May 22, 1975

THEORY AND ESTIMATION OF THE DEMAND FOR IMPORTS OF CONSUMER GOODS

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1. Introduction and Summary

Despite the abundance of literature on time-series estimation of import demand relationships, several important theoretical problems have not been treated adequately in major references on the subject, and empirical work in this area remains conceptually deficient. The purpose of this paper is to focus on specification problems that, to our knowledge, have not been adequately recognized, and to attempt to resolve a number of these. We present estimates of quarterly levels of U.S. imports for three types of consumer goods: foods, feeds and beverages from (1959 I through 1972 IV), consumer nondurables, excluding foods (1965 I - 1972 IV), and consumer durables, excluding automative products (1961 I - 1972 IV).

The importance of disaggregating imports by end-use is well-recognized; appropriate specification forms depend on whether we are considering consumer or producer demands, and whether the imports under study are durables or non-durables. This recognition, however, is not yet reflected by empirical work in the field. One purpose of this paper is to estimate the demands for imports of consumer durables using a stock adjustment model.

*/ This paper represents the views of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or its staff. We are indebted to several of our colleages, and especially to Daniel Roxon, for general criticism and for particular assistance in understanding the limitations of existing data.

Most empirical specifications of consumer demands for imports are based on utility maximization over a single-period horizon. This paper, in contrast, draws its demand specifications from a multi-period framework. A multi-period framework is capable of sorting out the relative impacts of income trends and income cycles on consumer demand for imports, and provides a clear rationale for incorporating lagged income and price variables into aggregate demand hypotheses--namely, as information used by consumers to form expectations about future incomes and prices. Lagged incomes and prices have no place in the single-period utility maximization framework, and although they may be important determinants of import deliveries when lags exist between orders and deliveries, the single-period framework may overlook important prior information about the shape of the lag distribution.

Section 2 presents what we feel to represent an appropriate derivation of aggregate consumer demand equations within a multi-period framework. Subsection 2.1 treats the case of nondurables; subsection 2.2 considers durables. Our models distinguish between imports and domestic products, which are imperfect substitutes at the level of commodity aggregation that we consider. Subsection 2.1 confronts the problem of aggregating over individuals and demonstrates that the existence of a stable aggregate demand function is consistent with a world in which individual consumers have different demand parameters and change over time. In our multi-period framework, the individual's demand for imports is related to his wealth or permanent income, rather than being a direct function of his current income. Current demands for imports also depend on the expected future prices of imports and domestic substitutes, which we express in terms of current prices and expected rates of inflation. For simplicity, we assume that at any moment the consumer expects the rate of inflation of import prices to remain constant over his planning horizon, although he continuously revises his expectations of the magnitude of this constant rate of price advance. Similar assumptions are made about the expected future prices of domestic substitutes. For imports of nondurable consumer goods, demand thus depends on permanent income, the current prices of imports and domestic substitutes, and the rates of inflation that the prices of imports and domestic substitutes are expected to show. Our proxy for permanent income is a geometrically-decaying, weighted average of current and past incomes; and our proxies for expected inflation factors are geometrically-decaying, weighted averages of current and past inflation factors.

These same variables affect the demand for imports of consumer durables. Since stocks of durables carry over from one period to the next, we formulate the consumers demand as an adjustment of actual to desired stocks, taking account of depreciation. Thus, our model for durables also includes speed-of-adjustment and depreciation parameters.

In Section 3 we define and discuss the inadequacies of our commodity groups and data. Additional information on data construction is provided in the Appendix.

Our most serious data problem, which is conceptual in nature, has received surprisingly little attention in the literature. This is the problem that sales of imported goods to consumers--the variable which measures the demand for consumer good imports--may, in fact, be quite different from the recorded level of consumer good imports--the only series available for use as a dependent variable.[1/] Imports are rarely ordered by consumers themselves; rather, sales

1/ Consequently, the dating of the dependent variable may not correspond to the dating of those income and price terms which it is most appropriate to use as independent variables.

to consumers equal recorded imports minus changes in the inventories of intermediaries. Unfortunately, adequate data are not available on intermediaries' inventories of imported goods. One serious consequence of omitting from regression models an explicit treatment of these changes in inventories will be a complicated pattern of autocorrelated disturbances. Simple adjustments for autocorrelation are inadequate when inventory behavior is complex.[2/]

Subsection 3.1 contains a brief discussion of the influence of import quotas on our dependent variables. Subsection 3.2 is a lengthy discussion of our choice of price data and their inadequacies, and also contains a description of tariff factors. A major shortcoming of the price data is their failure to capture the mark-ups between importers or domestic producers and the consumers whose aggregate demand functions are being estimated. A second shortcoming, particularly in the case of durables, is the fact that recorded prices do not adequately summarize the terms of purchase: they ignore installment and down payment terms, the generosity of trade-ins and other concessions, etc. A third shortcoming, independent of the quality of disaggregated price data, is that the weights used to construct aggregate price indexes may involve serious specification errors.

Subsection 3.3 discusses effective prices and omitted variables. It is argued that Gregory's (1971) formulation of effective price variables is inappropriate. We also note that the relative availability of imports and domestic substitutes is an important non-price attribute which, as an omitted

2/ This problem can be avoided by the complicated approach of explaining recorded imports as an order function adjusted for delivery lags. See Marston (1971).

variable, may underlie the high estimated income elasticities of demand for imports of non-food consumer goods since the early 1960's.

During our sample periods, approximately 30 percent of our quarterly import records reflect the influence of major U.S. dock strikes, which have had strong impacts on intermediaries' inventories of imports, although not necessarily on sales to consumers. As an effort to avoid the serious autocorrelation problems discussed above, we have obtained weekly longshore manhours data and have attempted to develop a sophisticated set of dock strike dummy variables. Our treatment of dock strikes is described in subsection 3.4.

Section 4 discusses our numerical estimates of import demand relationships for the three commodity groups, based on a nonlinear estimation procedure. In subsection 4.1 we present our results for foods, feeds and beverages (FFB) and consumer non-food nondurables (CND); in subsection 4.2 we present results for consumer durables (CD). For the FFB case we obtained plausible magnitudes and correct signs on all the important parameters of our multi-period demand model. For the CND case we were unsuccessful at estimating the multi-period model and were led to adopt a simplified structure, similar to conventional single-period models of import demand, by which standards our parameter estimates seem quite acceptable. For the CD case we were again unsuccessful at estimating a multi-period model. Our results for this case are weak, demonstrating only that plausible prior restrictions on depreciation and speed-of-adjustment parameters lead to plausible estimates of income and own-price elasticities. The existence of heterogeneous products within our commodity-group aggregates is a problem. Although the different commodities within each aggregate may exhibit similar income and price elasticities, for the case of durables the differences in speed-of-adjustment and depreciation parameters make it particularly difficult to estimate a stable and well-fitting aggregate demand equation.

2. Theoretical Foundations for Aggregate Consumer Demand Equations

In this section we derive aggregate consumer demand equations for imports based on utility maximization over a multi-period horizon. Our multi-period focus leads to an appropriate specification of the sensitivity of demand to income (thus sorting out the relative impacts of income trends and income cycles), and provides a clear rationale for incorporating lagged income and price variables into aggregate demand hypotheses. Subsection 2.1 deals with non-durable commodities and subsection 2.2 with durables. It is important to note in these subsections that the derivation of aggregate demand equations does not require the unrealistic assumptions that individual consumers are similar in their behavior or unchanging over time.

2.1 Demand for Non-Durable Goods

As in Friedman (1957) and Modigliani and Brumberg (1954), we begin by considering an individual consumer who is concerned with the allocation of his resources among goods for current and future consumption, with resources being his current net worth plus the sum of current and discounted future earnings. We take into account his expected consumption of goods and services in future periods 1, ..., L, L being the expected date of his death. His bequests are represented as goods in period L+1. When at times we refer to the consumer's demand for composite commodities, we are implicitly assuming either that the prices or the quantities of the different commodities within each composite are in fixed proportions, or that "homogeneous separability" obtains. For an excellent account of the types of separability and their implications for two-stage maximization of utility functions, see Green (1964).

We first consider the behavior of a consumer under conditions of complete certainty. In this context, the consumer's problem may be formulated as follows: Maximize

(1) $u[\underline{C}_0, \underline{C}_1, \ldots \underline{C}_{L+1}]$

subject to

(2)
$$W_0 = V_0 + H_0$$
$$= V_0 + E_0 + \frac{E_1}{1+r_0} + \ldots + \frac{E_L}{(1+r_0)\ldots(1+r_{L-1})}$$
$$= \underline{p}_0\underline{C}_0 + \frac{\underline{p}_1\underline{C}_1}{(1+r_0)} + \ldots + \frac{\underline{p}_{L+1}\underline{C}_{L+1}}{(1+r_0)\ldots(1+r_L)}$$

where

$\underline{C}_t$ is an m x 1 vector of consumptions in period t, with imported products distinguished from domestically-supplied products,

$\underline{p}_t$ is a 1 x m vector of the corresponding prices in period t,

r_t is the rate at which the consumer can borrow or lend money between periods t and t+1,

W_0 is the consumer's wealth in period 0,

V_0 is the consumer's non-human wealth in period 0, i.e., the present value of all non-human assets less the present value of all non-human liabilities, and

H_0 is the consumer's human wealth, which is measured by his current earnings from work, E_0, plus the present value of $E_1, \ldots, E_L$, his expected earnings from work in the subsequent periods.

The utility function in (1) will have certain classical properties enumerated in Goldberger (1967). Given

$$W_0, \underline{p}_0, \ldots, \underline{p}_{L+1}, r_0, \ldots r_L,$$

the constrained maximization problem in (1) and (2) may be solved to obtain the consumer's vector of demands in period 0.

(3) $$\underline{C}_0 = \underline{C}_0[W_0, \underline{P}_0, \frac{\underline{P}_1}{1+r_0}, \ldots, \frac{\underline{P}_{L+1}}{(1+r_0)\ldots(1+r_L)}]$$

Following the work of Friedman, we define permanent income, y^P, as that rate of receipts per period which, if maintained at a constant level over one's lifetime, would have a present value equal to that of one's total wealth. Its value in period 0 is determined by solving the following equation for y_0^P,

(4) $$y_0^P[1 + \frac{1}{1+r_0} + \ldots + \frac{1}{(1+r_0)\ldots(1+r_{L-1})}] = W_0.$$

Accordingly, we may rewrite eq. (3) as:

(3a) $$\underline{C}_0 = \underline{C}_0[\theta y_0^P, d_0\underline{P}_0, d_1\underline{P}_1, \ldots d_{L+1}\underline{P}_{L+1}]$$

where

$$\theta = 1 + \frac{1}{1+r_0} + \ldots + \frac{1}{(1+r_0)\ldots(1+r_{L-1})}$$

$$d_0 = 1$$

$$d_\tau = \frac{1}{(1+r_0)\ldots(1+r_{\tau-1})} \quad \text{for } \tau = 1, \ldots, L+1$$

In (1) and (2) all $t > 0$ represent subjective planning time, and not historical time. Only at $t = 0$ is the consumption plan given by eq. (3a) actually implemented. The problem in (1) and (2) is handled so as to emphasize the effect of planning for the future upon present behavior, $\underline{C}_0$. At time $t > 0$

the consumer again solves the utility maximization problem in a form analoguous to (1) and (2) under a forward shift of time subscripts.

$$\text{(3b)} \qquad \underline{C}_t = \underline{C}_t[\theta y_t^P, d_0\underline{p}_t, d_1\underline{p}_{t+1}, \ldots d_{L+1}\underline{p}_{t+L+1}]$$

It should be emphasized that the only operable $\underline{C}_t$ is that decided at time t.

This whole procedure requires the assumption that a complete set of intertemporal preferences exists. On the question of whether this assumption is warranted, we quote Hicks (1946, p. 229):

> If we assume the individual to have a complete plan of expenditure, extending over a considerable future period, and complete in every detail, we are falsifying his actual behavior quite absurdly; but if we merely use this assumption not to determine the details of the purchases which may (or may not) be planned to be made in the future, but to determine the details of current expenditure alone, we are not involved in anything which is at all absurd. The determination of current expenditure will proceed just as if there was such a complete plan; if we assume the existence of a complete plan we can proceed to determine current expenditure with the minimum of trouble.

The functional form of the demands at time t depends on the functional form of utility at time t. In the spirit of generality (or ignorance) which characterizes the classical approach, however, it is possible to proceed without specifying a particular functional form for utility, see Paulus (1973). We take a log-linear approximation to (3b) as representative of the demand behavior which would arise from maximization of utility over the relevant range of variation of permanent income and expected future prices.

$$\text{(5)} \qquad \log C_{ijt} = \beta^*_{0ijt} + \beta^*_{1ijt} \log y^P_{it} + \sum_{k=1}^{m} \beta^*_{2ijkt} \sum_{\tau=0}^{L_i+1} w_{ijk\tau} \log d_\tau p_{ik,t+\tau}$$

$$(j = 1,2, \ldots, m)$$

where i indexes consumers, j and k index commodities, and L_i is the expected lifespan or planning horizon of the i^{th} consumer at time t. Note that we have factored the coefficients on the discounted future prices into two components: β^*_{2ijkt} and $w_{ijk\tau}$. If we interpret eqs. (5) as a straight log-linear approximation to (3b), the log θ term would be absorbed in β^*_{0ijt}; alternatively, we may interpret (5) as a modified log-linear approximation in which, following Friedman (1957, pp. 11-14), the income coefficient β^*_{1ijt} depends on θ, and hence, on expected future interest rates.

Notice that eqs. (5) allow different individuals to have different expectations regarding future prices. Note also that we do not force the coefficients of eqs. (5) to be identical for all consumers at all points in time; rather, we follow a general approach by allowing the coefficients to vary among individuals and over time. Given that individuals do indeed differ greatly in their behavior and change over time, it is doubtful whether any fixed-coefficient demand models integrated into a specific utility-maximization theory can compete with this variable-coefficient double-log model of demand. A similar argument is offered by Goldberger (1967, p. 107) while commenting on the Rotterdam School models; we have paraphrased at points:

> If one is to assess the fruitfulness of eqs. (5), it is important to recognize that no stigma attaches to their being approximate rather than exact. With the true utility function being unknown, there is after all no guarantee that any of the "exact" consumer demand models will be exact in fact. A formulation of the type eqs. (5) with varying coefficients, quite possibly, provides an adequate approximation to utility-maximizing behavior over a range of conceivably true utility functions; this without being exactly appropriate for any particular one. Such robustness is naturally desirable.

Up to this point we have been discussing consumer behavior under conditions of certainty. However, for a variety of reasons mentioned in Friedman (1957, pp. 14-17), the effect of uncertainty establishes no presumption against the form assigned to the demand functions in (5). According to Friedman, one way of introducing uncertainty is to include the ratio of nonhuman wealth to permanent income as a variable determining the income coefficient, β^*_{1ijt}. We do this implicitly: uncertainty is another reason for variability of coefficients.

One complication associated with the formulation in (5) is that it is uncomfortably rich in parameters when the number of commodities (m) and the consumer's planning horizon (L_i) are large. Accordingly, we first simplify the formulation of the system, as in Theil (1971, p. 579), by eliminating most of the cross-price terms under direct additivity assumptions; that is, we assume that most cross-price elasticities of demand are zero. To the extent that our commodities represent broad composites of consumer goods, direct additivity may be a plausible specification, see Goldberger (1967, p. 31). Specifically, we suppose that the utility function in (1) can be written as a sum of functions, each containing as arguments only the current and future imports and domestically-produced quantities of one composite commodity. With this simplification, the consumer's demand for imports of any composite commodity depends only on permanent income and the current and future expected prices of these imports and their domestic substitutes. When all these regressors are deflated by a conventional general price index, the consumer's demand function is also consistent with an alternative procedure of simplification which does not involve the assumption of direct additivity, see Goldberger (1967, pp. 101-4).

We now restrict our attention to the consumer's demand for a particular composite of imports. We let pm and pd, respectively, denote the prices of these imports and their domestic substitutes, where to allow for generality, it is understood that these variables, along with the y_i^p, are deflated by a general price index. The assumptions of the previous paragraph then leave the system as:

$$(6) \quad \log C_{it} = \beta_{0it}^{**} + \beta_{1it}^{*} \log y_{it}^{p} + \beta_{2it}^{*} \sum_{\tau=0}^{L_i+1} w_{im\tau} \log(d_\tau pm_{i,t+\tau}) + \beta_{3it}^{*} \sum_{\tau=0}^{L_i+1} w_{id\tau} \log(d_\tau pd_{i,t+\tau})$$

where β_{0it}^{**} now includes any combined effect on the dependent variable of the determining factors which are not introduced explicitly.

In a context of perfect foresight, the i^{th} individual's demand for imports depends on known values of future prices. To operationalize eq. (6) in a context of uncertainty, we must replace future values by their optimal forecasts. The implicit assumptions here are: first, individuals react to the forecasts of the future values; second, individuals base their forecasts on the past values of the variable in question, and optimize their forecasts given knowledge of some stochastic specification of the mechanism generating the time series of the causative variable, see Nerlove (1967, 1972).

In order to simplify the nature of the estimation problems, we assume that the stochastic structure generating the incomes and commodity prices is of the simple unobserved-components type suggested by Nerlove (1967). It should be noted, however, that the models which Nerlove (1967) uses for generating his optimal predictions of variables are classified as inconsistent models by Cyert and DeGroot (1974), since individuals do not know the form of the process which determines prices, and, in fact, base their decisions on an incorrect model.[3/]

The prices to be forecast in eq. (6) may be rewritten as

(7)
$$pm_{i,t+\tau} = (1+\rho m^{e}_{it,t+\tau})pm_{t}$$
$$pd_{i,t+\tau} = (1+\rho d^{e}_{it,t+\tau})pd_{t}$$

where pm_t and pd_t are the current prices faced by all consumers and $\rho m^{e}_{it,t+\tau}$ and $\rho d^{e}_{it,t+\tau}$ are the τ-period rates of inflation expected by the i^{th} consumer. To make the model tractable, we adopt the simplifying assumption that at any point in time (t), each consumer expects constant rates of inflation throughout the future; specifically

(7a)
$$pm_{i,t+\tau} = (1+\rho m^{e}_{it})^{\tau}\rho m_{t}$$
$$pd_{i,t+\tau} = (1+\rho d^{e}_{it})^{\tau}pd_{t}$$

The i^{th} consumer's expectations of future quarter-to-quarter rates of inflation (ρm^{e}_{it} and ρd^{e}_{it}) are revised from period to period, however, and therefore carry a time subscript.

3/ An alternative to our proxies for expected future rates of inflation would be the assumption of rational expectations of future rates of inflation. This rational expectations approach is difficult to implement, however, unless the relevant economic theory of price determination is known.

Combining (6) and (7a) yields:

$$\text{(8)} \qquad \log C_{it} = \beta_{0it} + \beta_{1it} \log y^{p}_{it} + \beta_{2it} \log pm_{t} + \beta_{3it} \log pd_{t} + \beta_{4it} \log (1 + \rho m^{e}_{it}) + \beta_{5it} \log (1 + \rho d^{e}_{it})$$

where β_{0it} includes terms in $\log d_{\tau}$ (for $\tau = 0, \ldots, L_i + 1$), and the price-elasticities, β_{2it} and β_{3it}, include both the direct impacts of current price changes and the indirect impacts that result as current price changes lead to revised expectations of future prices.

The preceding analysis is microeconomic in nature, and since data on individual consumers are not available, an explicit treatment of the aggregation problem is in order. We proceed as in Zellner (1969), Theil (1971, Section 11.5) and Swamy (1971, pp. 15-16). We assume the following:

(a) The vectors, $(\beta_{0it}, \beta_{1it}, \beta_{2it}, \beta_{3it}, \beta_{4it}, \beta_{5it})$, with different i and t subscripts, are random drawings from a six-dimensional distribution with the mean vector $(\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5)$ and a finite symmetric variance-covariance matrix.

(b) The coefficients are independent of the explanatory variables,[4/] which are uniformly bounded.

4/ This assumption is not true unless the indifference surfaces are homothetic with respect to the origin. It can be relaxed by taking each coefficient as an explicit function of economic variables plus an error. However, we make assumption (b) to make the estimation procedure more tractable. The dependence between the coefficients and the explanatory variables for a finite number of individuals does not hurt our procedure.

The means of micro coefficents reflect the "representative" tastes of the population and the deviations of micro coefficients from their means reflect idiosyncracies of individuals in tastes. This interpretation is due to McFadden (1974).

Now aggregate eq. (8) across individuals; this gives

$$(9)\qquad \frac{1}{n_t}\sum_{i=1}^{n_t} \log c_{it} = \beta_0 + \beta_1 \frac{1}{n_t}\sum_{i=1}^{n_t} \log y_{it}^p + \beta_2 \log pm_t + \beta_3 \log pd_t + \beta_4 \frac{1}{n_t}\sum_{i=1}^{n_t} \log (1 + \rho m_{it}^e) + \beta_5 \frac{1}{n_t}\sum_{i=1}^{n_t} \log (1 + \rho d_{it}^e) + u_t^* + \varepsilon_t$$

where $\beta_{\ell it} = \beta_\ell + \zeta_{\ell it}$ $(\ell = 0, \ldots, 5)$, n_t is the population in quarter t, $\zeta_{0it} = u_t^* + e_{0it}$, and

$$(10)\qquad \varepsilon_t = \sum_{i=1}^{n_t} [e_{0it} + \zeta_{1it} \log y_{it}^p + \zeta_{2it} \log pm_t + \zeta_{3it} \log pd_t + \zeta_{4it} \log (1 + \rho m_{it}^e) + \zeta_{5it} \log (1 + \rho d_{it}^e)].$$

The u_t^* are regarded as the individual-invariant time effects which are not accounted for by the included explanatory variables in eq. (9).

It is possible to show that under certain general conditions the vector $\varepsilon = (\varepsilon_1, \ldots, \varepsilon_T)$ has mean vector $\underline{0}$ and variance-covariance matrix of order n^{-1}

where n is the minimum of $n_t (t = 1, 2, \ldots, T)$, see Welsch and Kuh (1974). Consequently, for large enough n and finite T, the vector converges in probability to $\underline{0}$ and can be eliminated from eq. (9) without introducing any error.

Except for the price terms, each variable in eq. (9) is the arithmetic mean of logarithmic values. Arithmetic means of logarithmic values are logarithms of geometric means. Unfortunately, macroeconomic data represent arithmetic averages of micro observations, not geometric averages. If the logarithms of explained and explanatory variables in eq. (9) follow the normal distribution, however, we have a simple relation between geometric and arithmetic means. For given t, let $a_t(x)$ and $g_t(x)$ be the respective arithmetic and geometric means of a variable x_{it} (for $i = 1, \ldots, n_t$), and let $\sigma^2(x)$ be the variance of the logarithmic values of x_{it}. The variance $\sigma^2(x)$ is assumed to be constant at least over the sample period. We then find

$$(11) \qquad a_t(x) = g_t(x) e^{\sigma^2(x)/2}.$$

This means that the geometric means of micro variables show time movements close to arithmetic means. Using the relation (11), we can write eq. (9) as

$$(12) \qquad \log a_t(C) = \gamma_0 + \beta_1 \log a_t(y^P) + \beta_2 \log pm_t + \beta_3 \log pd_t + \beta_4 \log a_t(1 + \rho m^e) + \beta_5 \log a_t(1 + \rho d^e) + u_t^*$$

where

$$\gamma_0 = \beta_0 + \tfrac{1}{2}[\sigma^2(C) - \beta_1 \sigma^2(y^P) - \beta_4 \sigma^2(1 + \rho m^e) - \beta_5 \sigma^2(1 + \rho d^e)].$$

Since our dependent variable is $\log \sum_{i=1}^{n_t} C_{it} = \log(n_t \cdot a_t(C)) \equiv \log C_t$, and because we also wish to focus on $\log(n_t \cdot a_t(y^p)) \equiv \log y_t^p$ as an income variable, we transform (12) to

$$\text{(12a)} \qquad \log C_t = \gamma_0 + \beta_1 \log y_t^p + \beta_2 \log pm_t + \beta_3 \log pd_t + \beta_4 \log a_t(1 + \rho m^e) + \beta_5 \log a_t(1 + \rho d^e) + u_t$$

where $u_t = u_t^* + (\beta_1 - 1)(\log n_t)$.

We must now adopt specific predictors of permanent income and the expected rates of inflation. Let y_t denote personal disposable income in period t and note that historic price ratios, pm_{t-s}/pm_{t-s-1} and pd_{t-s}/pd_{t-s-1}, reflect historic values of the inflation factors $(1 + \rho m)$ and $(1 + \rho d)$. We adopt all the stochastic assumptions which make the quantities

$$\text{(13)} \qquad (1-\lambda_1)\sum_{s=0}^{\infty} \lambda_1^s \log y_{t-s},\ (1-\lambda_2)\sum_{s=0}^{\infty} \lambda_2^s \log(pm_{t-s}/pm_{t-s-1})$$
$$\text{and } (1-\lambda_3)\sum_{s=0}^{\infty} \lambda_3^s \log(pd_{t-s}/pd_{t-s-1})$$

the minimum mean square error predictors of $\log y_t^p$, $\log a_t(1 + \rho m^e)$ and $\log a_t(1 + \rho d^e)$, respectively; such stochastic assumptions are given in Nerlove (1967, pp. 142-3). In subsection 4.1 below we substitute (13) into (12a) and manipulate the resulting equation to arrive at our basic hypothesis for estimating imports of nondurable consumer goods.

Several important conclusions may be drawn from the analysis of this subsection. First, the existence of a stable aggregate consumer demand equation is consistent with a world in which the tastes of individual consumers differ from each other and change over time. Second, consumer demand in any period is not directly related to the prices or incomes that prevailed in the past; rather, it depends on lagged variables only insofar as consumers use historic information to evaluate their current wealth positions (or permanent incomes) and to forecast future prices. Third, if we believe that the consumer's budget constraint depends on his wealth or permanent income, and that consumption possibility sets are independent of cyclical income patterns, then consumer demand should be related to permanent income, and we should not expect or attempt to estimate a stable elasticity of demand with respect to current income.

2.2 Demand for Durable Goods

In analyzing the demand for durable goods it is desirable to allow for the fact that the services of a durable are not consumed entirely during the period in which the durable is purchased, as distinct from the case of non-durables. The value of durable goods held at the end of any period t by the i^{th} consumer, v_{it}, is equal to the value of the stock at the beginning of the period, v_{it-1}, plus the excess of purchases in that period, q_{it}, over the consumption of the period, d_{it}, i.e.,

(14) $$v_{it} = v_{it-1} + q_{it} - d_{it}.$$

We may rewrite eq. (14) as

(14a) $$q_{it} = v_{it} - v_{it-1} + d_{it}$$

As in Stone and Rowe (1960), we assume that

(15) $$v_{it} - v_{it-1} = \gamma_{it}(v^*_{it} - v_{it-1})$$

where $0 \leq \gamma_i \leq 1$ and v^*_{it} represents the value of the desired level of stocks. Following Tinsley (1971) we can develop a justification for the adjustment eq. (15). The basic premise of eq. (15) is the existence of some kind of costs of adjustment which prevents the individual consumer from being always in "equilibrium". The optimal target, v^*_{it}, is a moving convolution of future events anticipated over the planning horizon of the individual and can be shown to be a weighted average of all expected future prices of durable commodities. The adjustment coefficient, γ_{it}, is a function of the rate of interest and the relative curvatures of the indifference curves and cost of adjustment functions.

To complete the theory of consumer demand for durables, it is necessary to combine the theory of demand for net additions to stocks of durables with a specification of the depreciation or consumption terms d_{it}. To satisfy eq. (14), depreciation during any period is properly measured as the sum of the scrappage value of units scrapped during the period plus appropriate reductions during the period in the values of the initial stocks and purchases that are not scrapped.

In theory, stocks of consumer durables, and the depreciation of these stocks, should be valued in terms of the flow of consumer utilities that derive from the services of the durables, rather than original production costs, replacement costs, or accounting conventions; and market prices do not necessarily reflect these utility values. We shall refer to these theoretically appropriate values as "written-down values".

Our model of depreciation begins with the simplifying assumptions that for the i^{th} consumer in period t:

(i) $\mu_i q_{it}$ is the value of units scrapped from new purchases; μ_i will be zero if durable goods are not scrapped in the period in which they are bought.

(ii) If r_i is a vector of mortality rates appropriate to each age group in the i^{th} consumer's stock at the beginning of period t, $\hat{r}_i$ is the diagonal matrix whose j^{th} diagonal element is equal to the j^{th} element of $\underline{r}_i$, $\underline{p}_{it}$ is a vector whose elements express the i^{th} consumer's written-down values of units of different ages, $\hat{p}_{it}$ is a diagonal matrix whose j^{th} diagonal element is equal to the j^{th} element of $\underline{p}_{it}$, and $\underline{s}_{it-1}$ is a vector of numbers in each age group in the opening stock, then $\underline{r}_i'\hat{\underline{p}}_{it}\underline{s}_{it-1}$ gives the written-down value of units of different ages scrapped during period t from the stock held by the i^{th} consumer at the beginning of period t.

(iii) Consumption is a continuous process which uses up the existing stock at a constant proportionate rate. In any period, therefore, depreciation (apart from mortality) will consist of both $\underline{\delta}_i^{(1)'}(I - \hat{\underline{r}}_i)\hat{\underline{p}}_{it}\underline{s}_{it-1}$, where $\underline{\delta}_i^{(1)}$ is a vector of proportions of the written-down values of units of different ages not scrapped, plus a further, generally smaller, fraction, $\delta_i^{(2)}$, of the new purchases of the period not scrapped.

Assumptions (i) - (iii) imply

$$d_{it} = [\mu_i + \delta_i^{(2)}(1 - \mu_i)]q_{it} + [\underline{r}_i' + \underline{\delta}_i^{(1)'}(I - \hat{r}_i)]\hat{\underline{p}}_{it}\underline{s}_{it-1} \tag{16}$$

This formulation cannot be implemented empirically, however, without detailed data on initial holdings of consumer durables, new purchases of consumer goods and their mortality and depreciation rates--data which are not readily available. Consequently, we resort to the usual, apparently crude, procedures. We approximate eq. (16) by

$$\text{(16a)} \qquad d_{it} = \delta_{i1t} + \delta_{i2t}v_{it-1} + \delta_{i3t}q_{it}$$

We might expect $\delta_{i1t} = 0$ since there cannot be any services derived from durable goods if $\underline{v}_{it-1} = \underline{0}$ and $q_{it} = 0$. However, (16a) is merely an approximation to a more complicated function in (16). The approximation may become much closer if we allow ourselves the freedom of one more parameter such as δ_{i1t}.

Now let γ_{it} in eq. (15) be distributed independently of v^*_{it} and v_{it-1}, with mean $\bar{\gamma}$ and constant variance, and let the vectors $(\delta_{i1t}, \delta_{i2t}, \delta_{i3t})$ be independently of v_{it-1} and q_{it} with mean vector $(\bar{\delta}_1, \bar{\delta}_2, \bar{\delta}_3)$ and finite variance-covariance matrix. Then it follows from Theil's (1971, pp. 570-1) convergence theorem that for given t, when the number of consumers is sufficiently large and the variables v^*_{it}, v_{it-1} and q_{it} are uniformly bounded, eqs. (15) and (16a) aggregate perfectly over individuals to

$$\text{(17)} \qquad v_t - v_{t-1} = \bar{\gamma}(v^*_t - v_{t-1})$$

and

$$\text{(18)} \qquad d_t = \bar{\delta}_1 + \bar{\delta}_2 v_{t-1} + \bar{\delta}_3 q_t$$

where

$$v_t = \frac{1}{n_t}\sum_{i=1}^{n_t} v_{it},\quad v_{t-1} = \frac{1}{n_{t-1}}\sum_{i=1}^{n_{t-1}} v_{it-1},\quad v^*_t = \frac{1}{n_t}\sum_{i=1}^{n_t} v^*_{it},\quad d_t = \frac{1}{n_t}\sum_{i=1}^{n_t} d_{it}$$

and

$$q_t = \frac{1}{n_t}\sum_{i=1}^{n_t} q_{it}.$$

Similarly, eq. (14a) can be aggregated as

$$\text{(18a)} \qquad q_t = v_t - v_{t-1} + d_t$$

Substituting eq. (18) into eq. (18a) gives

$$q_t = \frac{\bar{\delta}_1}{1-\bar{\delta}_3} + \frac{1}{1-\bar{\delta}_3}[1 - (1 - \bar{\delta}_2)B]v_t \tag{19}$$

where B is the backward shift operator defined as $B^s x_t = x_{t-s}$ for any x. Lagging eq. (19) by one period and subtracting it from eq. (19), we have

$$\begin{aligned} \Delta q_t &= \frac{1}{1-\bar{\delta}_3}[1 - (1 - \bar{\delta}_2)B]v_t \\ &= \frac{1}{1-\bar{\delta}_3}[1 - (1 - \bar{\delta}_2)B]\bar{\gamma}(v_t^* - v_{t-1}) && \text{[by eq. (17)]} \\ &= \frac{\bar{\gamma}}{1-\bar{\delta}_3}[1 - (1 - \bar{\delta}_2)B]v_t^* - \bar{\gamma}(q_{t-1} - \frac{\bar{\delta}_1}{1-\bar{\delta}_3}) && \text{[by eq. (19)]} \end{aligned} \tag{20}$$

Associated with the equilibrium level of stocks, v_t^*, there is an equilibrium level of purchases, q_t^*, which is wholly replacement demand and just sufficient to maintain stocks constant at the desired level. From eq. (19), these equilibrium purchases must satisfy

$$q_t^* = \frac{1}{1-\bar{\delta}_3}(\bar{\delta}_1 + \bar{\delta}_2 v_t^*). \tag{21}$$

Inserting this back into eq. (20) gives

$$q_t = (1 - \bar{\gamma})q_{t-1} + \frac{\bar{\gamma}}{\bar{\delta}_2} q_t^* - (1 - \bar{\delta}_2)\frac{\bar{\gamma}}{\bar{\delta}_2} q_{t-1}^* \tag{22}$$

Eq. (22) is in the form of Zellner's (1970) unobservable-variable model. If we interpret q_t^* as the services of durables that would be consumed during period t in an equilibrium state, we may hypothesize that the demand for this flow of services has a functional form similar to the demand for a flow of non-durable goods, as given by (12a) of subsection 2.1. We therefore assume[5]

$$q_t^* = \alpha_0 + \alpha_1 y_t^p + \alpha_2 pm_t + \alpha_3 pd_t + \alpha_4(1 + \rho m_t^e) + \alpha_5(1 + \rho d_t^e) + u_t^* \tag{23}$$

where y_t^p is aggregate permanent income, pm_t is the own price of the durable-good imports on the demand for which we are focusing, pd_t is the price of domestic substitutes, ρm_t^e and ρd_t^e are the quarterly rates of inflation expected in the prices of imports and domestic substitutes, and u_t^* is a disturbance term.

3. Definitions and Inadequacies of Commodity Groups and Data

3.1 Commodity Groups and Data Sources

As indicated in Section 1, the empirical focus of this paper is on three groups of consumer goods: foods, feeds and beverages (FFB); consumer nonfood, nondurables, manufactured and unmanufactured (CND); and consumer durables, except automobiles, manufactured and unmanufactured (CD). Our focus is on quarterly data from 1958 I - 1972 IV for FFB, from 1964 I - 1972 IV for CND, and from 1960 I - 1972 IV for CD.[6]

5/ Because demand for durable imports is the sum of net additions to stocks plus depreciation or replacement, it is difficult to work with logarithmic variables in this case.

6/ These groups correspond to end-use categories 0(FFB), 40 plus 420(CND), and 41 plus 421(CD), as classified by the Office of Business Economics. The different sample periods were dictated by the availability of price data that we were willing to use, as discussed in subsection 3.2 below. Because of the lag structures in our regression hypotheses, each of our sample periods begins four quarters after the date cited here.

Both FFB and CND contain major import items that have been restricted by quotas during part or all of our data period, see Mintz (1973). Imports of meats, sugars and dairy products--all subject to quota restrictions--represented roughly 19, 13 and 2 percent, respectively, of total FFB imports in 1972.[7/] With respect to CND, cotton textile imports have been subject to mandatory quotas since late 1961, while noncotton textiles have been subject to mandatory quotas since late 1971 and voluntary quotas since at least 1965. For both categories, however, separate quotas have been imposed on imports from particular countries, without ever imposing global quotas on imports of cotton or noncotton textiles. Country quotas have been imposed sequentially over time, and the data show that as soon as imports from one country were restricted, imports from other countries accelerated, often sharply.[8/] Similarly, when quotas were applied to particular textile imports from a given supplying country, imports of other textile items from that country often accelerated. Consequently, we feel that quotas did not have a major influence during our data period on aggregate imports of cotton and noncotton textiles from all sources combined.

Our import data were taken from various publications of the U.S. Department of Commerce and Office of Business Economics. Personal disposable income was used as the explanatory income variable for all three categories. Both

7/ Data from U.S. Department of Commerce, Bureau of the Census: U.S. Foreign Trade; Highlights of Exports and Imports, FT 990 publication, December 1972, Table I3.

8/ See U.S. Tariff Commission (1968, Tables 8 and 10).

imports (in current dollars) and income were seasonally adjusted using the standard (default) option of the Census Bureau X-11 seasonal adjustment program. Explanatory price variables and the import price deflators were not seasonally adjusted. While we are not willing to assert that the Census X-11 is the best of all possible seasonally adjustment procedures, we do feel that it is better than a stable seasonal (or dummy variable) adjustment.[9/]

3.2 Price Data and Their Inadequacies

Econometric studies of import demands frequently lead to price elasticities that have wrong signs or are of questionable magnitudes. The poor quality of price statistics and misspecifications of the model may be responsible for these results. The first problem that we encountered in seeking price data was the unavailability of satisfactory data on retail prices--the prices that consumers face in choosing between imports, domestic substitutes and other goods. There is no easy way to take consumer price indices corresponding to our end-use groups and subdivide these indices into an import price component and a price index for domestically-produced import substitutes.

In selecting price indices for domestic substitutes, our choice was between the consumer price indices and the wholesale price indices most closely

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9/ For a critical evaluation of the Census X-11 technique, see Cleveland (1972). Fishman (1969, p. 69) discusses several informal spectral criteria for judging the adequacy of seasonal adjustment. Grether and Nerlove (1972) point out the inadequacies in spectral criteria for the proper assessment of methods of seasonal adjustment and devise methods of seasonal adjustment based on a minimum mean-square-error criterion of optimality. Cleveland (1972) develops alternative methods of seasonal adjustment which are based on Bayesian criteria of optimality.

corresponding to our end-use groups. Because of their smaller coverage of import items, wholesale price indices were chosen.[10/] Data were taken from various issues of the Monthly Labor Review. For FFB and CND we used wholesale price indices for finished consumer goods: in the former case, the "foods" index, in the latter case, the index for "other nondurable goods". We did not use the finished consumer goods index for durables due to its coverage of automobiles, which are excluded from our CD category. Instead, we chose the wholesale price index for "furniture and household durables", listed as industrial commodities group. We made no attempt to purge these indices of their import price components.

In constructing the import price variables, we started with a weighted average of unit value indices for FFB and weighted averages of foreign export price indices (converted into U.S. dollars at spot exchange rates) for CND and CD. These were then multiplied by tariff factors.

Several factors governed our use of these different types of price indices for different categories. In the absence of retail price indices for imports, we would have a strong preference for weighted averages of foreign export prices if such data were available for a fairly complete coverage of major supplying countries. In fact, export price indices are not widely available for commodity groups that might be assumed to correspond roughly to our end-use categories. This deficiency in the coverage of export price

10/ In January 1973, 91 (or 43 percent) of the 210 nonfood commodities covered in the CPI had their CPI prices estimated from samples that included at least one import item. Of these 91, roughly one-third were commodities for which import prices accounted for at least 5 percent of the price quotations collected, 6 were commodities for which import prices accounted for at least 25 percent of the quotes collected, and in 4 cases, import quotes provided the majority of the sample. In comparison, the wholesale price index, in which it is possible to identify import items precisely, assigned 1.35 percent of its weight to import prices in December 1972. See, U.S. Department of Labor, Bureau of Labor Statistics, "The Representation of Imports in the CPI and WPI." Mimeographed note, March 1973.

statistics has to be balanced against the fact that, for our end-use breakdown, unit value indices are erratic and only available on a quarterly basis since 1967.

For CND and CD, the unit value indices seemed particularly erratic and there was no appealing way to match these end-use groups with other commodity groups for which unit value indices are available quarterly before 1967. On the other hand, imports of these items are somewhat concentrated by source, and we were able to come up with export price series for over 40 percent (1967 value shares) of the items in each of these two end-use groups. These data and our choice of weights are described in Appendix Tables A1 and A2.

For FFB, the most appealing option was a weighted average of unit value indices for crude foods and manufactured foods. Both of these series are available quarterly since 1958. We decided against splicing this series with the unit value index for the food group as a whole, available since 1967. The data and our choice of weights is described in Appendix Table A3.

For each end-use category the explanatory import price variable (scaled to 1967=100) was multiplied by an appropriate tariff factor (scaled to 1967=1). For the 1967-1972 period, which involved both the Kennedy Round reductions and the 1971 import surcharge, our tariff factors were based on Wilson's (1973) detailed calculations of average tariff rates for each of our three end-use groups. For the 1958-1967 period we used information provided by Hooper (1974) on percentage changes in the average tariff rate on all U.S. imports, assuming that the same percentage changes applied to each of our three end-use groups. Appendix Table A4 presents our tariff factors and explicitly describes their construction.

The questionable quality and limited coverage of our price indices are obvious deficiencies. It is particularly important to emphasize three ways in which our price data may be conceptually inadequate. First, as noted above, our prices are measured to exclude the mark-ups between importers, or domestic producers, and consumers. Ideally, our prices should be multiplied by appropriate mark-up factors. It is conceivable that these mark-up factors were relatively stable during the 1960s, but very likely that percentage mark-ups changed significantly during 1971-72, when higher import prices resulting from foreign currency revaluations were partly absorbed by domestic importers, while domestic mark-ups were influenced by price and wage controls.

A second problem, particularly in the case of durables, is that measured price does not adequately summarize the terms of purchase: the demand for relatively expensive durables depends upon down payment and installment terms, the generosity of trade-ins and other concessions, warranty offers, etc. This problem applies equally to both import prices and the prices of domestic substitutes.

A third problem is that our explanatory price variables may involve serious specification error. Theil (1967, pp. 150-1, 208-19) has shown that the true cost of living price index can be closely approximated by a moving-weight index based on moving expenditure shares, but we have not followed this procedure. The statistical insignificance of estimated price elasticities may be due as much to incorrectly specified index numbers as to the poor quality of the data used to construct these indexes.

3.3 Effective Prices and Omitted Variables

We have noted above that quoted prices do not always summarize the relative attractiveness of imports and domestic substitutes to the consumer. In addition to the actual quoted prices, variables such as relative waiting times, trade credit terms, rebates, discounts, and the general ability of sellers to meet customer requirements influence consumer demands, particularly in the case of durables. Gregory (1971) has coined the term effective price in reference to a multi-dimensional vector which describes those price and non-price attributes of the seller's commodity or services that are relevant to the buyer's decision. Consideration of relative effective prices at home and abroad determines whether the commodity is purchased from domestic or foreign suppliers. The conventional focus on income and relative observed prices as explanatory variables in the demand equation may be quite misleading unless relative observed prices have the same time movements as relative effective prices.

Unfortunately, the applied econometrician lacks data on many important components of the effective price vector. Consequently, Gregory has developed a theory of price dynamics which leads him to replace his effective price vectors with proxy variables for which data are available. Some of the assumptions involved in Gregory's derivation of these proxies are subject to serious criticism,[11/] however, and we have chosen not to imitate his approach.

11/ For example, Gregory assumes that the supply function for a firm under competitive market conditions depends, among other things, on the quantity demanded, which does not seem appropriate, see Klein (1962, pp. 126-7). Gregory also postulates that market prices change in proportion to excess demand, an assumption which has been criticized for ignoring the behavioral underpinnings of price dynamics. An excellent discussion of the theory of price dynamics in disequilibrium markets is provided by Gordon and Hynes (1970), who argue that the competitive model is completely unsatisfactory as a framework within which to analyze price dynamics. Disequilibrium price dynamics must entail some form of imperfect information introduced through a stochastic demand schedule under quasi-monopolistic conditions, where supply functions are not well (cont. . .)

Nevertheless, we share Gregory's opinion that empirical work should focus more on the non-price attributes which help determine the relative attractiveness of imports and domestic substitutes to the consumer. The rapid growth of CND and CD imports during our sample period was in part due to interrelated rapid changes in the availability of imports relative to domestic substitutes.[12/] To the extent that relative availability and income are correlated, this phenomenon may explain the high apparent income elasticities in many estimates of the demand for imports of nonfood consumer goods.

3.4 Treatment of Dock Strikes

In theory, dock strikes affect consumer demands for imported goods only indirectly, if at all, through delivery lags and effective price changes. Data limitations, however, have forced us to use recorded imports as our dependent variable, rather than consumer demands for imported goods as reflected in purchases out of the foreign-good inventories of domestic merchants. This choice of dependent variable forces us to account for the direct effects of dock strikes. Since 1958, major dock strike disruptions have affected import volumes significantly in roughly 3 out of every 10 quarters, with imports curtailed during strike periods, stimulated just prior to longshore contract deadlines and Taft-Hartley expiration dates, and typically stimulated during the recovery periods which follow contract settlements. Because of the small

defined. Demand equations with random coefficients (such as those hypothesized in eq. (5) of Section 2.1) are appropriate for markets which are out of equilibrium, see Cyert and DeGroot (1974). Statistical analysis of such demand functions is discussed in Swamy and Mehta (1973).

12/ This is apparent in the rapid growth of foreign car franchises, cheap import houses, shelf space allotted to imported stereophonic equipment and televisions, etc.

number of data points that were not affected by strikes, which becomes even smaller when imports are specified to depend upon lagged dependent variables, we prefer the dummy variable approach to the alternative of discarding observations that were affected by strikes.

While it is obvious that dock strikes have had a major impact on quarterly movements of imports during the last two decades, little attention has been devoted to constructing sophisticated dock strike dummies.[13/] We were fortunate to obtain data from the New York Shipping Association on weekly longshore manhours worked in the Port of New York, which encouraged us to construct a new set of dock strike dummies, see Isard (1975). The construction of these strike dummies is explained in Table A5 of the Appendix.

4. Numerical Results

4.1 Estimated Demand Equations for FFB and CND Imports

The specification hypothesis for FFB and CND imports is based on eq. (12a) and assumptions (13) of Section 2.1. For notational convenience we let

M_t = logarithm of the recorded volume (or deflated value) of imports in period t

$Y^p_t = \log y^p_t$ $\qquad$ $Y_t = \log y_t$

$PM_t = \log pm_t$ $\qquad$ $PD_t = \log pd_t$

$\pi m^e_t = \log a_t(1 + \rho m^e)$ $\qquad$ $\pi d^e_t = \log a_t(1 + \rho d^e)$

13/ Hooper (1974), and others have based their strike dummies on "mandays lost" statistics, but much more sophistication is possible.

It should be emphasized here that y_t measures personal disposable income in constant dollars, and that pm_t and pd_t have each been divided by the deflator for personal disposable income, for the reason discussed in Section 2.1. In addition, since recorded imports differ from the demand for imports during periods affected by dock strikes, as discussed in Section 3.4, M_t corresponds to consumption of imported goods, i.e., the dependent variable in eq. (12a), plus a dock strike adjustment, $\beta_6 D_t$. Thus, we rewrite (12a) and (13) as:

(12b) $$M_t = \gamma_0 + \beta_1 Y_t^p + \beta_2 PM_t + \beta_3 PD_t + \beta_4 \pi m_t^e + \beta_5 \pi d_t^e + \beta_6 D_t + u_t$$

(13a) $$Y_t^p = (1 - \lambda_1)\sum_{s=0}^{\infty} \lambda_1^s Y_{t-s}$$

(13b) $$\pi m_t^e = (1 - \lambda_2)\sum_{s=0}^{\infty} \lambda_2^s (PM_{t-s} - PM_{t-s-1})$$

(13c) $$\pi d_t^e = (1 - \lambda_3)\sum_{s=0}^{\infty} \lambda_3^s (PD_{t-s} - PD_{t-s-1})$$

Substitution of (13a-c) into (12b), using the Koyck transformation, then yields:

(24) $$\begin{aligned} M_t = {} & \gamma_0(1-\lambda_1)(1-\lambda_2)(1-\lambda_3) + (\lambda_1+\lambda_2+\lambda_3)M_{t-1} - (\lambda_1\lambda_2+\lambda_2\lambda_3+\lambda_3\lambda_1)M_{t-2}+\lambda_1\lambda_2\lambda_3 M_{t-3} \\ & + \beta_1(1-\lambda_1)Y_t-\beta_1(1-\lambda_1)(\lambda_2+\lambda_3)Y_{t-1}+\beta_1(1-\lambda_1)\lambda_2\lambda_3 Y_{t-2}+[\beta_2+\beta_4(1-\lambda_2)]PM_t \\ & - [\beta_2(\lambda_1+\lambda_2+\lambda_3)+\beta_4(1-\lambda_2)(1+\lambda_1+\lambda_3)]PM_{t-1}+[\beta_2(\lambda_1\lambda_2+\lambda_2\lambda_3+\lambda_3\lambda_1) \\ & + \beta_4(1-\lambda_2)(\lambda_1+\lambda_3+\lambda_1\lambda_3)]PM_{t-2}-[\beta_2\lambda_1\lambda_2\lambda_3+\beta_4(1-\lambda_2)\lambda_1\lambda_3]PM_{t-3} \\ & + [\beta_3+\beta_5(1-\lambda_3)]PD_t-[\beta_3(\lambda_1+\lambda_2+\lambda_3)+\beta_5(1-\lambda_3)(1+\lambda_1+\lambda_2)]PD_{t-1} \\ & + [\beta_3(\lambda_1\lambda_2+\lambda_2\lambda_3+\lambda_3\lambda_1)+\beta_5(1-\lambda_3)(\lambda_1+\lambda_2+\lambda_1\lambda_2)]PD_{t-2} \\ & - [\beta_3\lambda_1\lambda_2\lambda_3+\beta_5(1-\lambda_3)\lambda_1\lambda_2]PD_{t-3}+\beta_6 D_t-\beta_6(\lambda_1+\lambda_2+\lambda_3)D_{t-1} \end{aligned}$$

(cont. . .)

$$+ \beta_6(\lambda_1\lambda_2+\lambda_2\lambda_3+\lambda_3\lambda_1)D_{t-2}-\beta_6\lambda_1\lambda_2\lambda_3D_{t-3}+u_t-(\lambda_1+\lambda_2+\lambda_3)u_{t-1}$$

$$+ (\lambda_1\lambda_2+\lambda_2\lambda_3+\lambda_3\lambda_1)u_{t-2}-\lambda_1\lambda_2\lambda_3u_{t-3}$$

Eq. (24) is "over-identified" with respect to its parameters because there are a total of 19 coefficients which are determined by only 10 basic parameters. Hence, we must estimate the 10 parameters under 9 constraints, and since those constraints are nonlinear, recourse must be made to a nonlinear estimating technique.[14/]

To avoid dealing with a structure even more complicated than eq. (24), we make the simplifying assumption that the u_t follow the third-order autoregressive process,

$$(25) \qquad u_t = (\lambda_1+\lambda_2+\lambda_3)u_{t-1}-[\lambda_1\lambda_2+\lambda_2\lambda_3+\lambda_3\lambda_1]u_{t-2}+\lambda_1\lambda_2\lambda_3u_{t-3}+\epsilon_t$$

where the ϵ_t are independently distributed with means 0 and constant variance; that is, we assume that the disturbances of eq. (24) are serially independent. Although we have no evidence to support the plausibility of this assumption, we likewise have no evidence to support the plausibility of any alternative assumption. Given that we have specified our import demand equation to conform to the structure of a consumer demand equation, whereas the M_t in eq. (24) deviate from sales to consumers by any changes in the imported inventories of intermediaries, we have good reason to believe that the u_t will exhibit a complicated pattern of serial correlation which reflects these inventory fluctuations; but we cannot confidently specify the nature of this serial correlation.

14/ We have used a nonlinear estimation program which incorporates Marquardt's (1973) iterative procedure.

Before discussing the parameter estimates associated with eq. (24), attention should be given to their economic interpretation in terms of the income and price responses of the theory of consumer demand. A unit log-change in current money income with all absolute prices constant results in a unit log-change in current real income with no change in relative prices. According to eq. (24), the resulting log-change in the quantity demanded is $\beta_1(1 - \lambda_1)$ in the short-run and β_1 in the long-run. Unlike these income elasticities, however, conventional price elasticities are not simply defined within our model, because our PM_t and PD_t variables represent the logarithms of prices divided by the deflator for personal disposable income. To the extent that a one percent change in import prices (or prices of domestic substitutes) affects the deflator, the change in PM_t (or PD_t) will differ from one unit, and Y_t and PD_t (or PM_t) will also change. Approximate expressions for conventional uncompensated (Cournot) own and cross-price elasticities can be derived in terms of average budget shares, see Goldberger and Gamaletsos (1970, pp. 359-60). In contrast, the β_2 and β_3 parameters in eqs. (12b) and (24) are income-compensated (Slutsky) price elasticities, see Goldberger (1967, p. 103).

The estimated equations for FFB imports are described in Table 1. In Case 1, with no prespecified parameter values, we estimated plausible magnitudes and appropriate signs for all six of the β coefficients; but the estimates of λ_2 and λ_3 are implausible. It was apparent that estimates of any one of the three λ parameters would be highly correlated with estimates of the other two, so that we could not hope to estimate all three precisely. Accordingly, we decided to constrain λ_2 and λ_3, setting both equal to zero in Case 2. This amounts to an assumption that the future rates of inflation

Table 1: Estimation Results for FFB Imports[a/]

	γ_0	β_1	β_2	β_3	β_4	β_5	β_6	λ_1	λ_2	λ_3	Sum of Squared Errors	Standard Error of Estimate
Case 1: no pre-specified parameter values	.855 (2.75)	.808 (.0724)	-.810 (.342)	1.06 (.542)	.482 (.600)	-1.37 (1.13)	.927 (.156)	.814 (.831)	-.999 (.815)	.925 (.500)	.182	.0629
Case 2: $\lambda_2=\lambda_3=0$	4.03 (2.47)	.733 (.0616)	-.727 (.295)	.389 (.467)	.496 (.440)	-.930 (.610)	.972 (.144)	.75[b/] (.0299)	0	0	.164	.0584

a/ Parameters are defined in eqs. (12b) and (13a-c) at the beginning of this subsection. Numbers in parentheses are standard errors. Sample period is 1959 I - 1972 IV, 56 observations. The mean of the dependent variable is 7.03.

b/ The statistical quality of the Case 2 estimates is highly insensitive to the value of λ_1 within the range between .5 and 1.0; see text.

expected as of period t are equal to the actual rates of inflation experienced between periods t-1 and t.

All of the estimated parameters for Case 2 have plausible magnitudes and appropriate signs. Despite its low standard error, the estimate of λ_1 is imprecise, and we have reported the midpoint of a range of values that have approximately equal statistical quality. The estimates and standard errors of all other parameters, as well as the sum-of-squared-error statistic, each varies by less than one percent as λ_1 moves from 1.0 to 0.5, but this insensitivity breaks down once λ_1 drops below .5. The income elasticity of .733 is significant and consistent with the notion that food is a necessary good; the dock strike parameter, β_6, is significant and close to our prior expectation of one (see Appendix Table A5). The positive signs of β_3 and β_4 confirm that FFB imports in period t are substitutes for similar domestic products in period t and for imports in future periods; and the sign of β_5, about which we have no strong prior information, suggests that current FFB imports and future domestic FFB products are viewed as complements. The standard error of estimate is less than one percent of the mean of the dependent variable.

The estimated equations for CND imports are described in Table 2. Given our particular data, the program seemed unable to achieve convergence in cases in which either λ_1, λ_2 or λ_3 was specified as a free parameter. Accordingly, we again assumed $\lambda_2 = \lambda_3 = 0$; and we fixed $\lambda_1 = .75$, as suggested by our FFB results.

The Case 1 estimates, when no additional parameters are constrained, show an incorrect sign for β_3, the elasticity of imports with respect to the price of domestic substitutes. In view of the high correlation between the import

Table 2: Estimation Results for CND Imports[a/]

$\lambda_1 = .75;\ \lambda_2 = \lambda_3 = 0$ in all cases

	γ_0	β_1	β_2	β_3	β_4	β_5	β_6	λ_1	λ_2	λ_3	Sum of Squared Errors	Standard Error of Estimate
Case 1	21.4	2.15	-.448	-5.85	-.938	1.80	.295	.75	0	0	.0337	.0367
	(5.52)	(.259)	(.348)	(.951)	(.436)	(.995)	(.153)					
Case 2	-10.9	3.67	-1.35	0	-.962	0	.0274	.75	0	0	.0866	.0566
$\beta_3=\beta_5=0$	(2.59)	(.119)	(.487)		(.671)		(.226)					
Case 3:	-9.09	3.61	-1.66	0	0	0	.150	.75	0	0	.0932	.0577
$\beta_3=\beta_4=\beta_5=0$	(2.31)	(1.13)	(.445)				(.213)					

a/ Parameters are defined in eqs. (12b) and (13a-c) at the beginning of this subsection. Numbers in parameters are standard errors. Sample period is 1965 I - 1972 IV, 32 observations. The mean of the dependent variable is 6.27.

price and the price of domestic substitutes, the domestic price variables were eliminated in Case 2 (by imposing the constraints $\beta_3 = \beta_5 = 0$). The income elasticity for this case is significant and has the correct sign; its magnitude exceeds our a priori notions of the true income elasticities for necessity items such as CND, and we suspect that this high value reflects a high correlation between income growth and the rapid growth of the availability of CND imports relative to domestic substitutes during our sample period.[15/] The own-price elasticity, β_2, is significant with correct sign and sensible magnitude. The dock strike coefficient is insignificant and differs considerably from the expected magnitude of one (see Appendix Table A5),[16/] while β_4 is insignificant and has an incorrect sign.

In Case 3 we imposed the additional constraint $\beta_4 = 0$, thereby omitting expected future rates of inflation from the determinants of the demand for CND imports. This led to little change in the standard error of estimate and only moderate changes in the other estimated parameters.

Although our equation for Case 3 is similar to conventional import demand equations, by which standards our parameter estimates are quite acceptable, we have, nevertheless, failed to capture what we regard as the true structure of the import demand equation for this commodity group. In contrast to our FFB results, we have not been able to separate the own-price and cross-price elasticity parameters; and we have not met with success in estimating the sensitivity of import demand to expected future own-prices and cross-prices.

15/ Unfortunately, the omitted "relative availability" variable is difficult to quantify for inclusion in regression equations.

16/ The coefficient on the dock strike dummy for CND was also found to differ considerably from one in separate tests, which indicates that the quality of this dummy is probably lower than the quality of the dummies for the FFB and CD cases. See Isard (1975).

4.2 Estimated Demand Equations for CD Imports

The specification hypothesis for CD imports is based on equations (22) and (23) of Section 2.2., combined with proxy variables for y_t^p, $(1 + \rho m_t^e)$ and $(1 + \rho d_t^e)$. Substitution of (23) into (22) yields a relationship for consumer purchases of CD imports, q_t, which we assume to differ from recorded CD imports, m_t, according to:

$$(26) \qquad m_t = q_t + \alpha_6 D_t + u_t^{**}$$

where D_t is a dock strike dummy, u_t^{**} is a stochastic error term, and we expect the parameter α_6 to be approximately equal to one, (see discussion, Appendix Table A5). Because the model is cumbersome, we have chosen to simplify drastically our proxies for y_t^p, $(1 + \rho m_t^e)$ and $(1 + \rho d_t^e)$. Initially, we chose to replace permanent income with current income and to equate expected future inflation factors to current inflation factors:

$$(27a) \qquad y_t^p = y_t; \; (1 + \rho m_t^e) = pm_t/pm_{t-1}; \; (1 + \rho d_t^e) = pd_t/pd_{t-1}$$

When we were unsuccessful at estimating the coefficients on the expected future inflation factors, however, we eliminated $(1 + \rho m_t^e)$ and $(1 + \rho d_t^e)$ from the model and returned to our former proxy for permanent income, assuming:

$$(27b) \qquad y_t^p = (1-\lambda)\sum_{s=0}^{\infty} \lambda^s y_{t-s}; \; \alpha_4 = \alpha_5 = 0 \text{ (in eq. (23))}$$

Together, (22), (23), (26) and (27b) imply, after a Koyck transformation and using the notation $\bar{n} = 1/\bar{\delta}_2$:

(28) $$m_t = (1-\lambda)\bar{\gamma}\alpha_0 + (1+\lambda-\bar{\gamma})m_{t-1} - \lambda(1-\bar{\gamma})m_{t-2} + (1-\lambda)\bar{\gamma}\,\bar{n}\alpha_1 y_t$$
$$- (1-\lambda)\bar{\gamma}(\bar{n}-1)\alpha_1 y_{t-1} + \bar{\gamma}\,\bar{n}[\alpha_2 pm_t + \alpha_3 pd_t]$$
$$- [\lambda\bar{\gamma}\,\bar{n} + \bar{\gamma}(\bar{n}-1)][\alpha_2 pm_{t-1} + \alpha_3 pd_{t-1}] + \lambda\bar{\gamma}(\bar{n}-1)[\alpha_2 pm_{t-2} + \alpha_3 pd_{t-2}]$$
$$+ \alpha_6 D_t - (\lambda+1-\bar{\gamma})\alpha_6 D_{t-1} + \lambda(1-\bar{\gamma})\alpha_6 D_{t-2} + u_t - (\lambda+1-\bar{\gamma})u_{t-1} + \lambda(1-\bar{\gamma})u_t$$

where $u_t = \bar{\gamma}\,\bar{n}u_t^* - \bar{\gamma}(\bar{n}-1)u_{t-1}^* + u_t^{**}$. As in the nondurables case, we assume

(29) $$u_t - (\lambda+1-\bar{\gamma})u_{t-1} + \lambda(1-\bar{\gamma})u_{t-2} = \varepsilon_t$$

where the ε_t are independently distributed with means 0 and constant variance.

Our initial attempts to estimate equation (28) ran into two problems. As in the case of CND imports, our estimation program seemed unable to achieve convergence when λ was entered as a free parameter, so we again set $\lambda = .75$, as suggested by the FFB results. In addition, we were again dealing with high correlations between the import price and the price of domestic substitutes; and because we were unable to estimate correct signs for α_2 and α_3 simultaneously, we decided to eliminate the cross-price term from our model, setting $\alpha_3 = 0$.

Table 3 describes several estimated equations under the constraints $\lambda = .75$ and $\alpha_3 = 0$. It should be noted at the outset that relative to the mean of the dependent variable, the standard errors of estimate for this case are quite large.

For Case 1, all estimated parameters have correct signs, but only the dock strike variable is significant and the estimated speed of adjustment, $\bar{\gamma}$, is implausibly low. The estimate $\bar{n} = 6.00$, or $\bar{\delta}_2 = 1/\bar{n} = .167$, is highly plausible and, in fact, corresponds precisely to our best a priori guess about the true value of $\bar{\delta}_2$. To see this let s be the rate of scrappage per quarter, and let

Table 3: Estimation Results for CD Imports[a]
$\lambda = .75$, $\alpha_3 = 0$ in all cases

	α_0	α_1	α_2	α_6	$\bar{\gamma}$	$\bar{n}$	Sum of Squared Errors	Standard Error of Estimate	Long-Run Elasticities at Sample Means: Income[b]	Long-Run Elasticities at Sample Means: Own-Price[c]
Case 1: $\bar{\gamma},\bar{n}$ free	58.7 (139.)	4.34 (4.03)	-45.5 (87.9)	.708 (.0860)	.0252 (.0489)	6.00 (4.52)	5.77	.371	3.14	-6.32
Case 2: $\bar{\gamma}=.25,\bar{n}=6.0$	-8.04 (2.88)	3.80 (.306)	-3.56 (1.93)	.644 (.119)	.25	6.0	9.49	.464	2.75	-.495
Case 3: $\bar{\gamma}=.33,\bar{n}=6.0$	-9.78 (2.48)	3.78 (.264)	-2.48 (1.66)	.612 (.141)	.33	6.0	12.3	.529	2.73	-.345
Case 4: $\bar{\gamma}=.50,\bar{n}=6.0$	-11.6 (2.13)	3.76 (.227)	-1.37 (1.42)	.526 (.200)	.50	6.0	20.9	.690	2.72	-.190
Case 5: $\bar{\gamma}=.75,\bar{n}=6.0$	-12.6 (1.96)	3.74 (.209)	-.734 (1.31)	.345 (.308)	.75	6.0	39.8	.951	2.70	-.102

a/ Numbers in parentheses are standard errors. Sample period is 1961 I - 1972 IV, 48 observations. The mean of the dependent variable is 7.33.
b/ Approximated, using mean of current income rather than mean of permanent income.
c/ Describes the income-compensated response of imports to a change in own-price.

d be the rate of decline in the written-down value of units that have not been scrapped, so that $\bar{\delta}_2 = 1-(1-d)(1-s)$. Straightforward computation then shows that the estimate $\bar{\delta}_2 = .167$ is consistent with the joint assumptions that (i) the written-down value of durables falls by 30 percent per year ($\therefore (1-d)^4 = .7$) and (ii) it takes precisely 8 years (32 quarters) before 95 percent of an initial purchase is scrapped ($\therefore (1-s)^{32} = .05$).

Because of the implausibly low $\bar{\gamma}$ for Case 1, we decided to test the sensitivity of the other parameter estimates and the standard errors of estimates to prior restrictions on $\bar{\gamma}$. In this testing we discovered that our estimates of $\bar{n}$ declined monotonically as we increased the prespecified value of $\bar{\gamma}$, and plausible restrictions on $\bar{\gamma}$ did not lead to plausible estimates of $\bar{n}$. Accordingly, we report as Cases 2-5, some estimates associated with a range of plausible $\bar{\gamma}$ restrictions together with the constraint that $\bar{n} = 6.0$.

Because the standard error of estimate is 25 percent greater in Case 2 than in Case 1, we cannot argue that the estimates for Case 2 are as good on statistical grounds as those for Case 1, although it may be noted that in Case 2 the income and own-price terms are more significant, and the own-price elasticity seems more plausible. The results for Cases 2-5 tell us that plausible restrictions on the depreciation and speed-of-adjustment parameters are consistent with plausible estimates of income and own-price parameters, but we cannot argue that any of these cases corresponds to the true structure. The insensitivity of the income elasticity to the prespecified value of $\bar{\gamma}$ is noteworthy. As in the CND case, we suspect that the high apparent income elasticities overstate the true income elasticity due to a high correlation between income growth and the rapid growth of the availability of CD imports relative to domestic substitutes during our sample period.

4.3 Some Caveats in Connection with the Numerical Results

In assessing our numerical results, due allowance must be given to the defects of the data, the limitations of our theoretical models, and the fact that nonlinear estimation techniques cannot guarantee convergence to a global minimum. There are serious deficiencies in the time series we have used to represent prices, consumer expenditures on imports, and dock strike impacts. Our data are subject to both systematic and random errors which, as Griliches and Ringstad (1970) remark, may lead to severe distortions in estimates of a nonlinear specification. Moreover, we have noted numerous difficulties encountered in the development of our theoretical models.

It is also certain that our commodity-group aggregates are far from homogeneous. Although the different commodities within each aggregate may exhibit similar income and own-price elasticities, for the case of durables the differences in speed-of-adjustment and depreciation parameters make it particularly difficult to estimate a stable and well-fitting aggregate demand equation.

APPENDIX

Table A1: Description of Import Price Index and Value Deflator for CND

1.) Component Series

PJAPAN = Japanese (fixed-weight) export price index for nondurable consumer goods, from Bank of Japan publications, converted into dollars[a] and scaled to 1967=100.

PITALY = Wholesale price index for women's all leather shoes (with calfskin uppers) in Milan, from Instituto Centrale di Statistica, Bolletino Mensile di Statistica, various issues. Quarterly averages of monthly prices, converted into dollars,[a] and scaled to 1967=100.

PKOREA = Export price index for South Korea, all commodities[b] from International Monetary Fund data bank, corresponding to line 74p in International Financial Statistics, scaled to 1967 = 100.

PCHINA = Export price index for Taiwan, all commodities,[b] from International Monetary Fund data bank corresponding to line 74p in International Financial Statistics, scaled to 1967=100.

2.) Import Price Index

$$PMFOB = .5501 \cdot PJAPAN + .1900 \cdot PITALY + .2599 \cdot POTHER$$

where

$$POTHER = .5446 \cdot PKOREA + .4554 \cdot PCHINA$$

Weights in PMFOB reflect base-year (1967) relative shares in the value of total CND imports of (i) CND imports from Japan (.5501), (ii) CND imports of leather footwear and other leather goods (end-use #4110) from Italy (.1900), and (iii) CND imports from Far East Asia excluding Japan and Hong Kong (.2599). These three categories combined represented 41 percent of total CND imports in 1967. From Census end-use data.

Table A1: (continued)

Weights in POTHER reflect relative magnitudes of 1967 imports from Korea and Taiwan of schedule A commodities 83, 84, 85 and 89. Data from Census, FT 155, 1967 Annual.

PMFOB is multiplied by tariff factors (see Table A4) to get the explanatory variable used in our regressions.

3.) Import Value Deflator

$$\text{DEFLATOR} = W_1 \cdot \text{PJAPAN} + W_2 \cdot \text{PITALY} + W_3 \cdot \text{POTHER}$$

If VJAPAN, VITALY, and VOTHER denote the current-quarter values of the three import categories and

$$q_1 = \frac{\text{VJAPAN}}{\text{PJAPAN}}, \quad q_2 = \frac{\text{VITALY}}{\text{PITALY}}, \quad q_3 = \frac{\text{VOTHER}}{\text{POTHER}}, \quad \text{then}$$

the weights are defined as $W_i = \dfrac{q_i}{q_1 + q_2 + q_3}$ for i=1, 2,3.

Values for 1965 I - 1972 II are from Census end-use data. Values for 1964 are quarterly averages for 1965. Note that the W_i would be unaffected if the denominators of the q_i were all multiplied by the same tariff factors.

4.) Notes

a/ Exchange rates are quarterly averages of the monthly spot rates published in the Federal Reserve Bulletin. Monthly rates are averages of certified noon buying rates in New York for cable transfers.

b/ The export prices for Korea and Taiwan are Paasche (moving-weight) indices. Initial sources are Bank of Korea, Monthly Economic Statistics and Republic of China, Taiwan Financial Statistics Monthly.

Table A2: Description of Import Price Index and Value Deflator for CD

1.) Component Series

PJAPAN = Japanese (fixed-weight) export price index for durable consumer goods, from Bank of Japan publications, converted into dollars[a] and scaled to 1967=100.

PGERMANY = German (fixed-weight) export price index for all consumer goods and all destinations, from Statistisches Bundesamt Wiesbaden, Preise Löhne Wirtschaftsrechnungen, various issues. Quarterly averages of monthly prices, converted into dollars,[a] and scaled to 1967=100.

2.) Import Price Index

$$PMFOB = .1577PGERMANY + .8423PJAPAN$$

where weights reflect base-year (1967) relative shares in the value of total CD imports. PMFOB is multiplied by tariff factors (see Table A4) to get the explanatory variable used in our regressions.

3.) Import Value Deflator

$$DEFLATOR = W \cdot PGERMANY + (1-W) \cdot PJAPAN$$

where W is defined from current-quarter import values (VGERMANY and VJAPAN) as

$$W = \frac{\dfrac{VGERMANY}{PGERMANY}}{\dfrac{VGERMANY}{PGERMANY} + \dfrac{VJAPAN}{PJAPAN}}$$

Thus W and 1-W represent current-quarter quantity shares.

For quarters from 1960I to 1964IV, W was estimated from average values of VGERMANY and VJAPAN during 1965.

4.) Note

a/ See note a, Table A1.

Table A3: Description of Import Price Index and Value Deflator for FFB

1.) Component Series

UVMFD = unit value index for the economic class of manufactured foods, converted to 1967=100.

UVCRUDE = unit value index for the economic class of crude foods, converted to 1967=100.

2.) Import Price Index

$$PMFOB = .4403 \cdot UVCRUDE + .5597 \cdot UVMFD$$

Weights are relative shares of crude foods and manufactured foods in the value of total food imports in 1967.

PMFOB is multiplied by tariff factors (see Table A4) to get the explanatory variable used in our regressions.

3.) Import Value Deflator

$$DEFLATOR = w \cdot UVCRUDE + (1-w) \cdot UVMFD$$

If QCRUDE and QMFD are the Census Bureau quantity indices of imports of crude foods and manufactured foods (converted to 1967=100), then $.4403 \cdot QCRUDE$ and $.5597 \cdot QMFD$ are indices of the constant-1967-dollar values of these imports, and

$$w = \frac{.4403 \cdot QCRUDE}{.4403 \cdot QCRUDE + .5597 \cdot QMFD}$$

Table A4: Tariff Factors Prior to Normalization[a]

time period	FFB	CND	CD
1956 II	1.1859	1.3005	1.2527
1956 III - 57 II	1.1764	1.2901	1.2427
1957 III - 58 II	1.1669	1.2797	1.2327
1958 III - 62 II	1.1574	1.2693	1.2227
1962 III - 63 II	1.1420	1.2524	1.2064
1963 III - 64 II	1.1266	1.2355	1.1901
1964 III - 67 IV	1.1112	1.2186	1.1738
1968	1.1080	1.2125	1.1603
1969	1.1049	1.2064	1.1467
1970	1.1018	1.2000	1.1332
1971 I, II	1.0996	1.1939	1.1196
1971 III[b]	1.1496	1.2439	1.1696
1971 IV[b]	1.1885	1.2828	1.2085
1972	1.0955	1.1875	1.1061

Source: See subsection 3.2.

Notes: a/ The correct form of the tariff-inclusive price index is $\sum_j w_j \frac{pm_{jt}TF_t}{pm_{jo}TF_o}$ where the w_j are fixed weights, the pm are f.o.b. prices and the TF are tariff factors. Thus we multiply our f.o.b. price indices by TF_t/TF_o, or the above factors deflated by their 1967 base-period values.

Table A4 (continued)

Notes: b/ A 10 percent surcharge on import values applied from August 15 to December 20, 1971 -- for half of 1971 III and roughly 8/9ths of 1971 IV. For these quarters we calculated the tariff factors as $\left(1 + \tau + \frac{.10}{2}\right)$ and $\left(1 + \tau + \frac{.8}{9}\right)$ respectively, where τ denotes Wilson's estimated tariff rate.

Table A5: Description of Dock Strike Dummies

Our strike dummies are based on estimates of the ratio (R) of actual import volume (M) during any strike-affected quarter to the "normal" import volume that would have prevailed in the absence of a strike. If "normal" imports are explained by some behavioral relationship, f(income, prices, ...), then $M=R \cdot f$. Since $\log M = \log R + \log f$, $D = \log R$ is an appropriate strike dummy for use in our FFB and CND equations, and in equation (12b) we expect to estimate a coefficient (β_6) on D equal to one. For the CD case, our dependent variable is M, rather than log M, so we construct our strike dummy as $D = (R-1)M/R$, thereby satisfying $M = f + D$. Thus, in equation (26) we expect to estimate a coefficient (α_6) on D equal to one.

For strike-affected quarters we use the following values of R, based on Isard (1975). For all other quarters, R = 1.

		FFB	CND	CD
1959	III	1.0616	-	-
	IV	.9358	-	-
1962	III	1.0606	-	1.0398
	IV	.9672	-	.9784
1963	I	.9201	-	.9474
	II	1.0084	-	1.0055
1964	III	1.0594	1.0444	1.0391
	IV	1.0660	1.0494	1.0434
1965	I	.8094	.8574	.8746
	II	1.0272	1.0204	1.0179
1968	III	1.0520	1.0389	1.0342
	IV	.9718	.9789	.9815
1969	I	.7870	.8407	.8599
	II	1.1032	1.0772	1.0679
1971	III	1.0041	.9681	.8312
	IV	.8146	.8951	1.0271
1972	I	1.1126	1.0743	1.0355
	II	.9784	.9864	.9963

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