IMPACT OF DEMOGRAPHIC CHANGE ON INDUSTRY STRUCTURE IN AUSTRALIA

A joint study by the Australian Bureau of Statistics, the Department of Employment and Industrial Relations, the Department of Environment, Housing and Community Development, the Department of Industry and Commerce and the Industries Assistance Commission

ESTIMATION OF THE ELASTICITY OF SUBSTITUTION BETWEEN IMPORTED AND DOMESTICALLY PRODUCED INTERMEDIATE INPUTS

by

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The views expressed in this paper do not necessarily reflect the opinions of the participating agencies, nor of the Australian government.

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I. INTRODUCTION

Econometric estimates of the elasticity of substitution between imported and domestically produced goods are of interest to economists because the elasticity of substitution can be taken as a measure of the responsiveness of imports to changes in their prices and the prices of domestic substitutes. Hence estimates can provide some measure of the effectiveness of exchange rate manipulations in correcting balance of payments problems.

Additional interest in estimating the elasticity of substitution has been generated by Armington's (1969) trade model in which the elasticity of substitution features as an important parameter. His formulation is an advance over models in which the elasticity of substitution is implicitly assumed to be either zero or infinity (goods do not substitute at all or are perfect substitutes)[1] as it permits imperfect substitution.

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1. These assumptions are a feature of the Evans (1970, 1972) model of protection, and are critically appraised in Dixon and Butlin (1975).

Armington's model has led to the development of general equilibrium models in which the elasticity of substitution is an important parameter (for example : the Multilateral Exchange Rate Model of the IMF, the Trade Flow Model Project of the United States' Central Intelligence Agency (CIA), and the ORANI Module of the IMPACT Project).[1]

In this paper we shall develop a model to estimate the elasticity of substitution between imported and domestically produced intermediate inputs for use in the ORANI module. Estimating equations are derived from the production functions of the ORANI module by assuming that output is produced at minimum cost. In developing the econometric model, account is taken of the time sequence of ordering and production, producer expectations and the effect of the availability of domestically produced intermediate inputs on the demand for import substitutes.

The paper is organized as follows. Initially we shall discuss the effect of domestic bottlenecks on the demand for import substitutes, and the treatment of this phenomenon in import demand studies. In section III, the econometric model is developed and the remaining sections are concerned with the construction of various data series used.

II. DOMESTIC BOTTLENECKS AND IMPORT DEMAND

It is widely recognized that during periods of excess domestic demand, import demand increases independently of prices and domestic activity. The usual explanation provided for this phenomenon is that under conditions of excess demand, producers have difficulty in meeting their orders at ruling

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1. For an outline of the IMF model, see Artus and Rhomberg (1973); the CIA model is discussed in Goodman (1975); the main features of the IMPACT Project can be found in Powell and Lawson (1975), and the structure of the ORANI module is discussed in Dixon (1975).

prices, However, recognising the short term nature of this increased demand,[1] producers are reluctant to increase prices, and prefer to ration their output by increasing their delivery lags, with the direct effect of increasing queue lengths. Thus the consumer pays two prices for the good: the quoted price and the imputed cost of queuing. In an attempt to minimise total cost, the consumer may turn to imports. When this occurs, import demand is no longer fully explained by nominal prices and activity.[2]

In econometric work this problem has been overcome by incorporating a proxy variable for waiting time (actual or quoted) into the import demand equation. For example, proxies have been constructed from capacity utilization series[3] (Barker (1970), Gregory (1970), Ahluwalia and Hernandez-Cata (1975)), unemployment statistics (Talbot (1971), White and Thirwall (1974)), the difference between the ratio of actual to potential GNP and the desired ratio of actual to potential GNP (Parrish and Dilullo (1972), Ahluwalia and Hernandez-Cata (1975)) and the ratio of unfilled orders to current production (Gregory (1970)). In disaggregated studies, the proxy variable chosen is often one which is closely related to the cause of the bottlenecks.

The manner in which the quoted price and the imputed cost of waiting interact in the determination of imports was investigated by Gregory. He postulated that imports respond to effective prices, where

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1. It has been postulated that a ratchet mechanism operates for imports, that is, that imports caused by domestic bottlenecks tend to become permanent. This hypothesis was tested by Barker (1970) and White and Thirwall (1974). In both cases the hypothesis was rejected. A model which can be used to test this hypothesis is developed in section IV.

2. For a detailed discussion, see: Leamer and Stern (1970), pp. 13-14 and Gregory (1970).

3. For a discussion of the theoretical difficulties involved in defining the concept of capacity, see Klein (1960). The problems associated with the measuring capacity are discussed in Phillips (1963) and Evans (1969), pp. 255-256.

the effective price is defined as the actual quoted price weighted by all the factors which affect the availability of a particular commodity, for example waiting times (as quoted by suppliers) and trade credit restrictions.

Data on these non-price factors were unavailable; however, Gregory constructed proxies for the most important component, quoted waiting times. These proxies were based on the quotient of unfilled orders and current production and the lagged quotient of inventory levels and current production. Gregory was unable to construct an effective price series for imports, and his regression equation included the ratio of domestic effective prices to actual import prices. Gregory found that all regressions based on the effective price concept were significant. The econometric model which is developed in the next section includes the effective price concept.

III. THE ECONOMETRIC MODEL

The production functions of the ORANI module (Dixon (1975)) are of the Leontief type and can be written:

$$X_j = \min_i \left\{ \frac{x_{ij}}{A_{ij}} \right\} \qquad i,j = 1, \ldots, n \ , \qquad (1)$$

where:

X_j is the output of industry j ;

x_{ij} is the effective input (defined below) of good i into the production of good j ;

A_{ij} is the minimum amount of good i required to produce a unit of good j .

The concept of effective inputs is introduced to permit substitution between similar inputs drawn from different sources. The effective input is defined by a CES function:

$$X_{ij} = \left\{ \sum_s b_{isj} \, x_{isj}^{-\rho_{ij}} \right\}^{-\frac{1}{\rho_{ij}}} \tag{2}$$

where:

x_{isj} is the output of good i from source s into the production of good j ,

b_{isj} and ρ_{ij} are parameters ($b_{isj} > 0$; $\rho_{ij} > -1$) :

and the elasticity of substitution (ES) is given by

$\sigma_{ij} = 1/1+\rho_{ij}$.

Assuming that producers are efficient (that is, output is produced at minimum cost), input demand functions can be derived from:[1]

$$X_j = \frac{x_{1j}}{A_{1j}} = \frac{x_{2j}}{A_{2j}} = \ldots = \frac{x_{nj}}{A_{nj}} , \tag{3}$$

and the demands for inputs from each source can be obtained by solving n problems of the type:

Minimise : $\sum_s p_{isj} \, x_{isj}$;

Subject to:

$$X_j = \frac{\left\{ \sum_s b_{isj} \, x_{isj}^{-\rho_{ij}} \right\}^{-\frac{1}{\rho_{ij}}}}{A_{ij}} . \tag{4}$$

1. For a detailed discussion of the derivation of the ORANI demand equations, see: Caddy (1975).

In order to obtain a realistic econometric model, we must modify (4) to take into account changes in the technological coefficients over time, the time sequence of ordering and production, and the role of expectations about future supply and demand conditions in determining the quantity of imports ordered.

Technological change over time can be taken into account by postulating that:

$$A_{ijt} = A_{ijt_o} e^{\phi_{ij} t} \quad , \qquad (5)$$

where:

- A_{ijt} is the input-output coefficient in period t ;
- A_{ijt_o} is the input-output coefficient in the base period ;
- t is time ;
- ϕ_{ij} is a parameter reflecting the rate of growth of productivity of input i in producing output j .

We shall now consider the effect of expectations and delivery lags on the decision to import intermediate inputs.

Because of the ordering and delivery lag for imports, we shall assume that imports are ordered k time periods before the production period, (t), and that the domestically produced input is ordered g time periods before the production period, where $g < k$.

In the import ordering period $(t - k)$, it is assumed that the producer knows the price of the imported good and also that any imports ordered are delivered on time. At this time the producer does not know the price of domestically produced input in period (t - g) nor the ability of the domestic supplier to deliver his order in the production period. However, it is assumed that the producer in the import-ordering period has expectations about the price of the domestic input in (t - g), its availability and his level of production in period (t).

Using these expectations, and the known price of imports in (t - k), the producer determines his import orders and his expected orders of domestically produced inputs in (t - g). Both the expected price of the domestic good and its expected availability can be incorporated into one variable using Gregory's concept of an effective price.

This model of behaviour implies that the problem facing the producer of good j in the import ordering period for input i can be written:

$$\text{Minimise :} \quad \hat{\hat{P}}_{i1(t-g)}(t-k) \cdot \hat{x}_{ij1(t-g)}(t-k) + P_{i2t}(t-k) \cdot x_{ij2t}(t-k) \; ;$$

$$\text{Subject to :} \quad \hat{X}_{jt}(t-k) = A^{-1}_{ijt_o} \cdot e^{-\phi_{ij}t} \cdot \left\{ b_{ij1} \cdot \hat{x}^{-\rho_{ij}}_{ij1(t-g)}(t-k) + b_{ij2} \cdot x^{-\rho_{ij}}_{ij2t}(t-k) \right\}^{-\rho_{ij}} , \qquad (6)$$

where:

$\hat{\hat{P}}_{i1(t-g)}(t-k)$ is the expected effective price of the domestically produced good i in period (t-g) as viewed in the import-ordering period (t-k) ;

$P_{i2t}(t-k)$ is the price of the imported good in period t as quoted in (t-k) ;

$\hat{X}_{jt}(t-k)$ is the expected level of output in period t as viewed in period (t-k) ;

$\hat{x}_{ij1(t-g)}(t-k)$ is the expected order of the domestically produced input in period (t-g) for use in production in period (t) as viewed in period (t-k) ;

$x_{ij2t}(t-k)$ is the amount of the imported good required for production in period (t) as viewed in (t-k) .

This is a standard constrained optimization problem which can be solved by forming the Lagrangean function and solving the set of equations obtained from the first order conditions for a mimimum. The solution yields the following demand equations:

$$x_{ij2t}(t-k) =$$

$$A^{-1}_{ijt_o} \cdot e^{-\phi_{ij}t} \cdot \hat{X}_{jt}(t-k) \cdot \left\{ b_{ij1} \left\{ \frac{\hat{\hat{P}}_{i1(t-g)}(t-k)}{P_{i2t}(t-k)} \cdot \frac{b_{ij2}}{b_{ij1}} \right\}^{\frac{\rho_{ij}}{1+\rho_{ij}}} + b_{ij2} \right\}^{\frac{1}{\rho_{ij}}} ; \quad (7)$$

$$\hat{x}_{ij1(t-g)}(t-k) =$$

$$A^{-1}_{ijt_o} \cdot e^{-\phi_{ij}t} \cdot \hat{X}_{jt(t-k)} \left\{ b_{ij1} + b_{ij2} \left\{ \frac{\hat{\hat{P}}_{i1(t-g)}(t-k)}{P_{i2t}(t-k)} \cdot \frac{b_{ij2}}{b_{ij1}} \right\}^{-\frac{\rho_{ij}}{1+\rho_{ij}}} \right\}^{\frac{1}{\rho_{ij}}} . \quad (8)$$

Equation (7) expresses the demand for the imported good i for use by industry j as a function of the expected effective price of the domestic substitute in its ordering period (t - g) as viewed in the import ordering period (t - k), the price of the imported good in its ordering period (t - k), the expected level of output of industry j in period t as determined in the import ordering period (t - k), and the technology of industry j in the production period (t). Equation (8) expresses the expected use of the domestically produced substitute in period (t) as determined in period (t - k) in terms of the same factors as equation (7).

In addition, we can add to (7) and (8) the production function:

$$X_{jt} = A_{ijt_o}^{-1} \cdot e^{-\phi_{ij}t} \left\{ b_{ij1}\, x_{ij1t}^{-\rho_{ij}} + b_{ij2}\, x_{ij2t}^{-\rho_{ij}} \right\}^{-\frac{1}{\rho_{ij}}} . \qquad (9)$$

Equation (9) can be inverted to express the use of imports in terms of actual output and the actual use of the domestic input:

$$x_{ij2t} = b_{ij2}^{\frac{1}{\rho_{ij}}} \left(X_{jt}^{-\rho_{ij}} \cdot A_{ijt_o}^{-\rho_{ij}} \cdot e^{-\phi_{ij}t\rho_{ij}} - b_{ij1}\, x_{ij1t}^{-\rho_{ij}} \right)^{-\frac{1}{\rho_{ij}}} , \qquad (10)$$

where:

X_{jt} is the observed output of industry j in period (t) ;

x_{ij1t} is the actual use of domestic good i by industry j in period t ;

x_{ij2t} is the actual use of the imported substitute i by industry j in period (t) . $(x_{ij2t} = x_{ij2t}(t-k))$.

The available data on the use of input i from both sources is not classified by using industry. Therefore we must sum (7) and (8) over using industries to obtain a model consistent with the data:

$$\sum_j x_{ij2t}(t-k) =$$

$$\sum_j A^{-1}_{ijt_o} \cdot e^{-\phi_{ij}t} \cdot \hat{X}_{jt}(t-k) \left\{ b_{ij1} \cdot \left\{ \frac{\hat{\hat{P}}_{i1(t-g)}(t-k)}{P_{i2t}(t-k)} \cdot \frac{b_{ij2}}{b_{ij1}} \right\}^{\frac{\rho_{ij}}{1+\rho_{ij}}} + b_{ij2} \right\}^{\frac{1}{\rho_{ij}}} ; \quad (11)$$

$$\sum_j \hat{x}_{ij1(t-g)}(t-k) =$$

$$\sum_j A^{-1}_{ijt_o} \cdot e^{-\phi_{ij}t} \cdot \hat{X}_{jt}(t-k) \left\{ b_{ij1} + b_{ij2} \left\{ \frac{\hat{\hat{P}}_{i1(t-g)}(t-k)}{P_{i2t}(t-k)} \cdot \frac{b_{ij2}}{b_{ij1}} \right\}^{-\frac{\rho_{ij}}{1+\rho_{ij}}} \right\}^{\frac{1}{\rho_{ij}}} . \quad (12)$$

Equations (11) and (12) are relationships which determine the expected amounts of each input required by all using industries. If there were no inventories, these equations would represent demand functions for each input. However, since inventories of intermediate inputs or excess production can accumulate when expectation about demand in the previous production period is unrealised, (11) and (12) do not _a priori_ represent demand functions for inputs.

The motives for holding inventories are similar to the Keynesian motives for holding cash balances.[1] These are the speculative motive, the precautionary motive and the transactions motive. Speculative stocks are held if there is a possibility of profit through changes in prices or other supply and demand conditions. Precautionary inventories are held as a hedge against uncertainty. Transactions stocks are held because it is not possible to synchronise perfectly the inflow or outflow of goods.

Since the goods in question are intermediate inputs, it is reasonable to assume that the speculative motive is not an important factor determining the inventory policy of the firm with respect to its inputs. We shall also assume that in general the cost of stock holding and the conditions leading to shortages are such that the firm is unlikely to build up inventories as a hedge against supply bottlenecks. That is, we are assuming that by the time the firm is aware that shortages are imminent, it is pointless for it to attempt to order more of an input that is being rationed by queuing, in order to avoid disruption to production. In addition, since the firm can use import substitutes to avoid the effects of domestic bottlenecks, this must reduce any incentive to hold stocks of domestically produced inputs as a hedge.

The most important factor determining the firm's level of inventories of intermediate inputs is the transactions motive. There are two basic approaches to determining the level of these stocks.[2]

The first is the simplistic view that a given level of production required a minimum amount of inventories to avoid disruption. This minimum level is determined by technical factors which cause lack of

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1. See Arrow, Karlin & Scarf (1958), pp. 1-13.

2. Ibid.

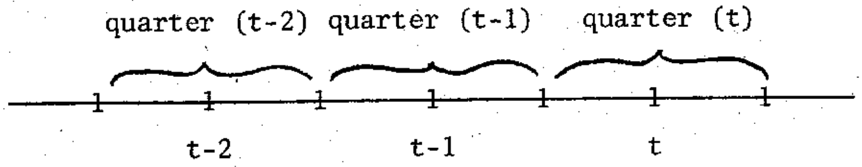
synchronisation. In this model, the level of inventories held at a given level of production is independent of the rate of interest and other economic factors. It is also assumed in this model that as the production level changes, all inflows and outflows change in the same proportion, hence it is assumed that the level of transactions stocks held is proportional to output.

The alternative view is more complex and realistic. In this view the level of transactions inventories is dependent on the procurement (or ordering) cost, the storage costs (which include the rate of interest), the per unit costs of the input (which are assumed to be independent of the amount ordered) and the level of production. The existence of the procurement cost provides an incentive not to order continuously. The usual assumption made in solving for the optimal inventory suggested by the conditions described above is that the inventory level is allowed to fall to zero before another order is made implying therefore that there is no ordering lag.

In discussing another inventory model, Baumol (1965) points out that it is more realistic to assume that the inventory level never falls to zero, but some minimum amount is held as a hedge against unexpected demands or delays in deliveries. These minimum reserves are of the same type as those discussed in the first example above, and can therefore be expected to vary in proportion to output. For our purposes, however, we shall assume that the producers aim to have a zero inventory level upon the arrival of a new quantity of previously ordered inputs.

Before proceeding further, we shall attempt to place values on the ordering lags g and k. For most Australian imports an ordering lag of one quarter is realistic. The domestic ordering and delivery lag however is much smaller than one quarter and it is closer to zero than to one. For the purposes of the model developed, it is assumed that $k = 1$ and g = 0.[1] We shall now consider how inventories of imported inputs can occur and how these affect the observed flow of imports.

The observations of the variables which enter our econometric equations are the total flows for each quarter, hence it is not appropriate to define the time subscripts and superscripts on the various variables as representing the <u>end</u> or <u>beginning</u> of a quarter; it is more appropriate to place them in the middle of the interval. This can be represented as follows:



Let us assume that the expectations on which orders for imported inputs for production in period (t-1) were based, are unrealised. The producer is then faced with an accumulation of unwanted stocks of imported inputs in (t-1). In this situation the producer would probably substitute some of the surplus stock of imported inputs for domestically produced inputs.[2] The remainder of the surplus would then form an unanticipated inventory of imported goods.

When ordering imports for use in the following period (t), his orders will be an amount which when added to the unwanted inventory of these goods will equal the quantity of the imported good which is required to produce the expected level of output in the following quarter.

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1. The assumption that there is a zero delivery lag for domestically produced inputs means that we are assuming that inventories of these goods do not accumulate as a result of unrealised expectations. Therefore, equation (12) <u>does</u> represent the expected demand for the domestically produced input.

2. This type of substitution can also occur in the other direction, that is domestically produced goods can substitute for imported goods when output exceeds expectations. In both cases the substitution will not be picked up in equations (11) or (12) because they are independent of the actual amounts of each input used in the production period. However, it will be detected in equation (10).

An alternative option open to the firm is to use the excess inputs to produce an inventory of finished goods which can be substituted for production in the following period. Whichever course is taken import orders for the following period will be less than the level implied by equation (11). We shall assume here that because intermediate inputs are cheaper to store than inventories of finished goods, the producers opt for the former option.

This implies the following relationship between the expected use of the imported input, the level of import orders and the surplus inventory of imported intermediate inputs:

$$x_{ij2t}(t-1) = m_{ijt}(t-1) + S_{ij(t-1)} \qquad S_{ij(t-1)} > 0 , \qquad (13)$$

where:

$x_{ij2t}(t-1)$ is the expected use of the imported input in period (t) as determined in period (t - 1), (this is defined by (7)) ;

$m_{ijt}(t-1)$ is the level of imports ordered in (t - 1) for use in period t ;

$S_{ij(t-1)}$ is the amount of the imported good left over (surplus inventory) from the previous quarter .

As mentioned, the surplus inventory is related to the extent to which expectations about production are realized, that is:

$$S_{ij(t-1)} = f(\hat{X}_{j(t-1)}(t-2) - X_{j(t-1)}) , \qquad \hat{X}_{j(t-1)}(t-2) > X_{j(t-1)} \qquad (14)$$

where:

$\hat{X}_{j(t-1)}(t-2)$ is the level of production of industry j expected from viewpoint (t-2) to prevail in (t-1) ;

$X_{j(t-1)}$ is the actual level of production of industry j in period t-1 ;

f( ) is a function which is restricted to a positive range .

Assuming that (14) can be approximated by a linear function, we can write:

$$S_{ij(t-1)} = \alpha_{ij}(\hat{X}_{j(t-1)}(t-2) - X_{j(t-1)}) \quad , \tag{15}$$

where:

$$\hat{X}_{j(t-1)}(t-2) > X_{jt-1} \text{ and } \alpha_{ij} > 0 .$$

The import demand function can now be written:

$$\sum_j m_{ijt}(t-1) = \sum_j x_{ij2t}(t-1) - \sum_j S_{ij(t-1)} \quad . \tag{16}$$

When $\hat{X}_{j(t-1)}(t-2) < X_{j(t-1)}$, it is assumed that the domestic input is substituted for the imported good. This does not, however, affect equation (12) which is an expression of what the expected use of the domestic input is in (t) as viewed in (t-1). This substitution will however be picked up in (10).

The estimation procedure for the complete model which is based on equations (10), (12) and (16) is discussed in the final section of the paper.

IV. SOURCES AND CONSTRUCTION OF DATA SERIES

Firstly, we shall discuss the sources of data which are actually observed. In the model developed, these are the price of the imported good in period t as quoted in (t - 1), the actual level of imports in period t (ordered in (t - 1)) and the level of output of industry j in period t. These series are being constructed within the Industries Assistance Commission (IAC).[1] Import prices can be related to the model by assuming that the actual landed price of imports is the quoted price in the ordering period.

We shall now consider the sources of series which are not directly observed. These are : the expected effective price of the domestically produced good in t as viewed in the import-ordering period (t - 1), the expected level of output in t as viewed in (t - 1), and the expected use of the domestically produced good in period (t) as viewed in (t - 1).

(a) Construction of the Expected Output and the Expected Domestic Input Demand Series

The only data series of producers' expectations which is available for the time period being considered is the Tendency Survey conducted by the Bank of New South Wales in conjunction with the Associated Chamber of Manufacturers (ACMA-BNSW). The questions in a typical survey are designed to obtain an assessment of current economic conditions, and to obtain information about current and anticipated changes in key economic indicators. A copy of the questionnaire is presented on page 17.

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1. These series are quarterly and span the period July, 1968, to June, 1975. The price indexes are based on unit values. A discussion of the method of construction, sources of basic data and limitations of these indexes will be available on completion of the IAC project.

SURVEY OF INDUSTRIAL TRENDS IN AUSTRALIA

Please return to:
ECONOMIC DEPARTMENT,
BANK OF NEW SOUTH WALES,
BOX 1, G.P.O.,
SYDNEY, N.S.W. 2001

Conducted jointly by
THE ASSOCIATED CHAMBERS OF MANUFACTURES OF AUSTRALIA
and
BANK OF NEW SOUTH WALES

No. 51

JUNE 1974

Please tick appropriate answers, if questions not applicable, please write N/A. If your company is a multi-unit or multi-product organisation, you may wish to report on the separate sections of your activities; further forms will be supplied on request.

A. In which one of the following activities is your company principally engaged?

(1) ☐ Food, beverages, tobacco.
(2) ☐ Textiles, fabrics, floor coverings, felt, canvas, rope.
(3) ☐ Clothing, footwear.
(4) ☐ Wood, wood products, furniture.
(5) ☐ Paper, paper products, printing.
(6) ☐ Chemicals, paints, pharmaceuticals, soaps, cosmetics, petroleum and coal products.
(7) ☐ Non-metallic mineral products: glass, pottery, cement, bricks.
(8) ☐ Basic metal products: processing, smelting, refining, pipes and tubes.
(9) ☐ Fabricated metal products: structural and sheet metal, coating and finishing, wire, springs, hand tools.
(10) ☐ Transport equipment: motor vehicles and parts, excluding repairs; rail, ship or aircraft, including repairs.
(11) ☐ Other machinery and equipment: electrical, industrial, scientific, photographic.
(12) ☐ Miscellaneous: including manufactures of leather, plastic and rubber, sporting equipment, jewellery.

B How many employees are covered by this return?
1-50 (1) ☐ 51-200 (2) ☐ 201-1000 (3) ☐ Over 1000 (4) ☐

C In which State is the main production to which this return relates?
W.A. (1) ☐ S.A. (2) ☐ Vic. (3) ☐ N.S.W. (4) ☐ Qld. (5) ☐ Tas. (6) ☐

D In which one of the following product classifications is your firm principally engaged?

(1) ☐ Appliances, etc.
(2) ☐ Furniture
(3) ☐ Clothing
(4) ☐ Food
(5) ☐ Other consumer goods
(6) ☐ Producers' equipment
(7) ☐ Producers' materials
(8) ☐ Automotive (vehicles, parts, fuel, etc.)
(9) ☐ Other

1 Do you consider that the general business situation in Australia will improve, remain the same, or deteriorate during the next six months?
Improve (1) ☐ Same (2) ☐ Deteriorate (3) ☐

2 Are you working at a satisfactorily full rate of operation?
(1) Yes ☐ (2) No ☐

3 What single factor, if any, is most limiting your ability to increase production?
(1) orders ☐ (2) materials ☐ (3) finance ☐ (4) labour ☐ (5) capacity ☐ (6) other ☐

4 Do you find it is now harder, easier, or the same as it was three months ago to get:

	(1) Harder	(2) Same	(3) Easier
(a) labour	☐	☐	☐
(b) finance	☐	☐	☐

5 Do you expect your company's capital expenditure during the next twelve months to be greater, the same, or less than in the past year:

	(1) Greater	(2) Same	(3) Less
(a) on buildings	☐	☐	☐
(b) on plant and machinery	☐	☐	☐

PAST AND FUTURE TRENDS

Excluding normal seasonal changes, what has been your company's experience over the past three months and what changes do you expect during the next three months in respect of:

		Change in position during the PAST THREE MONTHS			Expected Change during the NEXT THREE MONTHS		
		(1) Up	(2) Same	(3) Down	(1) Up	(2) Same	(3) Down
6	Numbers employed	☐	☐	☐	☐	☐	☐
7	Overtime worked	☐	☐	☐	☐	☐	☐
8	All new orders received	☐	☐	☐	☐	☐	☐
9	Orders accepted but not yet delivered	☐	☐	☐	☐	☐	☐
10	Output	☐	☐	☐	☐	☐	☐
11	Average costs per unit of output	☐	☐	☐	☐	☐	☐
12	Average selling prices	☐	☐	☐	☐	☐	☐
13	Export deliveries	☐	☐	☐	☐	☐	☐
14	Stocks of raw materials	☐	☐	☐	☐	☐	☐
15	Stocks of finished goods	☐	☐	☐	☐	☐	☐

If you wish your reply to remain anonymous please detach this slip, after completing it, and return it separately.

Name of Company .... Signature..

The survey results were originally classified into eight industry groups; however the classification was expanded into twelve industry groups based on the ASIC classification in the June quarter of 1974. This does not constitute a break in the series because the additional classifications are based on industry groups contained in the original classification. In addition, the industry coverage has remained the same and the number of respondents for each question is listed. Therefore, series based on the original eight way classifications can be calculated for the period after March, 1974.[1]

The survey is distributed in the last two weeks of each quarter, and questions asked concern changes in the past quarter and anticipated changes in the following quarter. In order to use the questions on expected changes, we must therefore assume that the expectations expressed at the end of a quarter prevailed during all of the quarter.

All of the questions concerned with changes require only 'up' or 'down' or 'the same' as an answer, and this information is converted into index form by subtracting the number of 'downs' from the 'ups' and dividing by the total number of responses. When converted to percentage form, this measure is called a diffusion index (DI).

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1. The eight industry classifications are : (1) Treatment of Non-Metal Minerals (cement, bricks, pottery, glass), (2) Chemicals (paint, oils, pharmaceuticals), (3) Engineering (machinery, iron and steel, electrical, industrial metals), (4) Vehicle Construction and Repair (rail, bus, motor, ship, aircraft), (5) Textiles (leather, clothing), (6) Food (drink, tobacco), (7) Paper (printing, cardboard), (8) Miscellaneous (including manufactures of wood, rubber, plastics).

The main use of this index in the past has been to provide a preliminary estimate or a forecast of changes in published output indexes.[1] It has been shown that the best correlation between a DI and a conventional economic index is obtained when the DI is correlated with the percentage change in the conventional index.[2]

In constructing the $\hat{X}_{jt}(t-1)$ and $\sum_j \hat{x}_{ij1t}(t-1)$ series we shall use the diffusion index calculated for the question on expected change in output, one quarter into the future. As mentioned, the available data on the use of intermediate inputs do not permit individual indexes to be compiled for each using industry, only aggregate data are available. In fact, the index of the domestic use of a particular input i is essentially an index of the output of this industry.

In constructing the $\sum_j \hat{x}_{ij1t}(t-1)$ series, we make the assumption that the output of a supplying industry is equal to the demand of all the using industries.[3] In addition, it is assumed that the expected change in output of the supplying industry (as measured by the DI) mirrors the expected change in the aggregate demand of the using industries. This latter assumption is tantamount to assuming that when suppliers were asked about their expected output (in the survey), they would have used information,

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1. For a detailed discussion of the ACMA-BNSW survey procedure, and the usual quantitative and qualitative uses to which the survey has been put, see: Kerr (1973) and Blyth (1967). Similar surveys are conducted in the United Kingdom (Central Statistical Office (1965)) and New Zealand (Gillion (1964)).

2. See: Theil (1961), Chapter 4 and Central Statistical Office, ibid.

3. This assumption is not valid for intermediate inputs which are exported and/or enter final demand. As export data are available, domestic data can be obtained by subtracting exports from domestic output. Intermediate inputs which enter final demand pose a problem which will be tackled at a later stage of the project.

then current, to estimate how the then current conditions would affect the demand for their product, and that their expectations are similar to those of the industries they supply.

The $\hat{X}_{jt}(t-1)$ and $\sum_j \hat{x}_{ij1t}(t-1)$ indexes can be constructed from the actual output series using the corresponding DI for each industry as follows:

$$\hat{X}_{jt}(t-1) = I_{j(t-1)} (1 + DI_{j(t-1)}) \quad , \tag{17}$$

$$\sum_j \hat{x}_{ij1t}(k-1) = I_{i1(t-1)} (1 + DI_{i1(t-1)})^{1} \quad , \tag{18}$$

where:

$I_{j(t-1)}$ is an index of the output of the using industry j ;

$DI_{j(t-1)}$ is the diffusion index of the expected output change between the periods (t-1) and t, as calculated from the survey distributed at the end of period t-1 ;

$I_{i1(t-1)}$ is an index of the output of industry i which produces a good which has an import substitute ;

$DI_{i1(t-1)}$ is the diffusion index of the expected output change between the periods (t-1) and t for industry i, as calculated from the survey distributed at the end of period (t-1) .

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1. The question in the survey questionnaire from which the diffusion indexes used in (17) and (18) are calculated are worded so as to exclude seasonal variation. Therefore, for consistency, $I_{j(t-1)}$ and $I_{i1(t-1)}$ should be deseasonalized.

(b) The Expected Effective Price Series

The construction of the expected effective price series involves two stages -

(i) The construction of the expected price series.

(ii) The development of proxies for quoted waiting time which can be used to weight the effective price series when the availability of domestically produced inputs is affecting production.

Generally, we can postulate that the expected price of a good is some function of historic and current prices:

$$\hat{P}_{i1t}(t-1) = (P_{i1(t-1)}, \ldots, P_{i1(t-i)}, \ldots, P_{i1(t-m)}) , \tag{19}$$

where:

$\hat{P}_{i1t}(t-1)$ is the expected price of domestic input i in period t as determined in period (t-1) ;

$P_{i1(t-i)}$ is the observed price of the domestically produced input in period (t-i) .

Expected prices are usually estimated by taking a weighted average of historic prices, however in periods when prices are rising quickly, producers may discount heavily the probability that prices pertaining in the immediate past will be sustained. That is, they will expect prices to rise even further. In this type of situation, a sliding least-squares projection is probably a better guide to producers' expectations that is a weighted average of past observations. A linear sliding trend projection model can be written:[1]

$$\hat{P}_{i1t}(t-1) = \sum_{h=1}^{m} \{2\ (2m + 1) - 6h/[m(m - 1)]\}\ P_{i1(t-h)}\ , \qquad (20)$$

where m is the number of observations used in forming the sliding trend projection.

In order to construct a proxy for the quoted waiting time for domestically produced intermediate inputs, the factors which affect the ability of producers of these goods to meet their orders must be identified. These factors depend on the type of industry. For example, an oligopolistic industry which has chronic excess capacity is more likely to be affected by shortages of materials (including labour) than by capacity.[2] We shall attempt to construct a proxy for quoted waiting times which is based on all the important factors which affect a domestic suppliers' ability to expand production.

In the ACMA-BNSW survey, producers are asked to identify which single factor is most limiting their ability to increase production. The respondents have a choice of six categories: (i) orders, (ii) materials, (iii) finance, (iv) labour, (v) capacity, (vi) other. The survey is available in a form which gives the proportions of replies for each category classified by industry groupings. The replies to this question given by producers of intermediate inputs should be related to the ability of the industry to meet its orders and hence the waiting times generally quoted to the users of its output.

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1. This model was used by Powell and Gruen (1967) in their econometric study of beef supply. For a discussion of an exponential extrapolative model, see Powell (1974), pp. 132-135.

2. For a discussion of this point, see Klein (1960).

Let us denote the proportion of replies which indicate that orders are limiting production as p and the proportion of all others as q, $(p + q = 1)$. When orders are not limiting production we can expect the magnitude of q to reflect the effect of all other factors on waiting times, that is when $p < .5$ we would expect waiting time to increase as q increases. Therefore we shall use q, when $q > p$ to construct a proxy for waiting times.

Since we need a proxy for expected waiting time, we shall assume that producers form their expectations on the basis of current experience, that is, expected waiting time in period t is some function of the waiting time in (t-1); therefore our proxy for expected waiting time in period t is some function of q_{t-1}.

Because we would not expect waiting time to be linear in (or linear in algorithms of) q, an exponential function with a non-linear exponent would be a suitable transformation. The proposed functional form of the variable part of the exponent is as follows:

$$Z_t = \begin{cases} 0 & q_{t-1} \leqslant .5 \\ \dfrac{q_{t-1} - .5}{1 - q_{t-1}} & .5 < q_{t-1} < 1 \end{cases} \qquad (21)$$

The waiting time proxy can now be written:[1]

$$W_t = e^{\theta Z_t} , \qquad (22)$$

where:

1. The main advantages in constructing a proxy for expected waiting-time in this manner are: (i) the problems associated with identifying and measuring important supply affecting factors for each industry which produces import competing intermediate inputs are avoided, and (ii) only one parameter is required to capture the effects of all important factors.

W_t is the proxy for expected waiting-time in period (t) as viewed in (t-1); and

Θ is a parameter $(\Theta \geqslant 0)$.

(Graphs of W_t and q for different values of Θ are plotted in Figure 1.)

The expected effective price is formed by weighting the expected price by the waiting-time proxy:

$$\hat{\hat{P}}_{ilt}(t-1) = \hat{P}_{ilt}(t-1) \, . \, e^{\Theta Z_t} \quad . \tag{23}$$

The value of q for each quarter from March, 1966, to June, 1967, for each industry grouping is plotted in Figures 2(a) to 2(h). An examination of these graphs reveals that for all industries q > . 5 for the period June, 1973, to June, 1974, with some industry groups having q > . 5 prior to June, 1973, and or persisting beyond June, 1974. This corresponds to a period in which it is known that bottleneck conditions were prevalent. This must lend some support to our choice of q > . 5 for the operation of the waiting-time proxy.

There are other periods prior to June, 1974, which exhibit values of q > . 5 ; these are between . 5 and . 75, the majority being between . 5 and . 6. These values are low compared to those in the major bottleneck period. An examination of Figure 1 indicates that these periods will have a low weight attached to them, indicative that the model will predict that there was only a small stimulus to imports from prevailing domestic supply conditions.

Figure 1

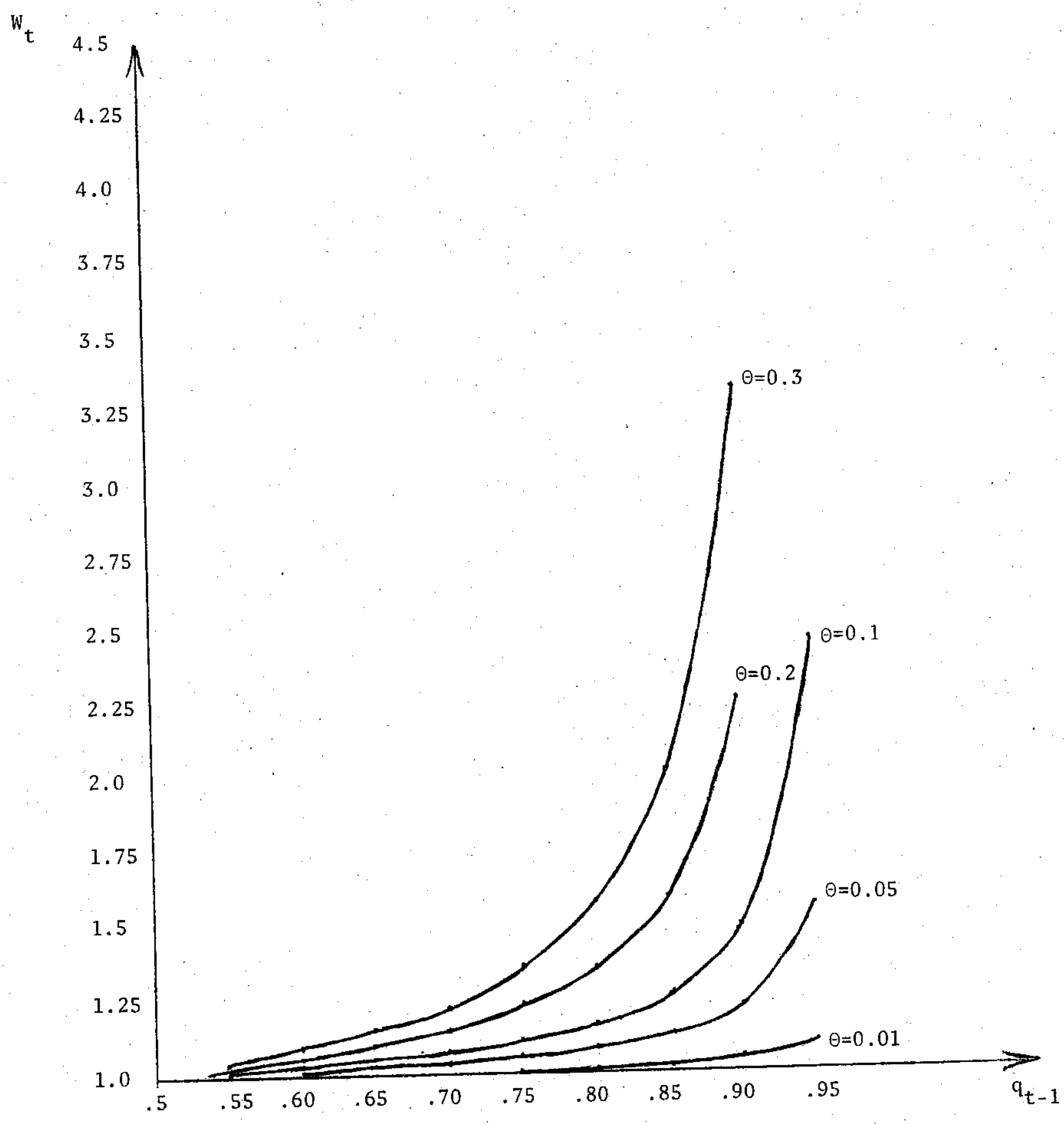

W_t
4.5
4.25
4.0
3.75
3.5
3.25
3.0
2.75
2.5
2.25
2.0
1.75
1.5
1.25
1.0
.5
.55
.60
.65
.70
.75
.80
.85
.90
.95
q_{t-1}
Θ=0.3
Θ=0.1
Θ=0.2
Θ=0.05
Θ=0.01

Figure 2 (a) TREATMENT OF NON-METAL MINERALS

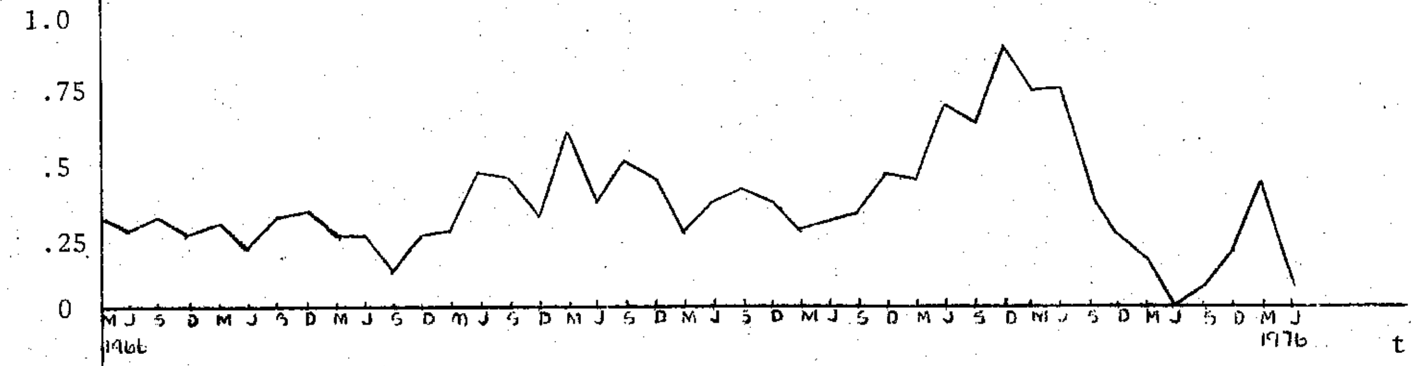


Figure 2 (b) CHEMICALS

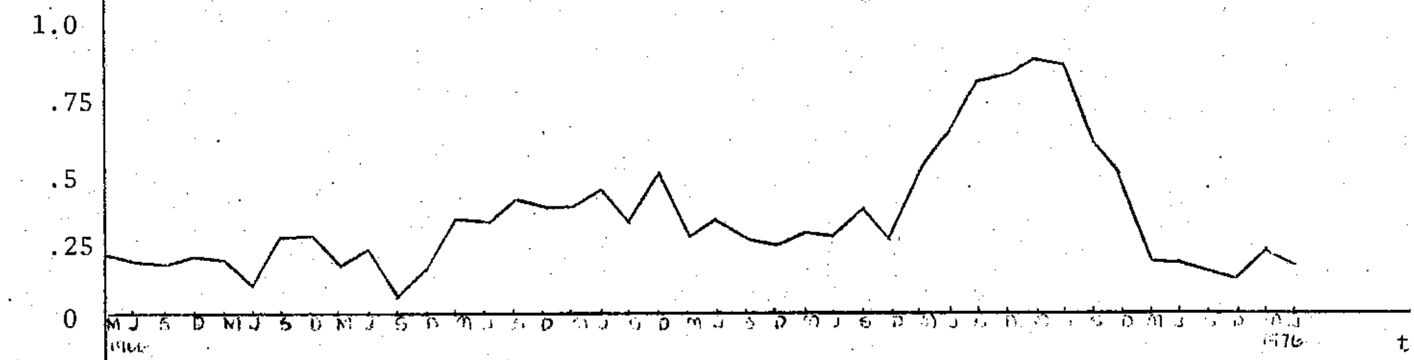


Figure 2 (c) ENGINEERING

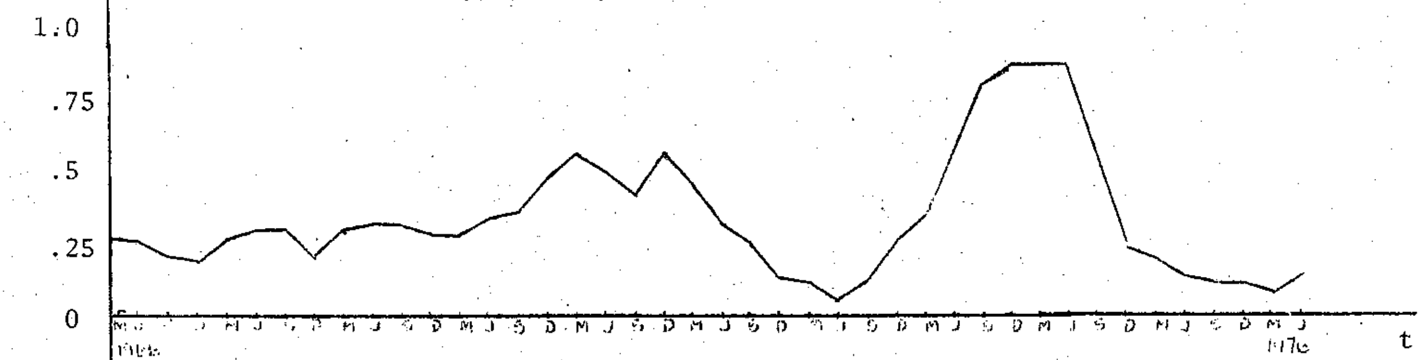


Figure 2 (d) VEHICLE CONSTRUCTION & REPAIR

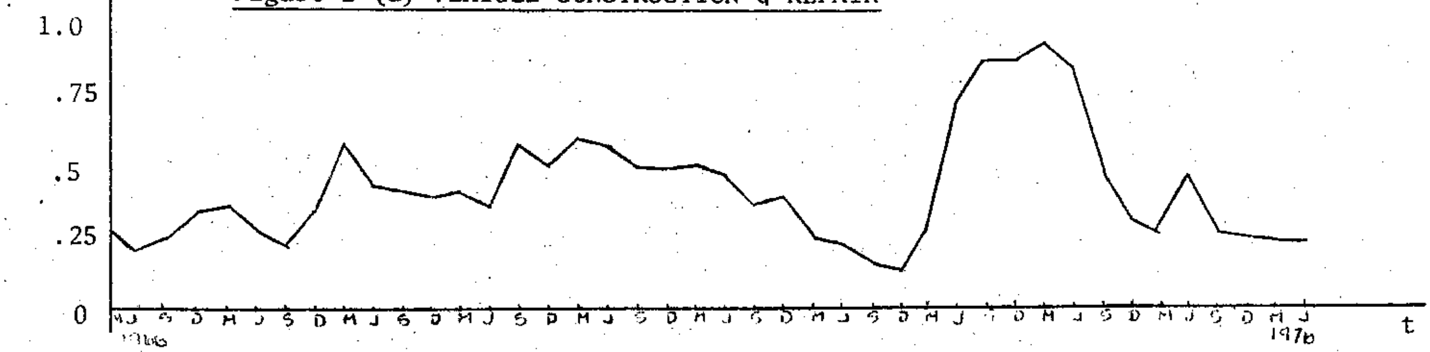


Figure 2 (e) TEXTILES

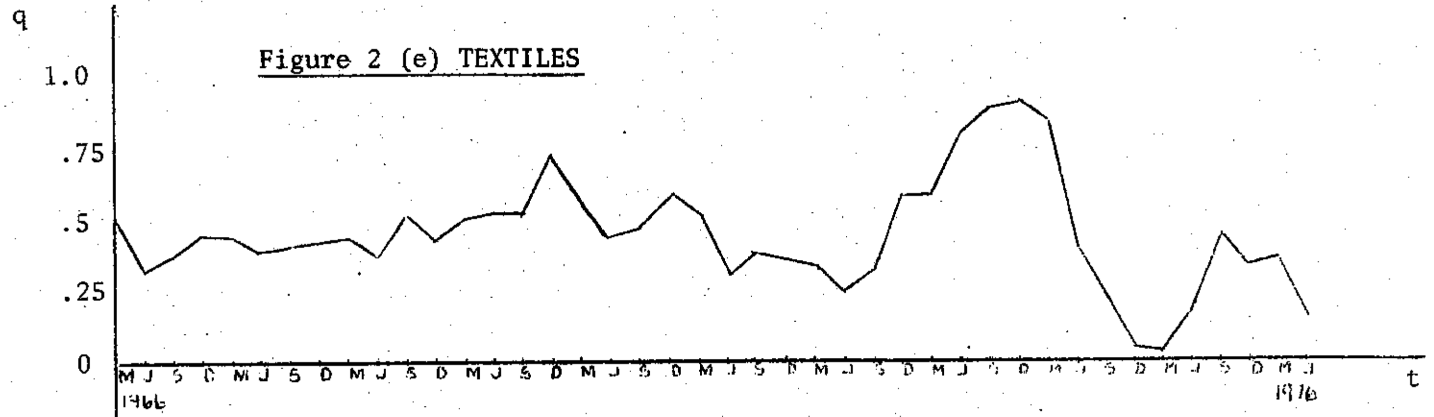


Figure 2 (f) FOOD

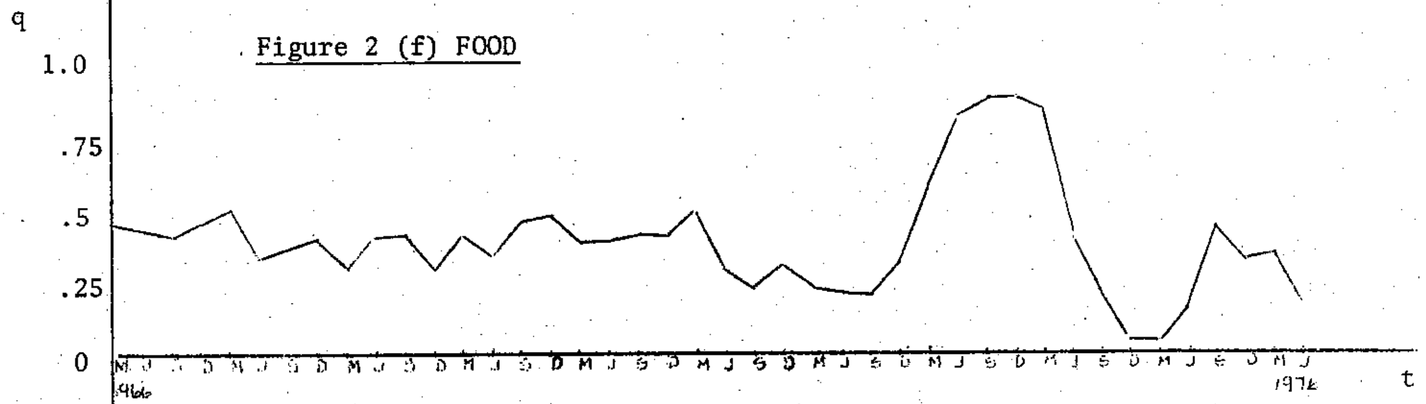


Figure 2 (8) PAPER

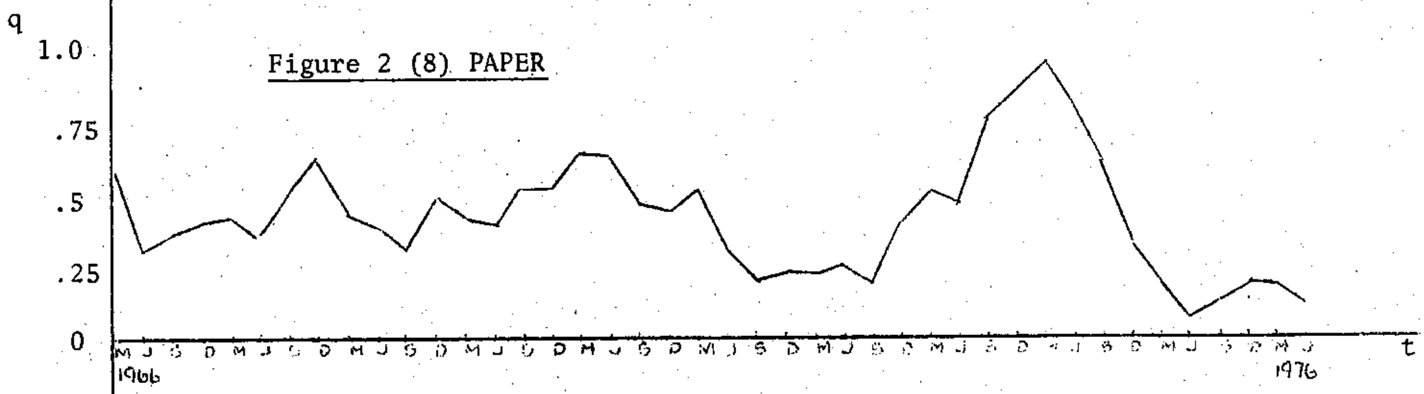
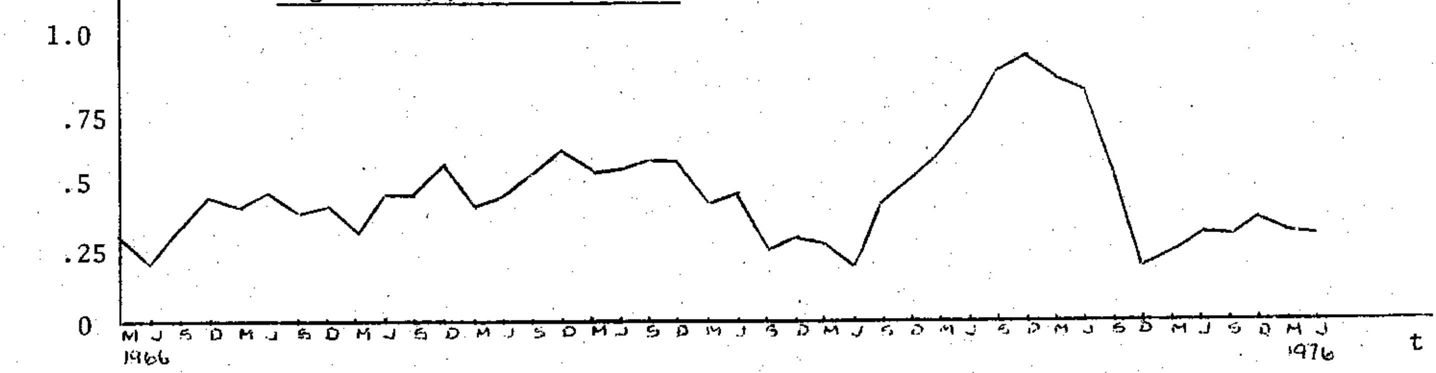


Figure 2 (h) MISCELLANEOUS



The waiting-time proxy developed above can also be used to construct a variable which can be used to test the hypothesis that a ratchet mechanism operates for imports, that is, imports caused by domestic bottlenecks tend to become permanent (see footnote 1, page 3). This variable can take the form:

$$R_t = e^{\beta Y_t} , \qquad (24)$$

where:

R_t is a variable which represents the cumulative effect on imports of previous bottlenecks ;

and

β is a parameter ;

Y_t is a weighted sum of all previous values of the variable part of the exponent of the waiting-time proxy; that is:

$$Y_t = \sum_{\tau=2}^{t} Z_{\tau-1} \, w(t - \tau) , \qquad (25)$$

in which the weights $w(t - \tau)$ would decline monotonically with $(t - \tau)$.

V. PLANNED APPROACH TO ESTIMATION

It is anticipated that the elasticity of substitution will be estimated from two systems of simultaneous non-linear equations based on equations (10), (12) and (16) (after substitution from (7)), which were derived in section III. In cases where there is only one using industry, equations (10), (12) and (16) will be treated as a system within which to estimate the elasticity of substitution. When there is more than one using industry, equations (12) and (16) constitute the system for estimation; the deletion of (10) in this case reflects data availability. The information required to determine which set of equations is applicable can be obtained from the input-output tables.

Where the number of using industries is large, some simplifying assumption will have to be made in order to reduce the number of parameters. For example, it could be assumed that for similar industries the CES parameters b_{ij} and ρ_{ij} are the same for each type of input.[1]

It is anticipated that all computations will be carried out using the ASIMUL and RESIMUL packages developed by C. R. Wymer. These programs can calculate full information maximum likelihood estimates of a general non-linear system of equations with any restrictions on parameters (both within and across equations). The programs use a Newton-Raphson iterative procedure to maximise the likelihood function.[2]

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1. Using industries could be grouped together on the basis of type of output; for example, it could be assumed that the parameters b_{ij} and ρ_{ij} are equal for all industries producing consumer durables.

2. C. R. Wymer (1973), Computer Programs : Asimul Manual, London School of Economics, pp. 29 (mimeo); Computer Programs : Resimul Manual, London School of Economics, pp. 25 (mimeo).

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