565	Packaging machinery	(5)	1.020	0.055	0.000	1.017	0.059	0.000	0.86	2.033	0.970	83
3566	Speed changers, drives	(5)	0.918	0.089	0.000	1.134	0.079	0.000	0.63	2.105	0.986	83
3567	Industrial process furnaces	(4)	0.868	0.056	0.000	0.991	0.080	0.000	0.77	2.081	0.985	74
3568	Power transmission equipment	(6)	0.928	0.051	0.000				0.80	2.672	1.000	83
3569	General industrial machinery	(6)	0.966	0.132	0.000				0.49	2.649	1.000	83
3571	Electronic computers	(6)	0.231	0.354	0.517				0.63	2.535	1.000	79
3572	Computer storage devices	(6)	0.976	0.116	0.000				0.60	2.763	0.006	83
3577	Computer peripheral equipment	(6)	0.981	0.183	0.000				0.56	2.533	1.000	83
3578	Calculating equipment	(6)	1.078	0.145	0.000				0.45	2.810	1.000	83
3579	Other office machines	(6)	1.097	0.127	0.000				0.58	2.593	1.000	83
3581	Merchandising machines	(6)	0.867	0.053	0.000				0.84	2.510	1.000	83
3582	Commercial laundry equipment	(6)	1.275	0.058	0.000				0.96	2.482	1.000	41
3585	Refrigeration/heating equipment	(4)	0.541	0.154	0.001	1.059	0.383	0.006	0.49	−0.033	0.974	83
3586	Measuring/dispensing pumps	(4)	0.978	0.040	0.000	1.050	0.030	0.000	0.94	3.691	0.000	83
3589	Service industry machinery	(6)	0.993	0.019	0.000				0.96	2.900	1.000	83
3593	Fluid power cylinders	(6)	0.905	0.058	0.000				0.79	2.819	1.000	83
3594	Fluid power pumps/motors	(4)	0.974	0.075	0.000	1.694	0.118	0.000	0.84	1.133	0.257	83
3596	Scales and balances	(4)	0.794	0.086	0.000	1.030	0.118	0.000	0.67	4.104	0.000	83
3599	Other industrial machinery	(6)	0.805	0.084	0.000				0.77	2.981	1.000	83
3612	Power transmissions	(6)	0.871	0.058	0.000				0.82	2.602	1.000	83
3613	Switchgear, apparatus	(4)	0.540	0.118	0.000	2.423	0.690	0.000	0.79	−0.660	0.510	83
3621	Motors, generators	(6)	1.024	0.192	0.000				0.89	2.400	1.000	83
3624	Carbon, graphite products	(6)	1.332	0.199	0.000				0.42	3.040	1.000	83
3625	Relays, industrial controls	(6)	0.713	0.129	0.000				0.46	2.875	1.000	83
3629	Other electric industrial apparatus	(6)	0.706	0.095	0.000				0.46	3.232	1.000	83

Table 1 (*Continued*)

SIC	Description	Equation	Short-run elasticities			Long-run elasticities			Adjusted R^2	DW/DH	DW/DH *P*-value	Observed
			Elasticity	S.E.	*P*-value	Elasticity	S.E.	*P*-value				
3631	Household cooking equipment	(6)	0.784	0.142	0.000				0.45	2.678	1.000	83
3632	Household refrigerators and freezers	(6)	0.988	0.144	0.000				0.57	2.808	1.000	83
3633	Household laundry equipment	(5)	1.072	0.031	0.000	1.176	0.049	0.000	0.91	2.396	1.000	83
3634	Electric housewares, fans	(6)	0.979	0.072	0.000				0.83	2.266	0.996	83
3635	Household vacuum cleaners	(6)	1.036	0.125	0.000				0.64	2.284	0.997	83
3641	Electric lamps	(4)	0.203	0.120	0.095	0.986	0.780	0.206	0.73	−2.561	0.010	83
3651	Household audio and video equipment	(6)	−0.227	0.625	0.717				0.12	2.859	1.000	83
3671	Electron tubes	(6)	0.983	0.092	0.000				0.59	2.699	1.000	81
3672	Printed circuit boards	(6)	0.553	0.380	0.150				0.10	2.059	0.960	81
3674	Semiconductors	(6)	0.497	0.168	0.004				0.55	2.753	1.000	83
3675	Electronic capacitors	(6)	1.188	0.304	0.000				0.36	2.479	1.000	83
3676	Electronic resistors	(6)	1.376	0.426	0.002				0.22	2.766	1.000	83
3677	Electronic coils, transformers	(6)	0.745	0.139	0.000				0.50	2.984	1.000	83
3678	Electronic connectors	(6)	0.957	0.073	0.000				0.74	2.998	1.000	63
3679	Electronic components	(6)	0.789	0.075	0.000				0.57	2.710	1.000	83
3691	Storage batteries	(6)	0.756	0.168	0.000				0.27	2.627	1.000	83
3692	Primary batteries, dry/wet	(4)	0.473	0.157	0.004	1.326	0.409	0.001	0.79	−0.839	0.402	83
3694	Engine electrical equipment	(6)	0.742	0.103	0.000				0.62	2.578	1.000	83
3695	Magnetic, optical recording	(6)	1.524	1.516	0.320				−0.08	2.720	1.000	56
3699	Electrical machinery, equipment	(6)	1.514	0.623	0.018				0.49	1.327	0.097	72
3711	Vehicles, car bodies	(6)	0.940	0.041	0.000				0.92	2.554	1.000	83
3713	Truck/bus bodies	(5)	0.975	0.035	0.000	0.952	0.113	0.000	0.95	2.213	0.997	83
3714	Vehicles parts, accessories	(6)	1.659	0.241	0.000				0.93	2.478	1.000	83
3715	Truck trailors	(5)	0.880	0.103	0.000	1.351	0.610	0.027	0.55	2.418	1.000	83
3721	Aircraft	(4)	0.548	0.102	0.000	0.930	0.148	0.000	0.48	2.189	0.995	81
3724	Aircraft engines, parts	(6)	0.897	0.060	0.000				0.85	2.559	1.000	83
3731	Ship building, repairing	(6)	0.779	0.201	0.000				0.22	3.045	1.000	76
3732	Boat building, repairing	(4)	0.462	0.095	0.000	1.192	0.245	0.000	0.78	0.724	0.469	83
3751	Motorcycles, bicycles, parts	(6)	1.359	0.532	0.013				0.39	2.477	1.000	83
3792	Travel trailor/campers	(6)	0.900	0.150	0.000				0.75	2.070	0.963	83
3799	Other transportation equipment	(6)	0.859	0.097	0.000				0.71	2.415	1.000	83
3812	Search/navigation equipment	(6)	0.722	0.072	0.000				0.61	2.978	1.000	83
3822	Environmental controls	(6)	0.934	0.151	0.000				0.50	3.075	1.000	83
3823	Process control instruments	(6)	0.758	0.157	0.000				0.33	2.694	1.000	83
3824	Fluid meters, counting devices	(6)	0.549	0.180	0.003				0.20	2.538	1.000	83
3825	Electrical measuring instruments	(4)	1.036	0.139	0.000	1.779	0.293	0.000	0.56	−0.676	0.499	82

3826	Analytical instruments	(6)	0.955	0.122	0.000				0.39	2.812	1.000	83
3827	Optical instruments, lenses	(6)	0.911	0.224	0.000				0.34	2.438	1.000	51
3829	Other measuring devices	(6)	1.022	0.112	0.000				0.43	2.873	1.000	83
3841	Surgical/medical instruments	(6)	0.940	0.072	0.000				0.70	2.995	1.000	83
3842	Surgical appliances, supplies	(6)	1.006	0.167	0.000				0.44	2.447	1.000	83
3843	Dental equipment, supplies	(6)	0.947	0.062	0.000				0.79	2.800	1.000	83
3844	X-ray apparatus	(6)	0.539	0.088	0.000				0.55	2.768	1.000	81
3845	Electromedical equipment	(6)	1.107	0.060	0.000				0.89	2.993	1.000	83
3851	Ophthalmic goods	(4)	0.852	0.123	0.000	1.353	0.171	0.000	0.68	1.998	0.046	83
3861	Photographic equipment	(4)	0.918	0.197	0.000	4.003	1.229	0.001	0.74	0.402	0.688	83
3873	Watches, clocks, watchcases	(6)	0.864	0.415	0.041				0.25	3.021	1.000	83
3915	Jewelers’ materials	(4)	0.989	0.031	0.000	1.055	0.033	0.000	0.96	4.247	0.000	83
3931	Musical instruments	(6)	0.871	0.077	0.000				0.79	2.537	1.000	83
3944	Games, toys	(4)	0.512	0.212	0.018	0.579	0.255	0.023	0.18	2.004	0.959	83
3949	Sporting and athletic goods	(6)	0.766	0.105	0.000				0.66	2.869	1.000	83
3951	Pens, mechanical pencils	(5)	0.743	0.275	0.009	0.864	0.363	0.017	0.47	2.030	0.969	83
3952	Lead pencils, art goods	(5)	1.040	0.203	0.000	2.148	0.198	0.000	0.62	2.302	0.999	83
3955	Carbon paper, inked ribbons	(6)	0.686	0.114	0.000				0.54	2.483	1.000	83
3965	Fasteners, buttons, needles	(6)	0.825	0.190	0.000				0.51	2.270	0.997	83
3991	Brooms, brushes	(4)	0.150	0.083	0.074	0.209	0.128	0.102	0.19	0.880	0.379	83
3993	Signs, advertising displays	(4)	0.780	0.094	0.000	1.080	0.174	0.000	0.59	5.436	0.000	83
3999	Other manufacturing industries	(6)	0.699	0.141	0.000				0.67	2.222	0.994	83

Note: The regressions are corrected for heteroskedasticity using White’s correction method; the standard errors are heteroskedastic-consistent. The Durbin–Watson statistic is reported for the ECM and differenced model and the Durbin-s *h* statistic is reported for the AR1 model; the corresponding *P*-values are reported in the next column (where the null hypothesis is no autocorrelation).

5.3. Within-sector variation

In order to examine the relevance of estimation at the four-digit SIC level over the three-digit level, we conduct common means tests within three-digit SIC levels to determine how comparable elasticities are within the same broadly defined industries. Theory is ambiguous on the question of whether the demand response to price changes for intermediate goods should reflect that for finished goods. This issue arises in applied work, because modeling exercises often pertain to a detailed product category. However, lack of data often forces modelers to use the more aggregate estimates as a proxy.

Statistically significant differences exist among most of the four-digit SICs within the respective three-digit SIC category. Only the statistically significant estimates were tested. For example, consider SIC 281. The null hypothesis that the difference between estimated elasticities for SIC 2812 and SIC 2813 is not statistically significant was rejected; hence, the difference between elasticity estimates SIC 2812 and SIC 2813 was found to be statistically significant. For 367 of the 416 means tests conducted on short-run elasticity estimates, the null hypothesis that the elasticity estimates within the same three-digit SIC were not statistically significantly different was rejected. Similarly, the null hypothesis was rejected for the 25 of the 27 means tests conducted on the long-run estimates.[24]

Our long-run estimates are generally higher than those obtained by other authors who use time-series estimation techniques to directly estimate import price elasticities. For example, our estimates tend to be higher than those obtained by Blonigen and Wilson (1999), who report an average elasticity across 146 sectors of 0.81 and by Reinert and Roland-Holst (1992), who report a range between 0.04 and 3. Estimates by Shiells et al. (1986) ranged from 0.5 to 6.5 with an average of about 2.5. One clear exception is a recent paper by Erkel-Rousse and Mirza (2002) who estimate trade price elasticities in a time series framework. Unlike previous studies (including this one), those authors exploit the supply-side considerations using instrumental variables. Their range of estimates is from 1 to 13, broader than comparable studies. On average, our long-run estimates were generally higher than existing short-run estimates, and our set of estimates provides a greater level of disaggregation.

6. Concluding remarks

This paper provides the most comprehensive and disaggregated set of Armington elasticities to date. The trade substitution elasticity is a key parameter in applied modeling, to which results derived from partial or general equilibrium models prove to be highly sensitive. Because most applied modeling exercises attempt to estimate the long-run effects of a policy shock, we attempt to extract the long-run relationships from the data when possible. On average, the long-run estimates are twice as large as the short-run estimates, and overall up to five times larger than the long-run estimates. One of the most useful aspects of the econometric estimates in this paper is that they offer guidance on the relative ease of substitutability across sectors. We find statistically significant differences within most three-digit SIC industries. Since much of applied-trade-policy analysis is conducted at the disaggre-

[24] The results of the means test are available upon request.

gated product level, our results highlight the importance of obtaining elasticity estimates at the most disaggregated level that the data allow.

Challenges remain in determining these key parameters. The literature is scarce on a number of issues that would affect applied modeling exercises, such as whether country-specific characteristics or the composition of trade affect the degree of substitutability. One important extension of this literature is an analysis of determinants of these elasticities across industries. Blonigen and Wilson (1999) analyze whether product, industry, and political characteristics between domestic and import goods are related to systematic differences in Armington elasticities across U.S. industries. Our estimates at a relatively detailed level of disaggregation should provide researchers opportunities for future work.

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