Estimates of the Elasticities of Substitution between Imports and Home Goods for the United States
Author(s): Clinton R. Shiells, Robert M. Stern and Alan V. Deardorff
Source: *Weltwirtschaftliches Archiv*, Bd. 122, H. 3 (1986), pp. 497-519
Published by: Springer
Stable URL: http://www.jstor.org/stable/40439494

Estimates of the Elasticities of Substitution between Imports and Home Goods for the United States

By

Clinton R. Shiells, Robert M. Stern, and **Alan V. Deardorff**

Contents: I. Introduction. – II. Theory. – III. Estimation Procedure. – IV. Data. – V. Results. – VI. Comparison with "Best Guess" Estimates. – VII. Summary and Conclusions.

I. Introduction

This paper presents estimates of the elasticities of substitution between imports and home goods for the United States at a disaggregated level covering 3-digit SIC industries. These elasticities of substitution are calculated from econometric estimates of disaggregated import-demand equations. The rationale for our effort stems from the need for more accurate modeling of the effects of changes in relative prices on the division of expenditure between imports and home goods. Such changes in relative prices may come about, for example, as the result of changes in tariffs, nontariff barriers, exchange rates, domestic prices, and wages.

More particularly, in estimating the effects of trade on employment, it is common to assume, as in Baldwin *et al.* [1980], Bayard, Orr [1980], and Cline *et al.* [1978], that changes in imports in response, say, to changes in tariffs are translated into changes in domestic output on a dollar-for-dollar basis. This approach is not altogether satisfactory, however, because it does not take into account variations across industries in the degree of substitutability that may exist between imports and domestic goods. As a consequence, there is some uncertainty about the calculation of industry employment effects stemming from changes in trade.

A somewhat more satisfactory procedure has been followed especially in the work by Deardorff, Stern [1986] and Whalley [1984], who model the allocation of expenditure between home and imported goods for a given industry in proportions that depend on their relative prices. In calculating the requisite elasticities of substitution, the price elasticities of import demand used in these (and many other) studies have been drawn from the "best guess" estimates constructed by Stern *et al.* [1976] in their review of price elasticities

Remark: The research reported here was funded initially by the Division of Foreign Economic Research, Bureau of International Labor Affairs, U.S. Department of Labor. Our subsequent efforts have been supported by a grant from the Ford Foundation for a program of research on trade policy at The University of Michigan.

in international trade. Hamilton [1980] has more recently constructed disaggregated estimates of elasticities of import demand for Sweden, while disaggregated substitution elasticities have been estimated for Australia by Alaouze [1976; 1977] and Alaouze *et al.* [1977] in connection with the IMPACT Project and for West Germany by Lächler [1985]. However, since these recent studies as well as earlier ones surveyed by Stern *et al.* [1976] are somewhat limited in terms of their theoretical rationale, estimating procedures, and commodity and time coverage, we thought it worthwhile to attempt to construct new estimates of price elasticities of import demand for the U.S. which may serve as the basis for more reliable measures of the elasticities of substitution. These measures may in turn lead to improved estimates of the employment and other effects of changes in trade for the U.S.

In Sections II–IV, which follow, we present our theoretical framework, estimating procedures, and a brief description of the data. Results for three sets of 3-digit SIC industries are given in Section V. In Section VI, we compare our results with the "best guess" estimates noted above. Some conclusions are offered in Section VII.

II. Theory

Most previous attempts to estimate disaggregated import-demand functions have given little consideration to the theory underlying the selection of explanatory variables. It is commonly assumed that import demand is a function of the import price, the price of domestic substitutes, and an activity variable (typically GNP). Thus, the model used in aggregate import-demand estimation often has been employed with little or no modification to estimate disaggregated import-demand functions.

A number of articles have discussed the appropriate specification of the aggregate import-demand function. These include Murray, Ginman [1976], Kohli [1982], and Thursby, Thursby [1984]. However, little attention has been paid to which explanatory variables should be included in disaggregated import-demand functions. Exceptions include Mutti [1975; 1977], who shows how many previously used disaggregated import-demand models are special cases of a more general model.

The purpose of our study is to obtain a more comprehensive, disaggregated set of U.S. import-demand elasticity estimates than has been obtained in previous studies[1]. To do this, a model is needed which generates a consistent set of import demands for all product categories simultaneously. Previous studies, including Mutti's have not emphasized the linkage between the import-demand specification for one commodity group with the way import

[1] Earlier studies include Buckler, Almon [1972], Price, Thornblade [1972], Kreinin [1973], Mutti [1975], and Stone [1979].

demands in other commodity groups are specified. Instead, they have developed the import-demand equation for one commodity group in isolation from the import-demand equations for other commodity groups. It is not clear what difficulties might be present in such models when all groups are considered simultaneously. Therefore, we develop and estimate a model in which the import-demand specification for one product category is consistent with the specification of import demands for other categories.

To incorporate the fact that U.S. buyers allocate expenditure to imports in many different product categories, we assume that consumers and producers use a two-stage budgeting approach. In the first stage, total expenditure is allocated to different product categories, and, in the second stage, expenditure within each product category is allocated between imported (q_i^M) and domestic (q_i^H) goods within the group on the basis of relative prices. To proceed more formally, with respect to consumer demand, let $u = u(q_1^H, q_1^M,..., q_r^H, q_r^M)$ be the utility function for a group of identical consumers. It is to be maximized subject to the usual linear budget constraint for given prices, p_i^H, p_i^M, and total income or expenditure, Y. Assume that u(.) is weakly separable so that u(.) may be written as $u = u^* (X_1,...,X_r)$, where $u^*(.)$ is a monotone increasing function (in addition to the usual properties of a utility function), and $X_i = X_i(q_i^H, q_i^M)$ for $i = 1,...,r$ groups. Also assume that $X_1,...,X_r$ functions are homogeneous of degree one[2]. These two assumptions are sufficient for two-stage budgeting.

Consider the allocation of group i expenditure, e_i, given by the first-stage decision, between home-produced goods q_i^H, and imports q_i^M. The utility-maximizing consumer must maximize each X_i subject to the constraint of the given e_i; otherwise utility could be increased without violating the budget constraint. Hence demands q_i^H and q_i^M are the outcome of maximizing $X_i(q_i^H, q_i^M)$ subject to $p_i^H q_i^H + p_i^M q_i^M = e_i$, the total expenditure on industry i goods, so that

$$q_i^H = q_i^H(p_i^H, p_i^M, e_i) = q_i^H(p_i^H, p_i^M) \cdot e_i \qquad (1)$$

$$q_i^M = q_i^M(p_i^H, p_i^M, e_i) = q_i^M(p_i^H, p_i^M) \cdot e_i \qquad (2)$$

where the second equality in each case follows from the first-degree homogeneity of the utility function X_i. Domestic-good and import demands are thus based on industry i prices p_i^H and p_i^M, as well as expenditure e_i given by the first-stage decision.

Proceeding now to the first-stage decision, the consumer allocates expenditure to each industry based on indices of prices for each industry and total expenditure, given the assumptions of weak separability and first-degree

[2] The assumption that within-group utility functions are homogeneous of degree one is made in the theoretical exposition of two-stage budgeting, but not for the purposes of estimation (see fn. 4 below).

homogeneity of within-group utility functions[3]. Let $v_1(p_1^H, p_1^M) \cdot e_1,..., v_r(p_r^H, p_r^M) \cdot e_r$ be the indirect utility functions corresponding to utility functions $X_1,...,X_r$. That is, $X_i \equiv v_i(p_i^H, p_i^M) \cdot e_i$, for all p_i^H, p_i^M and e_i, for the maximizing consumer. The consumer's utility-maximization problem may then be stated equivalently as follows:

$$\max_{e_1,...,e_r} u^* [v_1(p_1^H, p_1^M) \cdot e_1,..., v_r(p_r^H, p_r^M) \cdot e_r] \tag{3}$$
$$\text{st: } e_1 + ... + e_r = Y$$

Using the above identity, the maximization problem becomes:

$$\max_{X_1,...,X_r} u^* (X_1,...,X_r) \tag{4}$$
$$\text{st: } P_1(p_1^H, p_1^M)\, X_1 + ... + P_r(p_r^H, p_r^M)\, X_r = Y$$

where $P_i(p_i^H, p_i^M) = 1/v_i(p_i^H, p_i^M)$. This maximization problem can be solved for $X_1,...,X_r$ in terms of $P_1,...,P_r$ and Y. Then, since $e_i = P_iX_i$,

$$e_i = e_i[P_1(p_1^H, p_1^M),...,P_r(p_r^H, p_r^M),Y] \tag{5}$$

That is, expenditure on group i is a function of price indices $P_1,...,P_r$ and total expenditure Y.[4]

If we assume that U.S. producers employ a two-stage cost-minimization process similar to the two-stage utility maximization process used by consumers, it can be shown that group specific expenditure is also an appropriate activity variable in the demands for imports of producer goods[5].

Elasticities of substitution will be calculated indirectly from import-demand price and expenditure elasticities as follows. Allen [1938, p. 512] has shown by differentiating the first-order conditions for utility maximization that

---

[3] In general, i.e., if within-group utility functions are not homogeneous of degree one, within-group expenditure depends upon all prices $p_1^H, p_1^M,..., p_r^H, p_r^M$.

[4] We are indebted to Hal Varian for this derivation. - If within-group utility is not homogeneous of degree one, then $e_i = e_i(p_1^H, p_1^M,..., p_r^H, p_r^M, Y)$. With a small number of groups relative to the number of goods in each group, the homogeneity assumption is useful for estimating the expenditure function since the number of price indices would be much smaller than the number of prices. However, in this paper we focus on 122 3-digit SIC manufacturing industries and two goods, domestic and imported, in each industry. The homogeneity assumption is therefore not useful for the estimation of disaggregated import-demand elasticities. Since homogeneous utility is a very restrictive assumption, we do not use it in our estimation. Because within-group utility functions are homogeneous of degree one iff expenditure elasticities of demands q_i^H and q_i^M are equal to one, the null hypothesis concerning the expenditure elasticity of demand for imports is tested against the alternative hypothesis that it is not equal to one. The corresponding hypothesis test for the home good is not performed because, as noted below, the demand for the home good is not estimated.

[5] Details of this argument are available from the authors on request.

$$\frac{\delta q_i^M}{\delta p_i^H} \cdot \frac{p_i^H}{q_i^M} \theta_i^H (\sigma_i - \frac{\delta q_i^M}{\delta e_i} \cdot \frac{e_i}{q_i^M}) \qquad (6)$$

where θ_i^H is the proportion of expenditure e_i on domestic goods q_i^H, and σ_i is the elasticity of substitution between imports q_i^M and home goods q_i^H. Rearranging this equation gives the elasticity of substitution in terms of the (uncompensated) cross-price and expenditure elasticities of import demand, and the home-good expenditure share:

$$\sigma_i = \frac{\delta q_i^M}{\delta p_i^H} \cdot \frac{p_i^H}{q_i^M} / \theta_i^H + \frac{\delta q_i^M}{\delta e_i} \cdot \frac{e_i}{q_i^M} \qquad (7)$$

The foregoing equation is used below to calculate estimates of substitution elasticities using mean domestic-budget shares.

Traditionally, substitution elasticities between imports and domestic output have been estimated by regressing the ratio of quantities, q_i^M/q_i^H, on the price ratio, p_i^M/p_i^H. Typically, no adjustment is made to distinguish movements along an indifference curve from movements between curves. In this paper, substitution elasticities measure substitutability between imports, q_i^M, and domestically-produced goods, q_i^H, for industry i holding the value of subutility function X_i constant. That is, our substitution elasticities measure responsiveness of quantities to price changes only at the second stage of expenditure allocation.

Knowledge of import supply must be used when estimating import demand, for unless import supply is infinitely price elastic, estimates of import-demand parameters using ordinary least squares will be biased downward [see Orcutt, 1950; Kakwani, 1972]. Assuming that domestic and foreign firms are profit maximizers and ignoring aggregation over firms for simplicity, import supply

$$q_i^M = q_i^M (p_i^{M'}, p_i', w_i', r_i') \qquad (8)$$

is a function of the price received in the foreign market for exports to the U.S., $p_i^{M'}$,[6] the price of goods in the exporter's own country p_i',[7] and the prices of productive factors, w_i' and r_i',[8] all measured in foreign currency.

[6] Prices received by exporters may differ from prices paid by consumers and producers in importing countries due to tariffs, NTBs, freight, and insurance.

[7] If there is uncertainty about the price of exports relative to the price of goods that can be sold in the home market and if there are start-up costs, then exporters will also produce goods to be sold in their home markets. For this reason, the price of output sold in the exporter's home market is included in the import-supply function. An import-weighted average of gross-domestic price deflators for countries which export to the U.S. is used as a measure of the price of goods in the exporter's own country.

[8] An import-weighted index of foreign manufacturing wages is used as a measure of the foreign wage. An import-weighted average of foreign interest rates is used as a measure of the rental rate on foreign capital.

Domestic demand and supply functions must also be added to the simultaneous equation system, since domestic and import prices and quantities are jointly determined. Otherwise, it is possible that simultaneity bias will result. The model of demand discussed above includes demand for domestic substitutes, so consider now the specification of the supply of domestic substitutes. Assuming that domestic suppliers are single-output profit maximizers, and ignoring aggregation over firms, domestic supply is a function of the price of domestic output, p_i^H, as well as the U.S. wage, w, and rental rate on capital, r.[9]

Functional forms for the system must be specified in order to perform estimation. We follow other studies of import demand and use log-linear forms[10]. For the i^{th} industry

$$\ln(e_i) = a_{i0} + \sum_{j=1}^{r} a_{ij} \ln(p_i^H) + \sum_{j=1}^{r} a_{i,j+r} \ln(p_i^M) + a_{i,2r+1} \ln(Y) + u_{i1} \quad (9)$$

$$\ln(q_i^H) = b_{i0} + b_{i1} \ln(p_i^H) + b_{i2} \ln(p_i^M) + b_{i3} \ln(e_i) + u_{i2} \quad (10)$$

$$\ln(q_i^M) = c_{i0} + c_{i1} \ln(p_i^H) + c_{i2} \ln(p_i^M) + c_{i3} \ln(e_i) + u_{i3} \quad (11)$$

$$\ln(q_i^H) = d_{i0} + d_{i1} \ln(p_i^H) + d_{i2} \ln(w) + d_{i3} \ln(r) + u_{i4} \quad (12)$$

$$\ln(q_i^M) = e_{i0} + e_{i1} \ln(p_i^M) + e_{i2} \ln(p_i') + e_{i3} \ln(w_i') + e_{i4} \ln(r_i') + e_{i5} \ln(exch_i) + e_{i6} \ln(1 + t_i) + u_{i5} \quad (13)$$

Eq. (9) represents allocation of expenditure to the i^{th} 3-digit SIC group[11], (10) is a domestic-good demand function, (11) is an import-demand function[12], (12) is a domestic-supply equation, (13) is an import-supply function. In (11), the cross-price elasticity of U.S. import demand is c_{i1}, the own-price

[9] An index of U.S. manufacturing wages is used as a measure of the U.S. wage, w. The U.S.interest rate is used as a measure of the U.S. rental rate, r.

[10] There are three reasons justifying the use of log-linear functional forms. First, estimated price elasticities of import demand are readily obtained from the estimated demand equation. Second, log-linear forms are preferable to linear forms because linear forms imply a falling price elasticity as import quantity grows relative to import price over time [see Barker, 1970, pp. 126–127]. Third, tests for the appropriate functional form of aggregate import-demand equations using the Box-Cox transformation favor log-linear functional forms [see Khan, Ross, 1977; Boylan *et al.*, 1980].

[11] The prices of domestic substitutes and of imports for all r groups are included in the expenditure allocation equation (9), as discussed above.

[12] We do not assume that import-demand functions (11) are free from money illusion for estimation purposes, since it is preferable to test this as an hypothesis instead. The alternatives to this procedure are: *(i)* imposing lack of money illusion as a constraint; and *(ii)* imposing lack of money illusion as a constraint if this hypothesis is not rejected. The first strategy would yield biased and inconsistent estimates in cases for which the constraint is false. The second procedure greatly complicates the sampling distributions of the resulting estimators, since the choice of estimator is based upon the outcome of a test. As a result, standard statistical tests are invalid.

elasticity is c_{i2}, and the expenditure elasticity is c_{i3}. Domestic and import prices and quantities – p_i^H, p_i^M, q_i^H, and q_i^M – as well as group expenditure, e_i, are endogenous. The exogenous variables include: foreign output price, p_i'; total domestic expenditure, Y[13]; tariff variable t_i; exchange rate $exch_i$; and domestic and foreign wages and rental fees, w, r, w_i', and r_i'. Eqs. (9) – (13) for all r groups are overidentified.

Now, the influence of lagged demand responses will be incorporated using a partial-adjustment model. The import quantity in (11) should be accordingly the desired consumption of imports, while actual and desired quantities are related as follows:

$$\ln(q_i^{M*})_t - \ln(q_i^{M*})_{t-1} = \lambda_i \left[\ln(q_i^M)_t - \ln(q_i^{M*})_{t-1}\right] \tag{14}$$

where the starred quantities are actual consumption, and λ_i is an adjustment parameter ($0 < \lambda_i \leq 1$).[14] The magnitude of λ_i indicates the speed with which actual demand adjusts to desired demand[15]. Note that the partial adjustment model imposes a strong a priori restriction on the shape of the lag distribution. In particular, the partial adjustment mechanism implies that the distributed lag coefficients decay geometrically. While the assumption that the lag distribution continually declines would be unrealistic for quarterly regressions, we felt that it would be acceptable for use with annual data.

III. Estimation Procedure

The method used to estimate import-demand equations for 3-digit SIC categories will be described in this section. From an econometric standpoint, a number of complications are involved. First, import demands are assumed to be subject to lagged adjustment, so that lagged endogenous variables must be included in the import-demand equations. Second, there is a simultaneous equations problem. Third, there is a possibility that the regression disturbances are serially correlated. Fourth, it is likely that stochastic disturbances corresponding to import-demand equations in different industries are contemporaneously correlated.

To begin, the influence of lagged adjustment on import demand will be discussed. Eq. (11) above gives the quantity of imports, q_i^M, that U.S. consumers and producers would like to buy. That is, it is a desired demand function. A simple stock-adjustment model is assumed to describe the lagged

[13] Gross domestic purchases, defined as gross national product minus net exports of goods and services, is used as a measure of Y.

[14] A negative adjustment speed makes no sense, because this implies that consumers move away from desired demand. Similarly, an adjustment speed greater than one is meaningless, since consumers do not choose to overshoot their desired consumption level.

[15] See Leamer, Stern [1970, pp. 19–28] for a discussion of lags in import-demand estimation.

adjustment of actual import quantity to desired import quantity. By substituting the stock-adjustment equation (14) into the desired import-demand equation (11), we obtain:

$$\ln(q_i^{M^*})_t = \lambda_i c_{i0} + \lambda_i c_{i1} \ln(p_i^H)_t + \lambda_i c_{i2} \ln(p_i^M)_t + \lambda_i c_{i3} \ln(e_i)_t + (1-\lambda_i) \ln(q_i^{M^*})_{t-1} + \lambda_i u_{i3t} \tag{15}$$

where, again, $q_i^{M^*}$ is actual import quantity. Import-demand equations for each industry, given in (15), will be estimated below[16].

Turning now to the mechanics of the estimation method, suppose one is interested in estimating a single import-demand equation only. A simple way to obtain consistent coefficient estimates is to perform two-stage least squares (2SLS) with no autoregressive correction, treating the lagged import quantity as if it is a current endogenous variable. The first stage consists of regressing all current and lagged right-side endogenous variables on a subset of the exogenous variables in the system using ordinary least squares (OLS). These first-stage regressions are used to form fitted values of the current and lagged endogenous right-side variables. The predictions are then inserted into the import-demand equation in place of actual values of these variables. In the second stage, OLS is applied to the import-demand equation, which has been modified to include predicted rather than actual right-side current and lagged endogenous variables. The resulting coefficient estimates are consistent, but estimated asymptotic standard errors are not consistent because no autoregressive correction has been made. As such, these estimates cannot be used as a basis for statistical inference.

A more acceptable procedure is to combine the 2SLS variant just described, which treats lagged endogenous variables as if they are current endogenous variables, with an autoregressive correction. Since the estimation procedure described in the last paragraph yields a consistent set of coefficient estimates, it can be used to calculate a consistent estimate of the autoregressive parameter in the usual way[17]. The consistently estimated

[16] However, the other equations in the simultaneous system will not be estimated, for the following reasons. First, expenditure-allocation equations contain far too many explanatory variables for estimation to be performed with any reasonable sample size. Second, the demand for domestic goods will not be estimated because only one demand equation may be estimated independently when there are two goods. Otherwise, the estimated covariance matrix of coefficient estimates will be singular. Third, supply equations will not be estimated because of the limited availability of factor price and output data on a detailed industry basis for most exporting countries. In the estimation of import-demand equations, data aggregated across all manufacturing industries in each foreign country will be used.

[17] First, the coefficient estimate is used to obtain regression residuals. Then, the sum of products of current and one-period lagged regression residuals is divided by the sum of squares of regression residuals. This yields a consistent estimate of the autoregressive parameter.

autoregressive parameter can now be used to perform a Cochrane-Orcutt transformation on the import-demand equation. Finally, the transformed import-demand equation can be estimated using 2SLS, modified so that all one- and two-period lagged endogenous right-side variables are treated as if they are current endogenous right-side variables. This involves regressing all current and lagged right-side endogenous variables on a set of first-stage regressors using OLS. To obtain consistent estimates, the matrix of first-stage regressors must include a constant term and must not include any lagged endogenous variables. In addition to a constant term, the matrix of first-stage regressors used below includes U.S. and foreign factor prices, the exchange rate, the foreign output deflator, and U.S. gross domestic purchases. In Shiells [1985], this estimation procedure is referred to as AM2LS.

The AM2LS estimator is a single-equation estimator which corrects for serial correlation when a lagged endogenous right-side variable is included in the import-demand equation. However, it is important to use a multi-equation estimation technique because it is likely that regression disturbances in different equations are contemporaneously correlated. Furthermore, it has been argued that only the import-demand equations should be estimated for the reasons discussed above. AM2LS can be generalized so that import demands for several industries may be estimated jointly. This generalization is referred to as AS3LS in Shiells [1985]. The AM2LS method constitutes the first two stages of this three-stage procedure. The third stage consists of applying generalized least squares to all of the import-demand equations in the set which one wishes to estimate jointly, using regression residuals from AM2LS to estimate the cross-equation covariances[18].

It should be noted that we have used only 17 annual time-series observations for each industry to estimate import-demand functions. Given the small sample size, our use of 2SLS and 3SLS variants requires some justification since these estimators usually are employed because of their desirable asymptotic properties. Stone [1979], for example, argues that OLS estimators have a larger bias but a smaller variance than 2SLS estimators in small samples based on Monte Carlo evidence. OLS might then be preferable if one is willing to trade some bias for added precision. Stone's results, however, suggest that there is a substantial degree of bias in OLS estimators of disaggregated import-demand functions. This evidence, we believe, provides some justification for utilizing 2SLS and 3SLS variants to estimate disaggregated import-demand functions even with a small sample size.

[18] It is expected that AS3LS will lower the asymptotic standard errors of the coefficient estimates relative to AM2LS. However, it is also possible that high asymptotic standard errors in one equation, along with the consequent volatility of coefficient estimates, will be spread to other equations in the system. Thus, imprecision in one equation is spread to other equations in the system when AS3LS is used.

IV. Data

Annual data for the period 1962–1978 covering 122 3-digit SIC industries are used to estimate the disaggregated model of U.S. import demand by the methods described above. Import values and quantities, which are used to construct unit values[19], are available at the 5-digit SITC level in UN, *Commodity Trade Statistics.* Export values also are available from this source. Unpublished data on the value of domestic output by SIC industry are available from the U.S. Commerce Department. Exchange rates, interest rates, and U.S. gross domestic purchases are available in IMF, *International Financial Statistics.* Foreign gross-domestic-product deflators are given in UN, *Yearbook of National Accounts Statistics,* Vol. II. Wages for exporting countries and for the U.S. are taken from ILO, *Yearbook of Labor Statistics.* Foreign variables are aggregated over countries using current-period U.S. import weights calculated for each industry from the UN import data.

As already mentioned, our estimates of disaggregated import-demand functions rely on unit values as proxies for import prices. In calculating unit values, it was necessary to have comparable quantity measures for particular import classifications for each year of the sample period. We thus used the most detailed information at the 5-digit SITC level and constructed unit-value measures whenever possible[20]. This yielded a complete time series of unit values for 41 of the 122 3-digit SIC industries. There were an additional 33 industries for which constructed unit values were available, but incomplete. In these instances, the missing years were estimated by means of a time-trend interpolation procedure[21]. For the remaining 48 industries, sufficient quantity

[19] The use of unit-value proxies of import prices results in errors of measurement and is thus a serious problem in estimation, as Kravis, Lipsey [1974] especially have noted. Because product groups, even at the 5-digit SITC level, are composed of heterogeneous products, changes in the composition of imports will change the unit value, which is calculated as value of imports divided by quantity, even if prices are unchanged. We would have preferred of course to use actual import prices for purposes of estimation, but such data are not available systematically on a disaggregated basis for any appreciable length of time. The Bureau of Labor Statistics has for some years now been publishing regularly import-price and export-price series for selected categories. Shiells [1985] estimated import-demand functions for a small number of these categories, using unit values and then actual import prices in order to assess the importance of errors of measurement arising from unit values. – Our estimation procedures correct for measurement-error bias of the coefficient estimates. The source of bias, as is well known, is that observed price (i.e., unit value) is correlated with the error term. See Orcutt [1950], Kemp [1962], and Kakwani [1972] for rigorous discussions of measurement-error bias, caused by the use of unit values in the estimation of import demand. In each of the estimation procedures described above, the unit value is purged of its correlation with the error term by using fitted prices in the second-stage regression.

[20] The SITC trade data used were concorded to a SIC basis, using a concordance based on U.S. imports (Schedule A) that we constructed.

[21] The interpolation procedure involved fitting a time trend, with the intercept constrained to be positive, to the existing data, using constrained least squares.

data were not available even to construct interpolated unit-value series. However, data for all variables except unit values were available. We decided therefore to use aggregate unit values as crude approximations of import prices for this residual group of industries[22].

V. Results

The AM2LS results for which unit-value data were complete are given in Table 1[23]. There were 19 negative and statistically significant own-price elasticities. In two cases, positive and significant price elasticities were obtained[24]. Values ranged from – 0.612 for SIC 203, fruit and vegetables, to – 5.085 for SIC 282, plastics. Expenditure elasticities were positive and significant in 20 cases, ranging from 0.246 for SIC 348, guns and weapons, to 3.714 for SIC 285, paint. Adjustment speeds were significantly less than one in 16 cases[25]. There were 16 positive and statistically significant substitution elasticities, with values ranging from 0.454 for SIC 208, beverages, to 6.507 for SIC 282, plastics. In one case, the estimated substitution elasticity was negative[26]. Finally, the null hypothesis of no money illusion was rejected in 10 cases[27]. As Grossman [1982] notes, the money-illusion test may be interpre-

[22] Aggregate unit values for finished manufactures and semimanufactures were taken from the U.S. Commerce Department publications, *Indexes of U.S. Exports and Imports by Economic Class, 1919 to 1971*, and *Report FT990, Highlights of U.S. Export and Import Trade*.

[23] The SIC definitions used in this study correspond to the product-based import SIC classification, as described in the U.S. Bureau of the Census publication, *U.S. Foreign Trade Statistics Classifications and Cross-Classifications*. This classification fits TSUSA codes into the domestic SIC, as described in the U.S. Office of Management and Budget publication, *Standard Industrial Classification Manual*, 1972. There are, however, some minor differences between import and domestic SIC classifications. A full description of the industry definitions used is available from the authors on request.

[24] Positive and statistically significant own-price elasticities may have resulted from a number of different factors. First, there may have been insufficient variation in those exogenous variables which shift the supply curves and, hence, identify the demand curve. Second, there may have been special industry characteristics or nonprice factors which have been omitted from the demand equations. Third, unit value import-price measures may not have captured the underlying price changes. In the first situation no estimator of the price elasticity may be defined. In the second case, elasticity estimates are biased and inconsistent unless the excluded factors are uncorrelated with the included variables. In the third case, elasticity estimates are consistent but biased. The actual situation is likely to have been a combination of all of these cases.

[25] These results suggest that our initial assumption of no adjustment lags is applicable in the remaining 25 cases. The adjustment speed was significantly greater than unity in one case, but, as noted in footnote 14 above, this is not an economically meaningful result.

[26] The remarks in footnote 24 may be applicable here.

[27] The null hypothesis for this test is: $c_{i1} + c_{i2} + c_{i3} = 0$, using the notation in (11). The fact that this null hypothesis was rejected in 10 cases means that it would have been inappropriate to have imposed money illusion as a constraint in these cases. In the remaining 31 cases, imposing the constraint of no money illusion would not significantly have changed the coefficient estimates, but the standard errors would have been lower than those obtained here.

Table 1 – *Two-Stage Least Squares Results for U.S. Import-Demand Functions, 41 SIC 3-Digit Industries, Complete Data Sample, 1962–1978, Corrected for Serial Correlation and Lagged Adjustment*

	Const.	Cross-price elast.	Own-price elast.	Expend-iture elast.	Adjust-ment speed	Substi-tution elast.	Import share	RHO	RSQ	Test
201 Meat	-1.269	-1.414	1.151	0.487	0.428	-0.980	0.036	-0.286	0.943	0.476
	(4.87)	(1.19)	(0.77)	(1.16)	(0.31)	(0.63)		(0.24)		
202 Dairy	-46.301	4.626	-7.755	6.255	0.378	10.925	0.009	0.363	0.223	0.822
	(98.96)	(12.79)	(12.64)	(19.29)	(0.46)	(14.38)		(0.23)		
203 Fruit & veg. ..	-7.480	-1.926	-0.612	2.225	0.971	0.217	0.041	-0.174	0.975	-2.391*
	(0.45)**	(0.35)**	(0.16)**	(0.22)**	(0.22)**	(0.20)		(0.25)		
204 Grain	-9.396	-0.917	-1.823	2.344	1.022	1.421	0.007	-0.157	0.828	-1.440
	(1.75)**	(0.89)	(0.34)**	(0.51)**	(0.18)**	(0.57)*		(0.25)		
206 Sugar	-2.935	-1.767	0.493	1.230	0.974	-0.767	0.115	-0.710	0.973	-0.347
	(1.51)	(0.74)*	(0.20)*	(0.50)*	(0.46)*	(0.39)*		(0.18)**		
207 Oils	-20.461	-7.388	-0.696	6.685	0.298	-0.866	0.022	-0.529	0.896	-1.684
	(17.43)	(7.60)	(0.80)	(6.46)	(0.36)	(1.39)		(0.21)*		
208 Beverages ...	-3.849	-0.871	-0.702	1.377	2.042	0.454	0.057	-0.793	0.989	-1.461
	(0.41)**	(0.15)**	(0.14)**	(0.08)**	(0.44)**	(0.09)**		(0.15)**		
209 Mis. fd. prep.	-6.501	-0.133	-0.821	1.358	0.625	1.218	0.048	-0.329	0.914	1.315
	(3.65)	(1.54)	(0.81)	(0.93)	(0.44)	(0.91)		(0.24)		
213 Tobac. N.E.C.	-8.080	5.512	-2.585	-1.471	0.997	4.371	0.056	-0.008	0.896	0.972
	(3.02)**	(0.74)**	(1.28)*	(0.84)	(0.60)	(0.71)**		(0.25)		
224 Narrow fabric.	241.463	-9.116	20.374	-46.841	0.032	-56.188	0.025	-0.236	0.142	-0.934
	(4136.97)	(152.64)	(349.41)	(814.09)	(0.51)	(950.69)		(0.24)		
225 Knit fabs. ...	15.981	-8.256	-0.315	2.641	0.764	-5.675	0.007	0.296	0.800	-1.841
	(10.81)	(3.10)**	(1.27)	(0.58)**	(0.37)*	(3.16)		(0.24)		
227 Carpet	-12.668	2.374	-1.590	1.089	0.957	3.537	0.030	-0.602	0.953	7.166**
	(1.77)**	(0.44)**	(0.34)**	(0.18)**	(0.16)**	(0.60)**		(0.20)**		
228 Yarns & thrd.	19.811	-10.795	7.574	-0.819	0.173	-11.694	0.007	-0.503	0.939	-1.169
	(19.38)	(15.08)	(10.37)	(1.34)	(0.23)	(14.77)		(0.22)*		
229 Text. N.E.C. .	1.189	-1.019	-0.875	1.151	0.873	-0.087	0.177	0.480	0.874	-2.669**
	(1.75)	(0.47)*	(0.35)*	(0.37)**	(0.14)**	(0.59)		(0.22)*		
232 Men's clo's. ..	-12.405	-2.625	0.378	2.773	1.126	-0.124	0.094	0.359	0.945	0.903
	(1.54)**	(1.80)	(0.93)	(0.41)**	(0.09)**	(1.67)		(0.23)		
239 Linens	-10.381	1.008	-1.031	1.214	1.087	2.241	0.018	-0.270	0.958	4.630**
	(1.12)**	(0.32)**	(0.18)**	(0.17)**	(0.12)**	(0.35)**		(0.24)		
261 Pulp	0.249	1.967	-3.146	1.012	0.282	5.027	0.510	-0.338	0.913	-0.680
	(2.62)	(2.26)	(2.27)	(0.93)	(0.15)	(4.30)		(0.24)		
262 Paper & newsprt	-1.009	-0.141	-0.881	0.916	1.275	0.748	0.157	0.135	0.818	-0.825
	(0.33)**	(0.60)	(0.33)**	(0.19)**	(0.36)**	(0.56)		(0.25)		
275 Prting N.E.C.	-14.355	2.603	-0.871	0.489	1.023	3.097	0.002	0.072	0.984	4.364**
	(1.75)**	(0.74)**	(0.16)**	(0.49)	(0.09)**	(0.29)**		(0.25)		
281 Chemicals ...	-2.102	14.579	-8.714	-2.452	0.072	14.000	0.114	-0.104	0.949	0.817
	(46.12)	(60.28)	(28.93)	(22.82)	(0.22)	(47.41)		(0.25)		
282 Plastics	-9.357	4.949	-5.085	1.301	0.392	6.507	0.049	-0.823	0.996	2.395*
	(1.92)**	(1.63)**	(0.97)**	(0.26)**	(0.04)**	(1.56)**		(0.14)**		
283 Drugs	-11.713	0.803	-1.063	1.514	1.028	2.337	0.026	-0.609	0.991	2.426*
	(1.68)**	(0.57)	(0.11)**	(0.19)**	(0.14)**	(0.43)**		(0.20)**		
284 Soap & cosm. .	-14.631	-0.192	-0.805	2.015	0.664	1.821	0.005	0.223	0.968	1.563
	(1.35)**	(0.92)	(0.27)**	(0.47)**	(0.17)**	(0.51)**		(0.24)		

(continued)

(continued)

	Const.	Cross-price elast.	Own-price elast.	Expend-iture elast.	Adjust-ment speed	Substi-tution elast.	Import share	RHO	RSQ	Test
285 Paint	-28.650 *(2.19)***	-0.153 *(2.16)*	-1.068 *(0.37)***	3.714 *(1.29)***	1.658 *(0.42)***	3.560 *(0.94)***	0.001	-0.500 *(0.22)**	0.897	3.174**
286 Ind. org. chem.	0.328 *(2.75)*	-0.381 *(0.59)*	0.087 *(0.75)*	-0.091 *(0.82)*	0.893 *(0.36)**	-0.473 *(0.62)*	0.001	-0.019 *(0.25)*	0.239	-1.483
287 Ag. chem. N.E.C.	-10.497 *(2.46)***	-2.333 *(1.58)*	-0.917 *(0.78)*	3.148 *(1.35)**	0.477 *(0.18)***	0.726 *(0.76)*	0.037	0.430 *(0.23)*	0.879	-0.164
289 Chem. prod. .	3.052 *(131.72)*	12.869 *(159.66)*	-10.679 *(117.99)*	-1.677 *(41.36)*	-0.064 *(0.83)*	11.832 *(126.53)*	0.047	0.181 *(0.25)*	0.858	-0.063
291 Ref. petrol. . .	-14.867 *(11.10)*	-3.895 *(4.25)*	-0.794 *(0.42)*	3.884 *(2.83)*	0.646 *(0.21)***	-0.303 *(1.75)*	0.070	-0.029 *(0.25)*	0.958	-0.720
311 Fin. leather . .	-3.106 *(3.54)*	1.140 *(0.72)*	-0.959 *(0.11)***	0.348 *(0.93)*	0.872 *(0.10)***	1.608 *(0.23)***	0.096	-0.210 *(0.24)*	0.953	1.549
321 Flat glass	-9.435 *(7.80)*	5.070 *(5.37)*	-3.543 *(3.12)*	0.437 *(1.54)*	0.293 *(0.21)*	6.102 *(5.29)*	0.105	0.357 *(0.23)*	0.669	1.008
329 Nonmet. minerals	-14.191 *(4.56)***	-2.602 *(3.15)*	-0.856 *(0.48)*	3.630 *(2.07)*	0.530 *(0.22)**	0.965 *(1.19)*	0.023	-0.175 *(0.25)*	0.938	0.219
331 Steel mill prod.	-6.329 *(4.89)*	1.647 *(1.01)*	-2.235 *(0.41)***	1.204 *(0.78)*	0.452 *(0.11)***	2.986 *(0.52)***	0.076	-0.460 *(0.22)**	0.982	1.828
332 Cast iron art.	-8.168 *(5.16)*	2.843 *(1.96)*	-2.657 *(1.17)**	0.618 *(1.68)*	0.586 *(0.26)**	3.469 *(1.14)***	0.003	0.521 *(0.21)**	0.690	0.947
333 Rf. nonfer. met.	-1.731 *(2.31)*	-0.098 *(1.13)*	-0.727 *(1.45)*	0.943 *(0.60)*	0.944 *(0.39)**	0.814 *(1.82)*	0.240	0.022 *(0.25)*	0.686	0.573
335 Pr. nonfer. met.	-10.388 *(1.47)***	-1.032 *(0.48)**	-0.627 *(0.45)*	2.032 *(0.42)***	1.250 *(0.31)***	0.974 *(0.40)**	0.025	-0.270 *(0.24)*	0.904	1.830
339 Metal N.E.C.	-8.741 *(5.71)*	-1.807 *(7.05)*	0.887 *(2.17)*	1.805 *(2.63)*	0.615 *(0.45)*	-0.107 *(4.84)*	0.055	0.023 *(0.25)*	0.935	0.301
344 B'lers & tanks	-15.684 *(1.56)***	-0.046 *(0.83)*	-1.586 *(0.39)***	2.419 *(0.42)***	0.651 *(0.18)***	2.372 *(0.53)***	0.005	-0.333 *(0.24)*	0.956	3.088**
348 Guns & weap.	-2.730 *(1.16)**	-0.526 *(0.43)*	0.724 *(0.20)***	0.246 *(0.06)***	1.871 *(0.91)**	-0.313 *(0.46)*	0.058	0.184 *(0.25)*	0.720	1.665
349 Fab. met. N.E.C.	-8.169 *(1.27)***	-1.048 *(0.56)*	-0.274 *(0.29)*	1.749 *(0.28)***	1.031 *(0.30)***	0.644 *(0.50)*	0.052	0.159 *(0.25)*	0.903	2.203*
356 Gen. ind. mach	-8.970 (2.67)**	-0.445 (0.87)	-2.144 (0.53)**	2.526 (0.57)**	0.441 (0.10)**	2.052 (0.43)**	0.063	0.367 (0.23)	0.975	-0.120
399 Mis. manuf. .	-2.457 *(1.38)*	1.729 *(2.13)*	-2.515 *(0.93)***	1.090 *(0.79)*	0.418 *(0.16)***	3.847 *(2.64)*	0.373	-0.607 *(0.20)***	0.988	0.423

Notes: Estimated asymptotic standard errors are in parentheses underneath the coefficient estimates. * denotes significance at the five percent level, ** denotes significance at the one percent level. – "RSQ" is the squared correlation between the actual and predicted RHO-differenced dependent variable. – "Test" is a test statistic for the null hypothesis of no money illusion, which is equivalent to testing the null hypothesis that the demand elasticities sum to zero.

ted as a specification-error test, since omission of relevant nonprice factors might lead to a violation of zero-degree homogeneity in import demands.

The AM2LS results for 33 industries using interpolated data are given in Table 2. There were 15 negative and significant own-price elasticities, which ranged from – 0.493 for SIC 357, office machines, to – 18.653 for SIC 211, cigarettes. Expenditure elasticities were positive and significant in 17 cases. They ranged from 0.876 for SIC 357, office machines, to 17. 862 for SIC 211, cigarettes. There was one negative and significant expenditure elasticity. Adjustment speeds were significantly less than one in 18 cases. Substitution elasticities were positive and significant in 17 cases, with values ranging from

Table 2 – *Two-Stage Least Squares Results for U.S. Import-Demand Functions, 33 SIC 3-Digit Industries. Interpolated Data Sample, 1962–1978, Corrected for Serial Correlation and Lagged Adjustment*

	Const.	Cross-price elast.	Own-price elast.	Expend-iture elast.	Adjust-ment speed	Substi-tution elast.	Import share	RHO	RSQ	Test
205 Bakery	83.299	16.871	1.860	-19.009	0.356	-2.067	0.004	-0.492	0.823	-0.420
	(77.97)	*(16.07)*	*(2.22)*	*(17.43)*	*(0.26)*	*(3.02)*		*(0.22)**		
211 Cigarettes ..	-47.867	-3.546	-18.653	17.862	0.249	14.314	0.001	-0.025	0.991	-3.239**
	*(13.75)***	*(6.01)*	*(5.09)***	*(4.49)***	*(0.07)***	*(3.42)***		*(0.25)*		
212 Cigars	329.502	-14.208	-10.229	-40.767	-0.009	-55.399	0.029	0.272	0.960	0.235
	(6649.82)	*(377.74)*	*(214.09)*	*(748.65)*	*(0.15)*	*(1124.44)*		*(0.24)*		
221 Cot. br. fab.	4.276	0.974	-0.409	-0.768	1.892	0.274	0.066	-0.151	0.208	-0.729
	(2.19)	*(0.43)**	*(0.33)*	*(0.32)**	*(0.84)**	*(0.46)*		*(0.25)*		
222 Silk & mnmd. br.	-10.585	-0.596	-3.076	3.422	0.367	2.797	0.047	-0.396	0.919	-0.358
	(7.87)	*(1.16)*	*(2.84)*	*(2.27)*	*(0.30)*	*(2.83)*		*(0.23)*		
238 Appar. N.E.C.	-9.856	3.971	-3.352	1.010	0.650	5.487	0.113	0.375	0.948	0.639
	(6.95)	*(2.02)**	*(3.43)*	*(0.75)*	*(0.37)*	*(2.17)**		*(0.23)*		
243 Plywd. & veneer	-2.559	0.291	-3.443	2.149	0.658	2.454	0.047	0.363	0.908	-1.529
	(3.47)	*(1.91)*	*(0.82)***	*(1.05)**	*(0.13)***	*(1.02)**		*(0.23)*		
244 Wd. con's. ..	-5.632	0.455	-0.836	0.588	1.334	1.045	0.003	-0.339	0.928	1.010
	*(1.11)***	*(0.52)*	*(0.11)***	*(0.37)*	*(0.19)***	*(0.30)***		*(0.24)*		
249 Mis. wood prod. .	1.497	2.998	-2.062	-0.633	0.811	2.691	0.098	-0.615	0.878	0.254
	(4.89)	*(3.52)*	*(1.22)*	*(2.08)*	*(0.70)*	*(1.87)*		*(0.20)***		
263 Paperbd. N.E.C.	-3.458	-2.384	-2.039	2.665	-0.921	0.275	0.003	-0.216	0.146	0.256
	(10.79)	*(6.58)*	*(4.69)*	*(5.38)*	*(5.09)*	*(2.88)*		*(0.24)*		
264 Coated paper	-13.053	1.520	-2.283	1.813	0.671	3.346	0.009	-0.475	0.984	2.471*
	*(1.40)***	*(1.13)*	*(0.41)***	*(0.59)***	*(0.12)***	*(0.61)***		*(0.22)**		
266 Build. board	-4.898	1.351	-1.914	0.554	1.036	1.909	0.003	-0.436	0.729	-0.013
	(4.35)	*(1.43)*	*(1.03)*	*(1.02)*	*(1.01)*	*(0.86)**		*(0.22)*		
278 Blankbooks .	-9.906	-3.535	-0.190	3.719	0.437	0.140	0.012	0.169	0.822	-0.005
	*(4.90)**	*(4.19)*	*(0.86)*	*(3.65)*	*(0.35)*	*(1.22)*		*(0.25)*		
295 Build. paper ·	-2.453	-6.678	-16.112	13.803	0.224	7.114	0.002	-0.033	0.763	-2.504*
	(4.99)	*(16.39)*	*(33.67)*	*(30.73)*	*(0.40)*	*(14.62)*		*(0.25)*		
301 Tires & tubes	-16.998	-0.843	-1.276	3.238	0.768	2.349	0.051	-0.683	0.992	2.311*
	*(1.20)***	*(0.89)*	*(0.14)***	*(0.49)***	*(0.11)***	*(0.48)***		*(0.18)***		
302 Rb. & pl. ft. .	-13.864	-0.509	-1.083	3.285	0.792	2.564	0.295	-0.281	0.977	4.075**
	*(1.48)***	*(0.77)*	*(0.35)***	*(0.87)***	*(0.13)***	*(0.48)***		*(0.24)*		
314 Nonrub. ft. .	-125.449	-18.329	-2.417	27.062	0.173	6.064	0.127	-0.460	0.967	2.306*
	(93.19)	*(18.22)*	*(2.02)*	*(22.03)*	*(0.13)*	*(3.79)*		*(0.22)**		
325 Brick & tile .	-14.826	-1.727	-1.037	3.774	0.945	1.977	0.039	0.199	0.943	7.621**
	*(1.49)***	*(0.49)***	*(0.08)***	*(0.49)***	*(0.09)***	*(0.20)***		*(0.24)*		
326 Ceramics & china	-8.571	-0.201	-1.374	2.369	0.756	2.124	0.180	-0.781	0.981	4.949**
	*(0.78)***	*(0.42)*	*(0.19)***	*(0.38)***	*(0.11)***	*(0.30)***		*(0.16)***		
327 Concr. & gypsum	-20.251	-1.653	-0.667	3.289	1.010	1.631	0.002	-0.466	0.915	1.525
	*(2.98)***	*(1.25)*	*(0.34)**	*(1.00)***	*(0.40)**	*(0.43)***		*(0.22)**		

(continued)

(continued)

	Const.	Cross-price elast.	Own-price elast.	Expend-iture elast.	Adjust-ment speed	Substi-tution elast.	Import share	RHO	RSQ	Test
342 Cutl. & tools	-2.905	2.928	-2.252	0.084	0.556	3.152	0.046	0.272	0.951	1.134
	(8.46)	*(3.40)*	*(1.10)**	*(2.23)*	*(0.16)***	*(1.36)**		*(0.24)*		
343 Heat. & plmb.	-12.104	-1.925	2.188	1.119	-0.966	-0.823	0.009	0.139	0.830	-0.214
	(·13.65)	*(3.52)*	*(2.84)*	*(2.01)*	*(3.13)*	*(4.87)*		*(0.25)*		
354 Metwork. mach.	-20.119	-0.451	-1.053	3.143	0.478	2.675	0.038	-0.288	0.958	5.677**
	*(4.88)***	*(0.47)*	*(0.34)***	*(0.84)***	*(0.14)***	*(0.65)***		*(0.24)*		
355 Spec. ind. mach.	-5.460	0.944	-0.042	0.349	0.823	1.386	0.089	-0.779	0.910	1.938
	(7.69)	*(1.48)*	*(0.42)*	*(1.64)*	*(0.23)***	*(0.46)***		*(0.16)***		
357 Office mach.	-45.442	9.118	-0.493	0.876	0.811	10.741	0.076	-0.184	0.996	5.214**
	*(7.88)***	*(1.97)***	*(0.08)***	*(0.12)***	*(0.04)***	*(2.02)***		*(0.25)*		
363 HH. appls. . .	-17.218	-1.549	-0.857	3.346	0.474	1.727	0.043	-0.203	0.960	1.227
	*(3.87)***	*(1.02)*	*(0.69)*	*(1.02)***	*(0.20)**	*(0.88)**		*(0.24)*		
365 TV & aud. rec.	33.438	-8.921	-0.855	1.651	0.557	-9.392	0.192	-0.160	0.977	-2.164*
	*(13.78)**	*(2.76)***	*(0.91)*	*(0.80)**	*(0.25)**	*(3.39)***		*(0.25)*		
371 Cars & Trcks	-19.952	-1.297	-1.068	3.189	0.254	1.754	0.096	0.641	0.762	0.364
	(13.87)	*(4.28)*	*(2.35)*	*(1.83)*	*(0.15)*	*(4.59)*		*(0.19)***		
372 Aircraft	-15.937	0.739	-0.491	1.729	1.112	2.490	0.029	-0.595	0.856	5.633**
	*(3.14)***	*(0.39)*	*(0.12)***	*(0.41)***	*(0.18)***	*(0.37)***		*(0.20)***		
375 Cycles	-7.675	2.085	-3.241	2.070	0.618	5.854	0.449	0.332	0.945	1.604
	(5.69)	*(2.33)*	*(2.08)*	*(0.65)***	*(0.26)**	*(4.83)*		*(0.24)*		
386 Photo equip.	-5.365	-1.038	-0.775	1.753	1.454	0.636	0.070	-0.026	0.898	-0.071
	(3.10)	*(1.13)*	*(0.13)***	*(0.24)***	*(0.22)***	*(0.99)*		*(0.25)*		
393 Music. instr.	-2.790	-1.549	-1.218	2.381	0.898	0.613	0.124	-0.298	0.995	-1.240
	*(1.01)***	*(0.54)***	*(0.08)***	*(0.31)***	*(0.06)***	*(0.33)*		*(0.24)*		
395 Pens & pncls	-4.973	-7.068	3.180	3.179	0.643	-4.069	0.025	0.004	0.965	-0.930
	(2.96)	*(2.06)***	*(1.64)*	*(0.51)***	*(0.18)***	*(2.05)**		*(0.25)*		

For notes see Table 1.

1.045 for SIC 244, wood containers, to 14.314 for SIC 211, cigarettes. In 2 cases, substitution elasticities were negative and significant. The null hypothesis of no money illusion was rejected in 12 cases.

AM2LS results for the 48 industries in the crude data sample are given in Table 3. In 16 cases, own-price elasticities were negative and statistically significant, ranging from − 0.759 for SIC 251, household furniture, to − 23.85 for SIC 373, yachts. Expenditure elasticities were significantly positive in 21 cases, ranging from 1.002 for SIC 384, medical equipment, to 5.767 for SIC 324, cement. In one case, the expenditure elasticity was negative and significant. Adjustment speeds were significantly less than one in 33 cases. There were 15 positive and statistically significant elasticities of substitution, ranging from 2.277 for SIC 364, electric lighting equipment, to 32.132 for SIC 373, yachts. One substitution elasticity was significantly negative. The null hypothesis of no money illusion was rejected in 22 cases.

AS3LS estimation was also performed for the 41 industries for which the

Table 3 – *Two-Stage Least Squares Results for U.S. Import-Demand Functions, 48 SIC 3-Digit Industries, Crude Data Sample, 1962–1978, Corrected for Serial Correlation and Lagged Adjustment*

	Const.	Cross-price elast.	Own-price elast.	Expend-iture elast.	Adjust-ment speed	Substi-tution elast.	Import share	RHO	RSQ	Test
223 Wool br. fab.	-15.880	3.348	-1.813	1.230	0.764	4.880	0.083	-0.100	0.982	-6.919**
	*(3.37)***	*(1.01)***	*(0.43)***	*(0.22)***	*(0.16)***	*(1.05)***		*(0.25)*		
231 Men's coats	-10.635	4.254	-1.462	-0.249	1.693	4.258	0.056	0.473	0.874	4.219**
	*(1.61)***	*(0.67)***	*(0.33)***	*(0.41)*	*(0.39)***	*(0.47)***		*(0.22)**		
233 Women's clothes	-31.739	6.630	-3.369	1.900	0.444	8.618	0.013	-0.041	0.963	2.255*
	*(4.72)***	*(2.75)**	*(0.62)***	*(1.23)*	*(0.12)***	*(1.91)***		*(0.25)*		
234 Wmn's linger	-38.362	6.608	-1.671	1.972	0.283	8.773	0.028	0.063	0.949	2.330*
	(23.13)	*(7.98)*	*(2.52)*	*(2.83)*	*(0.20)*	*(7.52)*		*(0.25)*		
235 Hats	-22.011	7.360	-3.629	0.640	0.370	8.784	0.096	-0.261	0.816	3.351**
	*(6.82)***	*(2.26)***	*(1.19)***	*(0.74)*	*(0.14)***	*(2.77)***		*(0.24)*		
236 Men's swtrs.	-21.273	4.361	-2.451	1.872	0.727	7.436	0.216	0.181	0.960	4.121**
	*(1.90)***	*(0.99)***	*(0.29)***	*(0.46)***	*(0.14)***	*(0.98)***		*(0.25)*		
237 Furs	53.613	-22.555	13.260	-2.502	-0.076	-26.089	0.044	-0.175	0.838	0.690
	(177.17)	*(104.87)*	*(55.95)*	*(22.58)*	*(0.20)*	*(96.39)*		*(0.25)*		
241 Logs	-0.343	-0.961	-0.999	1.093	0.945	0.110	0.021	0.259	0.953	-6.823**
	(0.75)	*(0.38)**	*(0.12)***	*(0.35)***	*(0.14)***	*(0.13)*		*(0.24)*		
242 Lumber	-31.026	-8.827	-0.309	8.472	0.449	-1.431	0.109	-0.469	0.925	-0.651
	(20.69)	*(8.63)*	*(1.59)*	*(6.01)*	*(0.15)***	*(3.77)*		*(0.22)**		
251 HH. furnit.	5.022	-0.784	-0.759	-0.097	1.050	-0.882	0.001	0.390	0.998	-10.056**
	*(0.25)***	*(0.16)***	*(0.07)***	*(0.04)**	*(0.09)***	*(0.14)***		*(0.23)*		
259 Furnit. N.E.C.	-14.021	9.220	-9.645	2.553	0.256	14.644	0.237	0.180	0.979	1.145
	(13.46)	*(11.91)*	*(9.20)*	*(0.59)***	*(0.17)*	*(15.79)*		*(0.25)*		
265 Paper boxes	-47.433	7.633	-5.815	4.079	0.367	11.716	0.001	0.178	0.811	2.291*
	*(19.17)**	*(5.60)*	*(2.88)**	*(2.48)*	*(0.15)**	*(5.92)**		*(0.25)*		
271 Nwsppr. publ.	-7.859	8.957	-3.919	-1.959	0.249	7.007	0.001	0.366	0.924	1.634
	(43.14)	*(30.67)*	*(9.38)*	*(15.84)*	*(0.47)*	*(15.26)*		*(0.23)*		
272 Period. publ.	-22.954	8.355	-3.765	0.028	0.308	8.417	0.004	0.243	0.917	1.510
	*(11.63)**	*(7.83)*	*(3.77)*	*(1.94)*	*(0.15)**	*(6.79)*		*(0.24)*		
273 Book publ.	-6.740	-0.208	-1.097	1.561	0.578	1.347	0.027	0.020	0.837	0.621
	*(2.34)***	*(1.88)*	*(0.66)*	*(1.02)*	*(0.14)***	*(1.03)*		*(0.25)*		
306 Rb. & pl. N.E.C.	-82.300	7.671	-13.014	13.274	0.308	20.968	0.003	-0.041	0.914	2.534*
	(47.01)	*(10.56)*	*(10.89)*	*(7.68)*	*(0.21)*	*(16.28)*		*(0.25)*		
307 Mis. pl. prod.	-27.057	3.179	-8.028	5.158	0.786	8.342	0.002	0.075	0.785	0.233
	*(12.59)**	*(4.34)*	*(4.94)*	*(1.77)***	*(0.29)***	*(5.89)*		*(0.25)*		
313 Leather shps.	-47.802	3.214	-0.564	6.051	0.208	9.378	0.034	-0.596	0.959	2.672**
	(60.86)	*(4.60)*	*(2.06)*	*(9.13)*	*(0.34)*	*(13.56)*		*(0.20)***		
315 Leather gloves	12.193	-17.794	4.232	9.732	-0.051	-11.005	0.142	-0.095	0.947	0.582
	(86.12)	*(77.56)*	*(16.73)*	*(45.67)*	*(0.21)*	*(48.00)*		*(0.25)*		
316 Luggage	-14.241	3.548	-2.389	1.426	0.341	5.611	0.152	-0.110	0.953	1.487
	(9.97)	*(5.85)*	*(2.64)*	*(1.05)*	*(0.16)**	*(6.07)*		*(0.25)*		
317 Purses	-15.435	0.232	-2.350	3.869	0.371	4.137	0.133	-0.211	0.977	0.653
	(10.07)	*(3.06)*	*(0.69)***	*(1.09)***	*(0.08)***	*(2.78)*		*(0.24)*		
319 Leathr N.E.C.	-7.271	4.545	-5.704	2.095	0.337	6.979	0.069	0.122	0.908	1.049
	(4.16)	*(4.80)*	*(3.54)*	*(1.19)*	*(0.17)**	*(4.62)*		*(0.25)*		
322 Glassware	-10.567	1.083	-2.689	2.153	0.554	3.252	0.014	0.228	0.829	0.883
	*(2.17)***	*(3.89)*	*(2.19)*	*(1.24)*	*(0.44)*	*(3.03)*		*(0.24)*		

(continued)

(continued)

	Const.	Cross-price elast.	Own-price elast.	Expend-iture elast.	Adjust-ment speed	Substi-tution elast.	Import share	RHO	RSQ	Test
323 Glass prod. .	-6.778	2.943	-2.457	0.662	0.413	3.830	0.071	-0.294	0.955	2.223*
	*(1.04)***	*(3.45)*	*(1.78)*	*(1.05)*	*(0.18)**	*(2.72)*		*(0.24)*		
324 Cement	-26.195	-1.627	-2.145	5.767	0.573	4.098	0.025	0.503	0.916	3.934**
	*(4.28)***	*(1.83)*	*(0.66)***	*(1.28)***	*(0.12)***	*(1.29)***		*(0.22)**		
328 Cut stone . . .	-10.024	0.685	-1.852	2.472	0.512	3.219	0.082	0.333	0.859	1.352
	*(4.03)**	*(3.15)*	*(0.95)*	*(1.68)*	*(0.12)***	*(2.23)*		*(0.24)*		
346 Forg. & stamp.	-32.009	9.618	-7.138	2.182	0.329	11.817	0.002	-0.156	0.891	3.147**
	*(9.18)***	*(7.17)*	*(3.85)*	*(2.25)*	*(0.15)**	*(5.87)**		*(0.25)*		
351 Engs. & turb.	-11.402	6.922	-5.555	0.714	0.312	7.893	0.036	-0.311	0.992	3.941**
	*(1.67)***	*(3.84)*	*(1.98)***	*(1.08)*	*(0.09)***	*(3.00)***		*(0.24)*		
352 Farm mach. .	-4.264	-2.367	0.044	1.936	0.452	-0.670	0.088	-0.208	0.972	-0.517
	(2.57)	*(2.60)*	*(1.25)*	*(0.67)***	*(0.26)*	*(2.36)*		*(0.24)*		
353 Constr. mach.	-14.602	-1.818	0.239	2.511	0.512	0.647	0.024	-0.875	0.966	1.613
	*(4.91)***	*(2.71)*	*(2.14)*	*(1.28)**	*(0.10)***	*(2.50)*		*(0.12)***		
358 Serv. ind. mach.	-13.468	-0.726	-1.438	2.555	0.972	1.826	0.005	0.069	0.845	0.236
	(8.00)	*(3.33)*	*(1.62)*	*(0.37)***	*(0.40)**	*(3.33)*		*(0.25)*		
361 El. dist. equip.	-18.963	0.343	-1.967	3.289	0.364	3.645	0.036	-0.313	0.987	2.511*
	*(3.02)***	*(1.29)*	*(1.04)*	*(0.48)***	*(0.14)**	*(1.50)**		*(0.24)*		
362 El. mot. & gen.	-23.765	-0.447	-3.617	5.118	0.249	4.641	0.062	0.080	0.970	0.915
	*(7.47)***	*(3.14)*	*(2.90)*	*(1.52)***	*(0.11)**	*(3.83)*		*(0.25)*		
364 El. lght equip.	-14.543	-0.482	-1.473	2.768	0.901	2.277	0.020	0.231	0.961	3.615**
	*(1.40)***	*(0.97)*	*(0.68)**	*(0.20)***	*(0.17)***	*(0.96)**		*(0.24)*		
366 Comm. equip.	-18.296	11.324	-1.622	-2.776	-0.102	9.000	0.038	-0.130	0.943	-.739
	(35.56)	*(41.07)*	*(11.11)*	*(16.21)*	*(0.33)*	*(28.74)*		*(0.25)*		
367 El. comps. . .	-137.177	22.356	-8.911	8.819	0.072	32.769	0.067	0.212	0.928	0.432
	(724.96)	*(138.65)*	*(42.27)*	*(32.64)*	*(0.28)*	*(180.66)*		*(0.24)*		
369 El. equip. . . .	-6.170	-1.474	-1.076	2.279	0.224	0.746	0.039	-0.846	0.997	-0.453
	*(1.92)***	*(1.61)*	*(0.75)*	*(0.53)***	*(0.05)***	*(1.31)*		*(0.13)***		
373 Yachts	-42.401	30.170	-23.850	1.606	0.278	32.132	0.012	-0.233	0.946	3.468**
	*(13.24)***	*(14.27)**	*(9.71)**	*(1.87)*	*(0.10)***	*(13.45)**		*(0.24)*		
374 Railrd. equip.	-12.759	1.736	-0.163	0.447	0.804	2.195	0.007	-0.715	0.910	3.719**
	*(4.34)***	*(2.91)*	*(2.68)*	*(1.03)*	*(0.13)***	*(3.10)*		*(0.17)***		
381 Meas. equip.	2.611	-3.726	0.185	1.822	-1.445	-2.042	0.036	-0.115	0.387	1.434
	(4.17)	*(2.32)*	*(0.65)*	*(0.59)***	*(1.55)*	*(1.87)*		*(0.25)*		
382 Control instr.	-25.138	3.086	-3.513	3.277	0.346	6.403	0.013	-0.176	0.974	2.058*
	*(4.65)***	*(2.15)*	*(1.17)***	*(1.22)***	*(0.07)***	*(1.88)***		*(0.25)*		
383 Optical instr.	-11.413	2.252	-0.970	0.897	0.318	3.595	0.166	-0.880	0.800	0.133
	(75.50)	*(20.85)*	*(1.55)*	*(3.27)*	*(0.22)*	*(22.00)*		*(0.12)***		
384 Med. equip. .	-7.447	-0.617	0.426	1.002	0.497	0.371	0.022	-0.170	0.976	1.014
	*(3.00)**	*(1.56)*	*(0.93)*	*(0.37)***	*(0.27)*	*(1.53)*		*(0.25)*		
385 Eyeglasses . .	-13.335	2.292	-1.884	1.737	0.345	4.288	0.101	0.120	0.959	1.371
	(15.67)	*(7.19)*	*(3.85)*	*(0.63)***	*(0.46)*	*(8.04)*		*(0.25)*		
387 Clocks & watches	3.132	-3.766	0.800	1.619	0.587	-3.117	0.205	-0.229	0.987	-1.475
	(4.95)	*(1.88)**	*(0.54)*	*(0.26)***	*(0.25)**	*(2.17)*		*(0.24)*		
391 Jewlry & silver	-4.509	2.431	-2.928	1.083	1.673	4.226	0.227	-0.078	0.964	2.273*
	*(0.52)***	*(1.14)**	*(0.97)***	*(0.19)***	*(0.72)**	*(1.30)***		*(0.25)*		
394 Toys & sports	-15.169	2.170	-2.237	2.063	0.756	4.499	0.109	0.459	0.911	3.209**
	*(3.63)***	*(1.58)*	*(0.81)***	*(0.34)***	*(0.18)***	*(1.74)***		*(0.22)**		
396 Notions	-1.821	-1.482	0.078	1.178	0.569	-0.451	0.090	0.362	0.287	-0.042
	(22.75)	*(9.85)*	*(4.17)*	*(1.10)*	*(0.45)*	*(10.30)*		*(0.23)*		

For notes see Table 1.

unit-value data were complete[28]. Since the interpolated unit-value data inevitably reflect the particular interpolation method utilized, we felt that it was not appropriate to subject these data to more refined system estimation. This was also the case for the remaining industries for which we used even more crude unit-value proxies. The results, which are available on request, indicate that the AS3LS coefficient estimates were comparable to the AM2LS estimates in most instances. But there were some noticeable differences, especially in: SIC 224, narrow fabric; SIC 232, men's clothes; SIC 332, cast iron articles; SIC 335, processed nonferrous metal; and SIC 339, metal, N.E.C. The AS3LS results thus suggest that caution be exercised in using AM2LS estimates in cases where cross-equation disturbances may be highly correlated.

VI. Comparison with "Best Guess" Estimates

We mentioned above that disaggregated import-demand and substitution elasticities are useful for a variety of analytical purposes, and that heretofore many investigators had relied upon the "best guess" estimates compiled by Stern *et al.* [1976]. It may be of interest accordingly to compare the elasticities that we have estimated here with the "best guesses" of Stern *et al.* In order to make this comparison manageable, we have aggregated our estimates, using 1976 import shares as weights[29], to correspond to the 3-digit ISIC classification used by Stern *et al.* Since most of the literature surveyed by Stern *et al.* dealing with disaggregated import-demand functions reflected U.S. experience, there is some basis for comparison. By the same token, however, it should be emphasized that the studies surveyed used a variety of estimating methods, data, and time periods. Further, the "best guesses" were calculated as point estimates since it was not possible to determine the associated standard errors.

The comparisons are reported in Table 4. The first column contains the "best guess" import-price elasticities taken from Stern *et al.* [1976, p. 22], and

[28] Given our data, AS3LS can be applied to 16 industries at a time, at most. Otherwise, the estimated asymptotic variance-covariance matrix is singular. To see this, let E be a $T \times N$ matrix of T regression residuals for each of N equations. The estimated asymptotic variance-covariance matrix is $S = E'E/T$. Now rank $(S) \leq \min(T,N)$, by the elementary properties of matrices. But S is an $N \times N$ matrix, so that if $T < N$, S is singular. In the present context, N is the number of industries included in the AS3LS estimation and T is the number of time-series observations. Since two observations are lost by correcting for lagged adjustment and serial correlation, there must be fewer than 16 industries included in the AS3LS estimation in order to prevent S from being singular. As a consequence AS3LS was applied only to groups of 3-digit SIC industries belonging to the same 2-digit classification. Since there were 6 such groups with only one industry, estimates for only 35 industries were calculated.

[29] We did not use the method of aggregation suggested in Barker [1970] since, for puposes of prediction, the future distribution of price changes may not necessarily correspond to historical patterns.

Table 4 – *Comparison of "Best Guess" and Estimated Price and Substitution Elasticities of Import Demand for the U.S. Using all Two-Stage Least Squares Estimates and Allowing for Adjustment Lags*

ISIC Industry		Import-Price Elasticities			Substitution Elasticities		
		"Best Guess"[a]	Estimated[b]	Wt. Av. St. Err.[c]	"Best Guess"[d]	Estimated[b]	Wt. Av. St. Err.[c]
311-12	Food prod.	-1.13	-0.21	(0.65)	1.13	0.31	(3.20)
313	Beverages	-1.64	-0.70	(0.14)	1.13	0.46	(0.24)
314	Tobacco	-1.13	-7.57	(2.83)	1.13	-16.19	(8.25)
321	Textiles	-1.14	-1.41	(0.79)	1.15	2.58	(1.98)
322	Wearing apparel	-3.92	-0.52	(1.32)	4.27	1.62	(2.75)
323	Leather & prod.	-1.58	-2.01	(1.20)	1.81	4.11	(5.11)
324	Footwear	-2.39	-2.42	(2.02)	2.83	3.15	(12.76)
331	Wood prod., excl. furn.	-0.69	-1.32	(1.35)	1.76	0.26	(11.06)
332	Furn. & fixt.,excl. metal	-3.00	-9.56	(9.12)	3.10	12.13	(2.58)
341	Paper & paper prod.	-0.55	-1.80	(1.06)	1.58	1.80	(1.66)
342	Printing & publ.	-3.00	-1.46	(1.50)	3.01	2.72	(4.09)
351	Industrial chem.	-2.53	-6.82	(5.76)	2.61	9.85	(2.78)
352	Other chem. prod.	-2.53	-5.00	(3.38)	2.61	6.08	(5.20)
353	Petroleum refineries	-0.96	-0.79	(0.42)	2.36	-0.34	(7.44)
354	Mis. prod. of pet. & coal	-0.96	-16.11	(3.67)	2.36	7.12	(7.12)
355	Rubber prod.	-5.26	-1.32	(0.23)	5.71	2.67	(1.63)
356	Plastic prod., N.E.C.	-2.53	-8.18	(4.95)	1.98	8.58	(6.21)
361	Pottery, china, earth.	-2.85	-1.37	(0.19)	2.78	2.11	(0.93)
362	Glass & prod.	-1.60	-2.86	(2.31)	1.63	4.29	(5.61)
369	Other non-met. min. prod.	-2.00	-1.18	(0.47)	2.78	1.95	(3.84)
371	Iron & steel bas. ind.	-1.42	-2.28	(0.45)	1.45	3.05	(1.95)
372	Non-ferr. met. bas. ind.	-1.38	-0.67	(1.31)	1.43	0.81	(1.97)
381	Metal prod., excl. mach.	-3.59	-0.94	(0.61)	3.67	1.54	(2.50)
382	Machinery, excl. elect.	-1.02	-0.88	(0.74)	1.02	3.34	(2.63)
383	Electric machinery	-1.00	-3.08	(1.45)	2.11	7.46	(6.46)
384	Transport equipment	-3.28	-1.24	(2.30)	3.59	2.01	(6.38)
385	Prof., photog. goods. etc.	-1.08	-0.44	(0.82)	1.98	0.45	(2.77)
389	Other manuf. ind.	-2.06	-2.37	(1.02)	1.98	3.55	(3.42)

[a] Based upon estimates in Stern *et al.* [1976, p. 22]. – [b] Based upon the results reported above in Tables 1-3 weighted by 1976 import shares. – [c] Upper bound on standard error of estimates obtained by weighting standard errors in Tables 1-3 by absolute values of weights used for elasticity estimates. – [d] Calculated based upon the relationships and data in Deardorff, Stern [1981].

the fourth column contains the associated "best guess" substitution elasticities calculated and used in the Michigan Model of World Production and Trade based on 1976 data – see Deardorff, Stern [1986]. In columns two and three and five and six, we report the AM2LS estimated import-price and substitution elasticities together with the weighted-average standard errors covering all of the 122 3-digit SIC industries that have been aggregated into the 28 3-digit ISIC categories noted[30]. These elasticities, which incorporate adjustment lags, include the AM2LS estimates that were statistically significant at the 5 percent level as well as those that were not significant[31].

If we compare the point estimates of substitution elasticities in Table 4, half of the "best guesses" were less than and half greater than those based on the weighted-average estimates. Rather than only considering point estimates, a better comparison might be to determine whether the "best guesses" lay within or outside the confidence intervals that are implied by the estimated substitution elasticities plus or minus twice the weighted averages of estimated asymptotic standard errors indicated. Using this criterion, the "best guess" substitution elasticities in Table 4 for furniture and fixtures (ISIC 332) and industrial chemicals (ISIC 351) lie below the lower limit while those for beverages (ISIC 313) and tobacco (ISIC 314) lie above the upper limit. The remaining "best guesses" lie within the confidence intervals, although these intervals are rather large. Given the width of the confidence intervals for the import-demand and substitution elasticities, it is important to solve computational models using a range of parameter values. The elasticity estimates and confidence intervals reported here may provide such a range.

VII. Summary and Conclusions

The purpose of this paper has been to present estimates of import-demand and substitution elasticities for disaggregated U.S. industries. Three groups of estimates were included, covering 41 3-digit SIC industries for which unit-value data could be calculated for the entire sample period from 1962–1978, 33 industries for which missing unit-value data were approximated by interpolation, and 48 industries for which unit values for aggregate commodity classes were used. Results corrected for simultaneity, serial correlation, and lagged adjustment were presented for these three groups of industries. Given the details involved and the special factors that may affect individual industries, the results seem reasonably successful, using as a criterion the number of negative and statistically significant import-price elasticities obtained especially for the first two groups of industries. It would be preferable if

[30] The weighted-average asymptotic standard errors provide an upper bound for the asymptotic standard errors of the aggregated estimators. Calculation of the asymptotic standard errors of the aggregated estimators would require knowledge of asymptotic covariances among the estimators being aggregated. Only if these estimators were perfectly correlated asymptotically, would the asymptotic standard error of the aggregated estimators equal the weighted average.

[31] It would have been preferable to use the AS3LS results for purposes of comparison, but for the reasons mentioned in the text we estimated AS3LS only for the industries in which the unit-value data were complete.

actual prices rather than unit-value proxies were used for estimation purposes, but the lack of price data precludes this option. While it is beyond the scope of our effort to determine how well the individual equations fit beyond the sample period, the elasticity estimates should provide a useful benchmark for investigators interested in particular industries.

A variant of 3SLS estimation was applied to investigate whether disturbances were correlated across equations. While the results were on the whole similar to those obtained using a 2SLS variant, there were some noteworthy differences. This suggests that care needs to be exercised in using estimates in which cross-equation disturbances are correlated.

Finally, we compared the "best guess" elasticities of import demand and substitution constructed by Stern *et al.* [1976] with the ones estimated directly and reported in our detailed tables. For the most part, the confidence intervals calculated from our estimates span the "best guesses". While there is imprecision in the estimated substitution elasticities and the associated standard errors, the substitution elasticities may nonetheless be useful for a variety of computational purposes. It would be advisable though in undertaking calculations to allow for a range of elasticities especially in cases where the results may be sensitive to the elasticity values chosen.

References

Alaouze, Chris M., *Estimation of the Elasticity of Substitution between Imported and Domestically Produced Intermediate Inputs.* IMPACT Project, Preliminary Working Paper, No. OP-07. Melbourne 1976.

–, *Estimates of the Elasticity of Substitution between Imported and Domestically Produced Goods Classified at the Input-Output Level of Aggregation.* IMPACT Project, Preliminary Working Paper, No. OP-13. Melbourne 1977.

–, **J. S. Marsden, J. Zeitsch,** *Estimates of the Elasticity of Substitution between Imported and Domestically Produced Commodities at the Four Digit ASIC Level.* IMPACT Project, Working Paper, No. 0-11. Melbourne 1977.

Allen, Roy G. D., Sir, *Mathematical Analysis for Economists.* London 1938.

Baldwin, Robert E., John H. Mutti, J. David Richardson, "Welfare Effects on the United States of a Significant Multilateral Tariff Reduction". *Journal of International Economics.* Vol. 10, 1980, pp. 405–423.

Barker, Terence S., "Aggregation Error and Estimates of the UK Import Demand Function". In: Kenneth Hilton, David F. Heathfield (Eds.), *The Econometric Study of the United Kingdom.* London 1970, pp. 115–145.

Bayard, Thomas, James A. Orr, *Trade and Employment Effects of Tariff Reductions Agreed to in the Tokyo Round of the Multilateral Trade Negotiations.* Washington, D.C., 1980.

Boylan, T.A., Michael P. Cuddy, I. O'Muircheartaigh, "The Functional Form of the Aggregate Import Demand Equation: A Comparison of Three European Economies". *Journal of International Economics,* Vol. 10, 1980, pp. 561–566.

Buckler, Margaret, Clopper Almon, *Imports and Exports in an Input-Output Model.* American Statistical Association, Proceedings of the Business and Economic Statistics Section. Washington, D.C., 1972.

Cline, William R.N., Noborn Kawanabe, T.O.M. Kronsjø, Thomas Williams, *Trade Negotiations in the Tokyo Round: A Quantitative Assessment.* Washington 1978.

Deardorff, Alan V., Robert M. Stern, *The Michigan Model of World Production and Trade: Theory and Applications.* Cambridge 1986.

Grossman, Gene M., "Import Competition from Developed and Developing Countries". *Review of Economics and Statistics,* Vol. 64, 1982, pp. 271-281.

Hamilton, Carl, "Import Elasticities at a Disaggregated Level: The Case of Sweden". *Scandinavian Journal of Economics,* Vol. 4, 1980, pp. 449-463.

Kakwani, Nanak C., "On the Bias in Estimates of Import Demand Parameters". *International Economic Review,* Vol. 13, 1972, pp. 239-244.

Kemp, Murray C., "Errors of Measurement and Bias in Estimates of Import Demand Parameters". *Economic Record,* Vol. 38, 1962, pp. 369-372.

Khan, Mohsin, Knud Z. Ross, "The Functional Form of the Aggregate Import Demand Equation". *Journal of International Economics,* Vol. 7, 1977, pp. 149-160.

Kohli, Ulrich R., "Relative Price Effects and the Demand for Imports". *Canadian Journal of Economics,* Vol. 15, 1982, pp. 205-219.

Kravis, Irving B., Robert E. Lipsey, "International Trade Prices and Price Proxies". In: Nancy D. Ruggles (Ed.), *The Role of the Computer in Economic and Social Research in Latin America: A Conference Report of the National Bureau of Economic Research.* London 1974, pp. 253-268.

Kreinin, Mordechai E., "Disaggregated Import Demand Functions - Further Results". *Southern Economic Journal,* Vol. 40, 1973, pp. 19-25.

Lächler, Ulrich, "The Elasticity of Substitution between Imported and Domestically Produced Goods in Germany", Weltwirtschaftliches Archiv, Vol. 121, 1985, pp. 74-96.

Leamer, Edward E., Robert M. Stern, *Quantitative International Economics.* Boston 1970.

Murray, Tracy, Peter J. Ginman, "An Empirical Examination of the Traditional Aggregate Import Demand Model". *Review of Economics and Statistics,* Vol. 58, 1976, pp. 75-80.

Mutti, John H., *Price Responsiveness in Import and Domestic Goods Markets.* Final Report to U.S. Department of Labor, Bureau of International Labor Affairs, Division of Foreign Economic Research, Contract No. 74-14. Washington, D.C., 1975.

–, "The Specification of Demand Equations for Imports and Domestic Substitutes". *Southern Economic Journal,* Vol. 44, 1977, pp. 68-73.

Orcutt, Guy H., "Measurement of Price Elasticities in International Trade". *Review of Economics and Statistics,* Vol. 32, 1950, pp. 117-132.

Price, James E., James B. Thornblade, "U.S. Import Demand Functions Disaggregated by Country and Commodity". *Southern Economic Journal,* Vol. 39, 1972, pp. 46-57.

Shiells, Clinton R., *A Disaggregated Empirical Analysis of U.S. Import Demand, 1962-1981.* The University of Michigan, Ph.D. diss. Ann Arbor, Mich., 1985.

Stern, Robert M., Jonathan Francis, Bruce Schumacher, *Price Elasticities in International Trade: An Annotated Bibliography.* London 1976.

Stone, Joe A., "Price Elasticities of Demand for Imports and Exports: Industry Estimates for the U.S., the EEC and Japan". *Review of Economics and Statistics,* Vol. 61, 1979, pp. 306–312.

Thursby, Jerry, Marie Thursby, "How Reliable Are Simple, Single Equation Specifications of Import Demand?" *Review of Economics and Statistics,* Vol. 66, 1984, pp. 120–128.

Whalley, John, *Trade Liberalization among Major World Trading Areas.* Cambridge 1984.

* * *

Zusammenfassung: Schätzungen der Substitutionselastizität zwischen Importen und heimischen Gütern für die Vereinigten Staaten. – Dieser Aufsatz enthält Schätzungen der Importnachfrage- und Substitutionselastizitäten für 122 dreistellige SIC-Industrien der USA, wobei jährliche Daten der Periode 1962–1978 und eine Variante der zweistufigen Methode der kleinsten Quadrate benutzt werden. Schätzungen aufgrund einer Variante der dreistufigen Methode der kleinsten Quadrate, die simultan für eine Untergruppe dieser Industrien vorgenommen werden, liefern einige Hinweise auf eine Korrelation der Residuen aus den Importfunktionen für die verschiedenen Industriezweige. Obwohl auch sie mit Ungenauigkeiten behaftet sind, bieten die geschätzten Elastizitäten doch einen wertvollen Anhaltspunkt für einzelne Industrien und für die Wahl von Parametern in Computermodellen und anderen Analysen des Außenhandels mit hoher Disaggregation.

*

Résumé: Estimations des élasticités de substitution entre des importations et des produits locaux pour les Etats Unis. – Dans cet article les auteurs présentent des estimations des élasticités de demande importatrice et de substitution pour 122 3-digit SIC industries dans les Etats Unis en utilisant des données annuelles pour 1962–1978 et une variante des moindres carrés à deux degrés. Des estimations basées sur une variante des moindres carrés à trois degrés et obtenues simultanément pour un sous-groupe de ces industries révèlent quelque évidence de corrélation entre les perturbances des différentes équations. Bienque soumises à l'imprécision les élasticités estimées donnent un point de repère pour des industries individuelles et pour le choix des paramètres à l'usage en modèles de commerce computables et en autres analyses de commerce extérieur au niveau désagrégé.

*

Resumen: Estimaciones de las elasticidades de sustitución entre importaciones y bienes nacionales no comerciados para los Estados Unidos. – Este trabajo presenta estimaciones de elasticidades de demanda de importaciones y de sustitución para 122 ramas industriales al nivel de tres dígitos de la CIUU para los EEUU, utilizando datos anuales para 1962–1978 y una variante del método de cuadrados mínimos de dos etapas. Estimaciones basades en una variante del método de tres etapas, obtenidas para un subgrupo de estas ramas, dieron evidencia de correlacion entre los residuos de las ecuaciones del modelo. A pesar de estar sujetas a imprecisiones, las elasticidades estimadas constituyen un dato útil para las ramas industriales y para la elección de parámetros para modelos computacionales de comercio internacional y otros análisis del comercio a nivel desagregado.