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

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THE CONSTRUCTION OF PRICE AND QUANTITY INDEXES FOR AUSTRALIAN TRADE FLOWS

by

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PREFACE

As part of the Industries Assistance Commission's study of Australian trade flows (hereafter referred to as IMPORT), merchandise imports and exports since July 1968 have been classified to 4 digit ASIC codes. Two types of index numbers are computed. These are unit value and quantity indexes. The index movements from one period to another have been constructed according to the Fisher formula and the indexes chained into a continuous series. The indexes will be available on a monthly, quarterly and annual basis and will ultimately cover most 4 digit ASIC codes. There also exists the capability to compute indexes for higher levels of industry aggregation, such as Input-Output industries or 2 digit ASIC codes.

One major issue of interest is the vetting of movements in unit values. Should all movements in unit values be included in the 'price' index or should large movements be excluded on the basis that such movements reflect changes in the quality rather than the price of the commodities? Is this question relevant for indexes based on the Fisher formula?

Because of the immediate relevance of this study to the IMPACT project, the current report is included in the project's working paper series. In due course it is planned to publish the series of indexes for general use.

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1. INTRODUCTION

Over the past year, there has been a major effort by the IAC in Canberra to assemble the data required for a detailed study of Australian trade flows. The intention was to compile quarterly price and quantity indexes for the seven-year period 1968-69 to 1974-75 for domestic, imported, and exported goods classified by 4 digit ASIC codes. Since all (available) source data are given on a monthly basis, monthly indexes have also been constructed. This paper describes the construction of price and quantity indexes for Australian imports and exports.

The immediate purpose of compiling the data bank is to analyse the sensitivity of imports flows to changes in activity levels and the relative prices of imported and domestic goods. However, the data are relevant to a wide range of issues of interest to the Commission, including the analysis of export flows and patterns of intra-industry trade.[2]

Despite the importance of trade to the economy there has been - to date - little analysis of the patterns or determinants of Australia's imports and exports.[3] With the exception of wheat, wool and other primary commodities, there are virtually no analyses of import and export flows at the industry level. The paucity of quantitative analyses of Australia's trade can be traced directly to the limitations of official statistics on movements in the prices and volumes of imports and exports and the extreme difficulty in compiling these data.

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1 This phase of the IMPORT project has drawn heavily on the tariff and statistical expertise of Neil Roger and other colleagues in the Commission and the ABS statistical outpost.

2 See IAC Annual Report, 1975-76, Ch. 2.

3 For a recent analysis of Australian import demand at a disaggregated level see Gregory and Martin (1976). This study classifies import flows by tariff level rather than by industry. For an analysis of import demand for one manufacturing industry see Marsden (1973).

In common with trade statistics of other countries, import and export price information is not available and unit values must be used to indicate price movements.[4] Because unit values can vary with changes in quality and commodity composition as well as with price changes, they are generally not considered to be good indicators of price. Moreover, for those commodity classifications which are heterogeneous (for example, "machinery not elsewhere included"), quantity information cannot be compiled. The extent of these two difficulties can be reduced by disaggregation since the more detailed the commodity classification, the more likely it is that the quantity data required to calculate unit values will be recorded consistently and that the commodities will be relatively homogeneous.

Following directly from the disaggregated approach adopted here, three claims can be made for the data. First, the use of the most detailed possible commodity classifications in the construction of the indexes should reduce the familiar problems associated with the use of movements in unit values in approximating movements in prices.[5] Second, it provides for the first time, at a highly disaggregated level, information on movements in the prices and quantities of imports and exports. Third, the allocation of exported and imported commodities to the domestic industries in which they were (or could be) produced is considered to be more accurate than any previous attempts.

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4 The alternative of using wholesale price indexes in the exporting countries as a measure of import prices is not practicable at the fine level of industry disaggregation; the detailed knowledge required on the time lag between production in each exporting country and arrival in Australia further reduces the feasibility of this approach. Moreover, the possibility of international price discrimination raises the question of whether movements in wholesale price indexes in the country of export are representative of movements in export prices of commodities entering world trade. For an empirical comparison of import price indexes based on unit values and import price indexes based on wholesale price indexes in the exporting countries see Goodman (1975). His results suggest that there is no reason to suppose that unit value indexes generally are better or worse than import price indexes based on reweighted wholesale price indexes. The judgement appears to depend upon the circumstances of each case.

5 When assessing the import price indexes described here against the criticisms of unit value indexes voiced by official bodies such as the United Nations (1975) it should be noted that the criticism is generally directed at unit value indexes based on 4 digit items of the Standard International Trade Classification (SITC), ie approximately 600 items. In contrast the unit values used here are based on more than 10 000 tariff item-statistical keys (TI*SK). Nonetheless, even at this level of disaggregation, quantity information is available only for 60 to 80 per cent of items.

Price and quantity indexes of merchandise imports and exports by industry were compiled for the period July 1968 to June 1975. The preferred indexes are variable weight, continually rebased, chained indexes with movements between consecutive periods described by Fisher Ideal Index numbers.

The export indexes refer to the (4 digit) ASIC class in which the commodities were primarily produced and are available for most ASIC classes. Similarly, imports were classified by the ASIC class in which they would have been primarily produced had they been produced in Australia. The use of (4 digit) ASIC classes permits the data and indexes to be obtained for Input-Output categories and higher levels of aggregation.

The following section assesses the currently available statistics on the prices and volumes of Australian import and export flows. Section 3 describes the basic data used in the current study. Sections 4 and 5 describe the commodity/industry concordances and tariff histories. Data preparation is described in section 6. Section 7 describes the historical linking of data for index calculation. The index number formulae and their interpretation are discussed in section 8. Section 9 considers the effects on the indexes of extreme unit value movements. The final section outlines the direction of planned future research.

2. OFFICIAL STATISTICS ON PRICES AND VOLUMES OF TRADE FLOWS

Statistics on prices and volumes of imports and exports are available from two official sources.

The Reserve Bank of Australia compiles an import price index by aggregating with base period weights wholesale and/or export price indexes for countries exporting to Australia.[6] This index is available for eight commodity groups (or five countries/regions) on a monthly basis, and the base period is 1966-67. The Australian Bureau of Statistics (ABS) compiles estimates of exports and imports of merchandise at constant prices on a quarterly basis for seven import commodity groups and six export commodity groups.[7] These volume estimates are compiled by revaluing quantities in successive periods by base period prices.[8] From the volume estimates implicit price indexes can be derived by dividing the current value series by the values at constant prices. The ABS also publishes a fixed weight export price index covering nine commodity groups.[9]

The Reserve Bank's import price index and the various ABS series are useful indicators of broad movements at the aggregate level but are deficient from other points of view.

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6 Reserve Bank of Australia, Statistical Bulletin, Sydney, monthly.

7 Australian Bureau of Statistics, Exports and Imports of Merchandise at Constant Prices, reference 8.22, Canberra, quarterly.

8 For example, the value of imports in period 1

$$V_1 = \Sigma p_1 q_1$$

is expressed in terms of constant (period 0) prices by substituting base period prices for the period 1 prices.

Thus $V_1^* = \Sigma p_0 q_1$

where V^*_1 is the value of imports in constant (period 0) prices.

In practice the quantity revaluation method uses unit values rather than prices. Traditionally, quantity revaluation has been the main method adopted by the ABS to obtain constant price estimates of economic aggregates. However, with the recent development of comprehensive price index series, price deflation is becoming more important as a method.

9 Australian Bureau of Statistics, Export Price Index, reference 9.2, Canberra, monthly.

First, the high level of aggregation and the fact that they are based on commodity rather than industry classifications, means that these series do not provide an adequate basis for analysing the relationship between changes in trade flows and the pattern of industry structure and development in Australia. Second, the coverage of the ABS import series in the commodity groups, "metal manufactures, machinery and transport equipment" and "other manufactures" is low - commodities directly revalued accounting for less than 40 per cent of the total value of imports in those groups. The ABS indexes are therefore less reliable for those commodity groups where imports are most important.[10] Third, the use of wholesale and export price indexes of exporting countries to approximate movements in the prices of imports into Australia is subject to a number of specific criticisms and one must concur with the Reserve Bank's statement[11] that short term movements in the index and inter-country comparisons should be treated with caution.

Finally, comparisons of the movements in the fixed weight import and export price indexes with movements in the (current weighted) implicit price indexes indicate that the (1966-67) weighting bases of the fixed weight indexes are becoming increasingly less relevant to current circumstances.

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10 See, Australian Bureau of Statistics, <u>Exports and imports of merchandise</u>, op. cit.

11 Reserve Bank of Australia, Submission to the Joint Parliamentary Committee on prices, 1973.

3. DATA SOURCES

3.1 Export data tapes

There is only one published source of export statistics, namely ABS Overseas Trade which uses the Australian Export Commodity Classification (AECC). The ABS has provided the 'deconfidentialised' copies of the computer tapes from which this publication is produced. The tapes record the value of exports on a free on board (fob) port of shipment basis for each of the 2300 AECC items.

The tapes also distinguish exports by country of destination. This information is not immediately relevant to current purposes and has therefore been deleted in order to reduce the size of the tapes.[12]

3.2 Import data tapes

The ABS Imports Cleared for Home Consumption data were preferred to the imports series in ABS Overseas Trade as the basic data source for three reasons, namely:

- . the more detailed commodity classification,
- . the more relevant timing of the recording of imports, (clearances as against landings)
- . the ability to identify the duty paid for each commodity.

The commodity classification used in Imports Cleared for Home Consumption is the Customs Tariff which is based on the Brussells Tariff Nomenclature. The basic unit of commodity classification for imports is therefore the tariff item. Within each tariff item there is a further disaggregation in terms of statistical keys. The data on imports for each month is therefore defined in terms of more than 10 000 tariff item/statistical keys (TI*SK).

The ABS has provided the 'deconfidentialised' copies of the computer tapes used to produce ABS Imports Cleared for Home Consumption for the years 1968-69 to 1975-76. The tapes contain monthly information classified by TI*SK showing values (duty paid), and quantities of imports, and the ABS economic class.

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12 Further reductions in the size of the tapes were achieved by deleting annual data and by compacting storage space for value and quantity records. A significant proportion of the exports data is classified as 're-export'. Provision has been made to optionally include or exclude such commodities from the final export indexes.

The tapes also contain other information not immediately relevant to the current study - specifically, information on country of origin and rate of duty. Because of the number of records on the tape, it was important to economise where possible. Less relevant information was therefore aggregated or eliminated and a reduced tape used. The contents of the reduced import data tape (hereafter called simply 'clearances data') are described below.

Value of imports: The value of imports is determined as value for duty (vfd) on an fob basis so that charges such as freight and insurance incurred after the goods have been exported from the port of shipment are excluded. Moreover, no reliable data are available for vfd to cost, insurance, freight (cif) conversions.[13]

Quantity of imports: For most TI*SK the quantity of goods imported is recorded. Depending on the commodity, the unit could be the number of items, gallons or kilograms and so on. For TI*SK which are heterogeneous

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13 As noted above, the value of imports is determined as vfd on an fob basis. The unit values would more closely approximate market prices if the value of imports were in cif rather than vfd terms. The ABS provides quarterly information on cif/vfd ratios for approximately sixty (2 digit) SITC commodity groupings from the results of a sample survey of Customs invoices.

The survey data on cif/vfd ratios were examined with a view to adjusting the vfd price indexes to cif terms. In general the ratios have shown only small movement over the total observation period remaining relatively constant at values around 1.1. However, some exhibited marked quarter-to-quarter variation. Most of this variation appears to result from changes in the relative importance of the exporting countries; changes in the relative importance of individual commodities in the (2 digit) SITC grouping; seasonal factors; and sampling error. The consensus on the available evidence is that greater error would be introduced into the import price indexes through adjusting the vfd indexes by the current survey data on cif/vfd ratios than would be the case if this information were ignored. Accordingly, vfd based indexes are used throughout the IMPORT study. Provision has been made to utilise the cif/vfd data if and when reliable survey data becomes available. It should be noted that where the cif/vfd ratio is constant, the inclusion of the ratio in the price indexes is irrelevant except at times of major tariff changes.

in type, in particular the "not elsewhere included" categories, quantity is not generally recorded. Some quantity information is also suppressed by ABS to preserve confidentiality.[14]

Economic class: The reduced import data tape combines information on the method of entry for tariff purposes with an aggregation of the finer economic class classification employed by ABS.[15, 16]

In the present study, the basic data for imports were classified by end-use into investment, intermediate use, and consumption. These end-uses were further classified by nature of tariff: by-law and non-dutiable clearances,[17] dutiable clearances, and government.[18]

For convenience the end-use/nature of tariff classification will be referred to throughout the paper as 'economic class' (EC).

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14 The quantities of some commodities (eg tyres) are recorded twice under different unit of quantity codes. To prevent double counting of values only one of the records has the corresponding value data. This record has been retained on the tape, the other deleted.

15 See Appendix 1.

16 The classification of merchandise by economic classes shown in ABS Australian import statistics distinguishes materials, capital equipment, finished consumer goods, and munitions and war stores. The economic class classification also identifies imports by degree of manufacture (crude, simply transformed, elaborately transformed). Goods classified as "non-merchandise" were readily identifiable by their ABS economic classification and were excluded from further processing. Examples of such commodities range from gold foil to goods for the personal use of the Governor-General.

17 The by-law system permits, under certain circumstances, the waiving or reduction of Customs duties imposed on imported goods. In terms of the value of imports and concessions granted, the most important use of the by-law system is to grant duty free import entry to goods for which there is no suitable equivalent reasonably available from Australian production (ie "non-produced goods"). In 1973-74 goods imported under by-law represented 37 per cent of total imports by value. For a description and discussion of the by-law system, see Customs By-Law Policy, A Discussion Paper, (Canberra: May 1975).

18 Government purchases have not been distinguished by end-use. The combination of the three-way method of entry classification with the three-way end-use classification therefore gives seven end-use classifications. See Table 1.

It should be noted that the TI*SK may appear in different economic classes. For example, a particular TI*SK might include goods classified to consumption – normal entry and to consumption - by-law entry.

Within each 4 digit ASIC code, the data have been disaggregated by economic class (ie ASIC cross-classified by economic class, ASIC*EC). Table 1 shows the distribution of imports across economic classes for selected ASIC classes in the manufacturing division. Because imports for each ASIC class fall predominantly into one end-use classification, the economic class readily identifies the area of macro-economic activity determining the demand for imports. The use of the ASIC*EC gives the potential to produce indexes based on end-use aggregations within industrial classifications.

Duty paid: For each TI*SK the value of duty paid at normal and by-law rates of duty is recorded.

In addition to the information contained on the reduced import data tape, two items contained on the original tape have been considered or used at various stages. These are:

AICC codes: The import data tape identified each TI*SK code with the corresponding Australian Import Commodity Classification code. In any particular year there are approximately 5000 AICC codes compared to more than 10 000 TI*SK codes. This second classification provides a useful check on various manipulations, as described in the following section.

Dumping duty paid: Information on dumping duties is not recorded at the TI*SK level but can be assigned to ASIC classes via their AICC codes. Dumping duties are additional to normal tariffs. They are imposed if local manufacturers and Customs Officers establish that the local manufacturers have been subject to 'unfair' competition in the sense that the export price for the particular shipment is below the normal value for duty (usually the domestic price in the country of origin).

TABLE 1 : DISTRIBUTION OF IMPORTS ACROSS ECONOMIC CLASSES, SELECTED ASIC CLASSES 1968-69 TO 1974-75

ASIC Class	Percentage of total value[a] for each Economic Class[b,c]							Total value
	1	2	3	4	5	6	7	
								$m
2912	44	1	..	..	50	..	1	757.8
2913	56	5	1	..	18	16	1	42.3
2914	40	..	..	..	59	..	..	279.2
2921	98	..	..	..	1	..	..	9.7
2922	98	..	..	..	1	..	..	1.7
2923	97	..	..	..	2	..	..	5.5
2924	81	..	..	5	13	..	..	16.8
2925	92	..	..	1	5	..	..	37.9
2926	94	..	..	..	4	..	..	29.1
2927	41	..	..	3	53	..	..	34.0
2928	51	..	..	1	42	..	1	72.8
2931	10	..	..	1	88	..	..	8.4
3111	68	..	..	..	31	..	..	1.1
3112	9	..	79	4	..	..	6	4.2
3113	65	..	..	4	29	..	..	9.1
3114	22	35	..	1	6	34	..	43.7
3121	14	23	22	4	22	6	6	5.3
3122	..	45	36	4	..	12	..	8.6
3123	7	..	85	1	3	..	1	56.0
3131	..	34	39	1	..	17	7	228.4
3132	33	26	12	..	17	6	4	85.3
3133	21	36	21	2	11	4	2	61.5
3135	64	..	1	..	32	..	..	94.5
3136	..	..	100	..	..	..	..	0.6
3137	16	4	51	3	5	3	15	332.5

a The distribution is derived from an aggregate of 7 years data (1968-69 to 1974-75); it is also available on a monthly, quarterly or yearly basis. The full table including ASIC classes outside the manufacturing division is available on microfiche.

b Percentages do not add to 100 due to truncation.

c Economic Class is allocated according to the following schedule. EC represents the End-Use Classification and NT describes the Nature of Tariff applicable.

ALLOCATION OF ECONOMIC CLASSES

NT \ EC	Materials	Investment	Consumption
Normal	1	2	3
Government	4	4	4
By-law	5	6	7

4. COMMODITY TO INDUSTRY CONCORDANCES

Because trade statistics are compiled on a commodity basis rather than an industry basis, commodity to industry concordances allocating AECC and TI*SK to 4 digit ASIC codes are required. The export commodity/industry concordances, which relate AECC to their primary industry of origin, were derived directly from the ABS Australian Standard Commodity Classification project.

The import commodity/industry concordance allocates TI*SK to the ASIC class to which they would have been primary had the goods been produced in Australia. Over the period of our initial study, July 1968 to June 1975, about 25 000 different TI*SK codes were used. These have been mapped into far fewer ASIC classes. In the manufacturing division of ASIC for example, there are 173 4-digit industries.

Appendix 2 describes a preliminary check on the validity of the TI*SK/ASIC concordance and compares this concordance with the AICC/ASIC concordance which it supersedes. The most efficient check on the validity of the TI*SK/ASIC concordance utilises tariff histories. This check is described in Section 6.2. The completion of the TI*SK/ASIC and AECC/ASIC concordances enables the value of imports and exports in each period to be allocated more accurately than has been previously possible to the 4 digit ASIC codes in which the commodities are (or would be) primarily produced (if produced locally).

5. TARIFF HISTORIES

In order to compute movements in unit values we need to be able to identify commodities from one period to another. This necessitates a detailed knowledge of the history of changes in the Customs Tariff.

The definitions of import and export commodity items change between periods as a result of aggregation and disaggregation of individual TI*SK and AECC. In addition, new items are initiated and existing items are discontinued from time to time. In the case of the export commodity classification the revisions are few and almost invariably occur at the beginning of financial years.

In the case of TI*SK codes the changes are pervasive. Although about 25 000 TI*SK codes were recorded over the seven-year period, the Customs Tariff lists only 10 000 or so codes at any one point of time. A further impression of the magnitude of the changes in the definition of TI*SK can be gained from the fact that only 17 per cent of the TI*SK for which imports were recorded in July 1968 were in existence in June 1975.

Changes in TI*SK codes occur for two main reasons: as a result of tariff duty changes (ie where previously differing rates become the same, or vice versa),[19] or due to refinements in statistical classifications. Changes in commodity codes resulting from tariff duty changes occur where necessary. In contrast, changes due to the revision of statistical classifications usually occur on 1 July each year. The latter is the more important, accounting for almost 60 per cent of changes in TI*SK codes over the period under study. Table 2 shows the distribution and relative importance of between-year, and between-month changes in TI*SK codes.

The tracing of TI*SK histories has, for many years, been the responsibility of the Commission's Technical Services Section. In the past they provided histories when they were necessary for tariff inquiries. In the last year, however, a complete record of all changes in the Customs Tariff over the period from July 1968 to June 1976 has been created.

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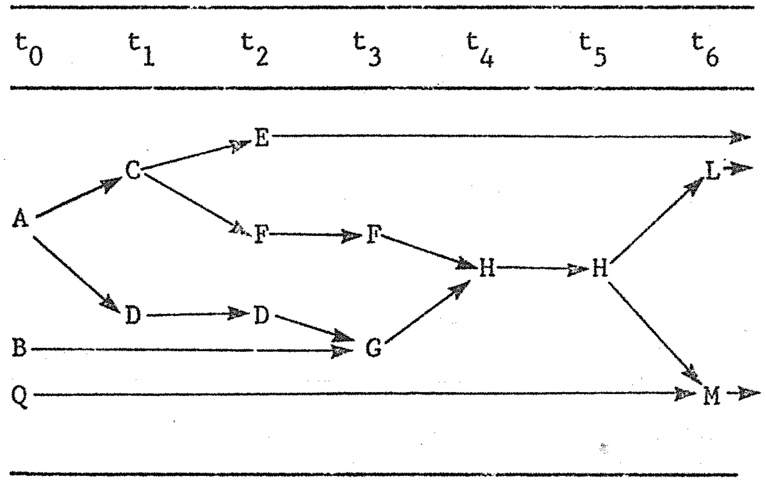
19 The immense turnover of TI*SK codes is also explainable in terms of changes in the requests of data users. For example, for an IAC inquiry, the Commission or other interested parties might ask the ABS to provide a more detailed breakdown of imports. Later, at the conclusion of the IAC's interest, the codes might be reaggregated, usually back to the initial codes.

A typical set of TI*SK histories in the graphical representation provided by Technical Services looks like a flow diagram and is illustrated below.

FIGURE 1 : ILLUSTRATIVE SET OF TI*SK HISTORIES



A, B, C etc are the TI*SK codes. The figure shows that at time t_1 A became C and D. At time t_3 D and B were aggregated to G. At time t_6, H was split into L and M. In the example, the aggregation of commodities H and Q at time t_5 is <u>linked</u> to the aggregation of commodities L and M at time t_6.

In practice, a particular TI*SK history diagram may be very complex. Splits and aggregations take place throughout the year and may involve hundreds of TI*SK codes. The possibilities for error in the initial tracing of the histories and in their recording on computer cards are considerable.

The two main sources of error were in the interpretation of each history (ie deciding which TI*SK should be included in a data link at a particular time), and in the possibility of overlooking a part of a history. A check revealed an initial error rate of about 20 per cent from misinterpretation or oversight. As a first step to reduce errors the entire coding was checked from the source documents. Further edits were combinations of programming and clerical procedures.

TABLE 2 : DISTRIBUTION OF CHANGES IN TI*SK CODES[a] (NO. OF TI*SK)

	1968	1969	1970	1971	1972	1973	1974	1975	Total
Jan	..	59	54	62	51	24	68	614	932
Feb	..	179	49	6	146	63	354	10	807
Mar	..	172	10	0	153	207	435	930	1 907
Apr	..	36	464	67	9	47	52	6	681
May	..	116	105	56	49	276	0	770	1 372
Jun	..	123	2	11	51	0	0	134	321
Jul	8	961	1 678	8 867[b]	1 564	1 010	2 588	..	16 476[b]
Aug	30	0	161	791	259	12	32	..	1 288
Sep	106	27	15	354	778	124	458	..	1 862
Oct	3	150	27	8	36	78	16	..	318
Nov	163	23	149	40	48	699	336	..	1 458
Dec	70	0	8	0	0	42	1 061	..	1 181

a Any change in history gives rise to at least two changes in TI*SK codes. There are 8300 changes in history involving 28 600 TI*SK with their allocation described by the table below. Here X refers to the number of original TI*SK and Y to the number of new TI*SK in a history change.

b Includes changes due to Tariff Simplification.

No. of TI*SK involved (X+Y)	X = 1 Y ≥ 1	X ≥ 1 Y = 1	X ≥ 1 Y ≥ 1
2	4 305	..	..
3	1 628	912	..
4	277	188	147
5	138	94	98
6	31	47	63
7	11	15	52
8	4	6	42
9	3	3	26
10	1	2	13
11	2	3	10
≥ 12	8	10	146
TOTAL	6 408	1 285	597

The maximum value for (X + Y) was 339.

6. DATA PREPARATION AND EDITS

6.1 Procedure

The preceding sections have described the assembly of the basic data (import clearances and export files, tariff histories and concordances). The next step, prior to linking the data for index calculation, involved the use of the concordances to assign ASIC codes to the import clearance and export files and to the tariff histories. This stage also involved the major edits of the data.

Level of aggregation: Data can be prepared for index construction at any level of commodity grouping or temporal aggregation. However, most processing is undertaken at the finest level of disaggregation for which indexes are required. This allows for more precision in editing. It is also relatively easy to move to higher levels of aggregation if required. Then, having validated monthly TI*SK histories, they can be chained to form quarterly or annual histories but the reverse procedure cannot be performed.

Extract clearances file: For the bulk of the editing and matching operations we required knowledge only of the existence of import data for each TI*SK in certain periods, rather than quantitative information such as value, duty paid etc. An extract file showing the existence of clearances for each TI*SK but not quantitative information was derived when allocating ASIC codes to the clearances file (see Appendix 3). The file has the advantage of being highly compact and so reducing computer processing costs.[20] This is particularly important since editing is generally iterative. Corrections to errors detected at a subsequent stage must be cycled back through the earliest point where they are likely to have had an effect.

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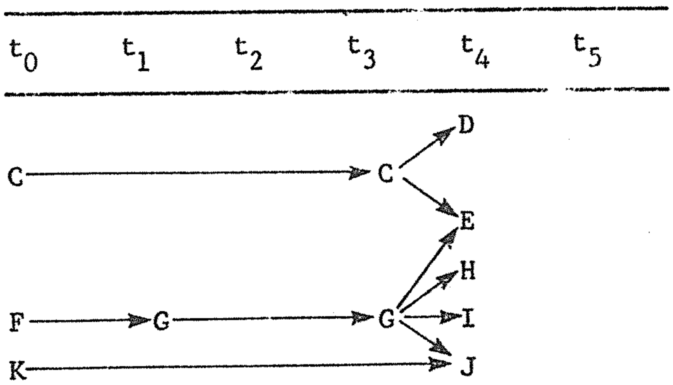
20 Relative file sizes:

(a) Original import clearances data received from ABS:120 000 TI*SK records for each year, each record containing twelve months data and appearing separately for each country (about one full reel of magnetic tape for each year).

(b) Reduced import data tapes (clearances file): 900 000 complete monthly TI*SK records for all seven years. The total volume of data is one-sixth of (a) above.

(c) Extract import clearances file (extract file) : 28 000 TI*SK records for all seven years, with no quantity, duty or value information. The total volume of data on this file is less than one per cent of that involved in (b) above.

Link sets: Since most editing involves validation of TI*SK histories, it is convenient for our discussion to introduce the following definitions. Let A, B, C etc. represent different TI*SK at time periods t_0, t_1, ... t_n. The graphical representation of the history is coded to form 'link sets' since they link TI*SK codes in successive periods. With reference to any particular transition date, we refer to the original TI*SK as 'link set elements' of 'type A', and to the new TI*SK as 'type B' elements. For example, the partial history below



gives rise to the following link sets

$$F \xrightarrow{t_1} G; \quad C,G,K \xrightarrow{t_4} D,E,H,I,J$$

where C,G,K are type A elements and D,E,H,I,J are type B elements at t_4, (note that G is of type B at t_1 and of type A at t_4).

It is also convenient, and indeed more meaningful, to refer to the file containing the coded histories as the 'link file' rather than the history file. Many changes in formal tariff history are not reflected in the reduced import data tapes and certain changes apparent from the data tapes do not appear in the formal history.

Where necessary, the links derived from the tariff histories were overridden to correspond to the reduced imports cleared data, thus producing a 'clearances history' which effectively linked TI*SK in the correct time periods. This is an important consideration, particularly for those who may wish to use the linking data for other purposes. All edits were designed to validate the clearances history, not the formal tariff history. All significant edits associated with the clearance histories are described in Appendix 4.

Editing: The importance of the edits can be illustrated by considering the example of the clearance histories. Even at the 4 digit ASIC level, some clearances data streams consist of as few as 4 or 5 TI*SK and there are often lengthy time gaps between successive clearances of a particular TI*SK. A change in commodity description for any of those items could introduce a very significant loss of information and perhaps a total discontinuity in the data series if it were not successfully linked to the TI*SK in the next time period.

The various edit procedures reveal a number of points of interest regarding the Customs Tariff and the import clearances data.

- Some TI*SK, which according to the Customs Tariff were in existence for several months, did not have clearances recorded against them in any part of the seven-year period for which data was available.

- There is often a substantial lag between the time a change is made to the formal tariff schedules and the time the changes become apparent in the clearances data.

Because of the low observedvalues associated with clearances lagging for more than one month behind a formal tariff change modification of the linking procedure to incorporate lags was restricted to an allowance for lags of one month only. Allowing a link to be current for more than one month after the date on which the change in TI*SK should have occurred would have induced unacceptably high levels of commodity aggregation across most of the data. The problem was less significant with quarterly data.

6.2 Inter and intra-ASIC linking operations

Conceptually, a major problem arises where changes in tariff classifications involve sets of TI*SK which are classified by the concordance to different ASIC codes. In general, X original TI*SK will aggregate or disperse or simply transform into Y new TI*SK which may or may not be in the same ASIC*EC. Where all TI*SK in a link set were of the same ASIC*EC grouping they were placed onto an intra-ASIC link file and underwent no further transformations until the data linking/index calculations phase. All other links were placed onto an inter-ASIC link file and examined. This examination revealed a significant number of errors in the TI*SK/ASIC concordance and proved to be the most efficient method of validating the concordance.[21]

The inter-ASIC link file was used for signalling to the data linking program those TI*SK which were to be specifically excluded from the index calculations. These had to be excluded since all clearances and linking data were processed sequentially in time period order within ASIC*EC groupings. Since inter-ASIC links crossed ASIC*EC groupings it was necessary to provide a separate data linking procedure in these cases. To ensure that the data were not included twice they were flagged at TI*SK level to be excluded from the main linking mechanism.

Note that inter-ASIC links not only required an aggregation of quantity, value and duty information, but also the assignment of an 'effective' ASIC*EC. The following method was adopted. If more than 50 per cent of the value of the original type A link elements came from a specific single ASIC*EC, then the entire original was deemed to have come from that ASIC*EC grouping. A similar test was applied to the new type B link elements. If the assignment resulted in the same ASIC*EC classification for both the type A and type B link elements, then the entire commodity movement was allocated to that ASIC*EC. Data aggregated and successfully classified in this manner were added to the imports cleared data stream in the appropriate time period.

In practice this procedure added little additional information - over the seven-year period it resulted in the addition of less than 50 items to the import clearances data. The main reason for this result is that a disproportionately high number of inter-ASIC links did not have clearances recorded in one or other period and were therefore discarded. Of the remainder, at least half were discarded because they did not satisfy the 50 per cent decision rule.

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21 It was found that the vast majority of the initial set of inter-ASIC links were due to errors in the original TI*SK/ASIC concordance. The several hundred errors detected in this manner were corrected but there was still a substantial volume of cases that did genuinely cross ASIC*EC classifications. After correction the tally was as follows:

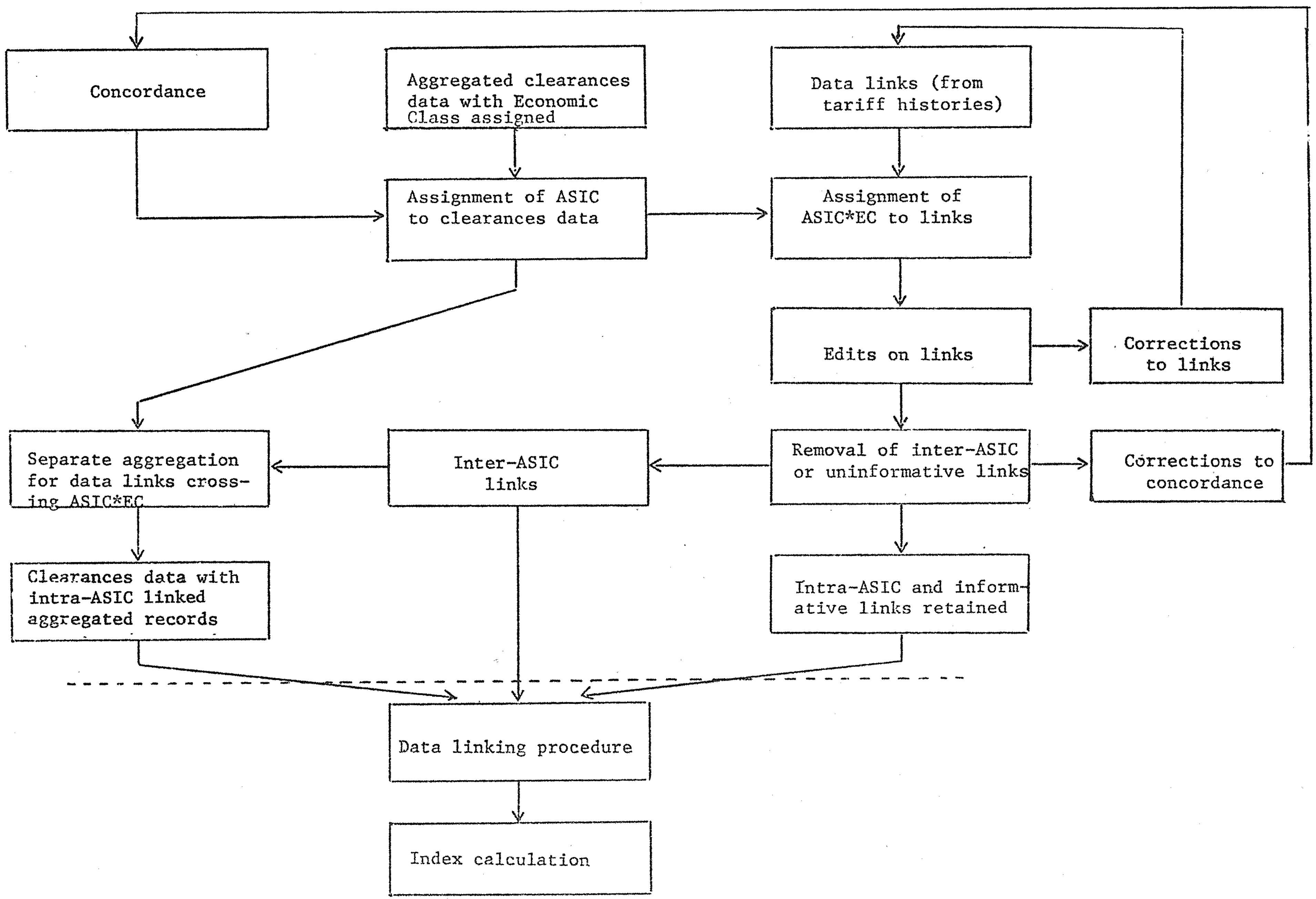
Intra-ASIC link elements (all in link set belong to the same ASIC*EC)...	20 983
Inter-ASIC link elements (elements in a set cross ASIC*EC)	2 152

While it is essential that inter-ASIC links be identified for the purposes of excluding corresponding clearances data in both time periods (due to the implicit linking procedure and the lagging of clearances beyond their formal cessation date - see section 7), it is not clear that inter-ASIC data, aggregated in the manner described, will be included in future updates of the indexes.

6.3 Inputs to the linking/index calculation phase

Starting with a concordance, aggregated clearances data, and a basic link file, we arrived at the necessary inputs for data linking. They are: clearances data with ASIC*EC assigned and 'intra-ASIC linked' aggregated records added in the correct industry grouping, plus a file of intra-ASIC data links, and a file of inter-ASIC links signalling those commodities which were to be excluded from the index calculation for a specific time period. The processes described thus far are illustrated in Figure 2. All edit procedures apply equally well in concept to export data except where specifically stated otherwise. Each stage represents a collection of programs or a variety of manual operations or both. Sorts and minor files specific to a particular stage are omitted for clarity.

FIGURE 2 : FLOW DIAGRAM OF MATCHING AND EDITING PROCEDURES.



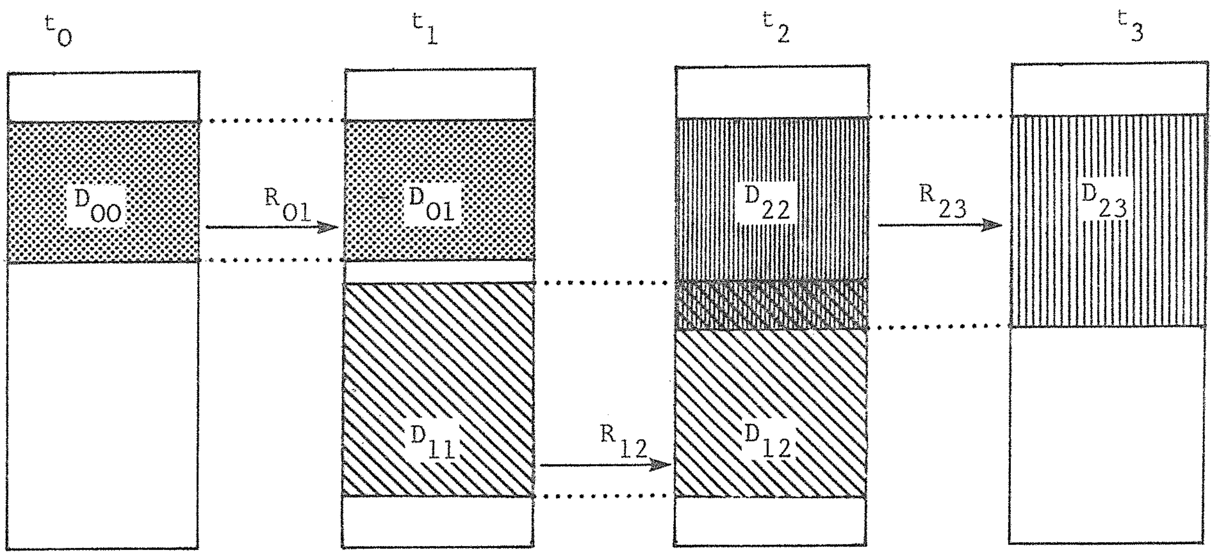
7. INDEX CALCULATION

7.1 Basic requirements

Index movements between successive periods t_0 and t_1 can be obtained from quantity and value data for commodities having clearances recorded in both periods.[22] For these purposes, a 'commodity' is the smallest of a TI*SK (AECC) or a set of TI*SK (AECC) that can be identified as the same 'commodity' in both periods. The process of identification is referred to as 'linking' the data. Thus the aggregate of all type A elements in a link set defines a single commodity that can be identified in the next period as the aggregate of all type B elements of the same link set. Where commodities are not 'explicity linked' in the manner just described, they may be 'implicitly linked' via the same TI*SK identifier appearing in both periods. In the latter case a commodity is invariably a single TI*SK.

Dual blocks of commodity data for successive time period pairs are readily constructed using the links[23] and clearances data described in the previous section. These are used to form price and quantity relatives from which the indexes can be calculated. The process is illustrated schematically in Figure 3. Let the large rectangles represent TI*SK clearances in the time periods indicated. The shaded areas labelled D_{ij} and $D_{i(j+1)}$ represent commodities for which data existed in the successive periods t_j and t_{j+1}.

FIGURE 3 : LINKING PROCEDURE FOR INDEX CALCULATION



22 A detailed discussion of index formulae is provided in Section 8.
23 Intra-ASIC and inter-ASIC links.

This section is devoted to the method of construction of the data blocks D_{ij} and $D_{i(j+1)}$, the processes whereby indexes are derived from them and various estimates of their reliability.

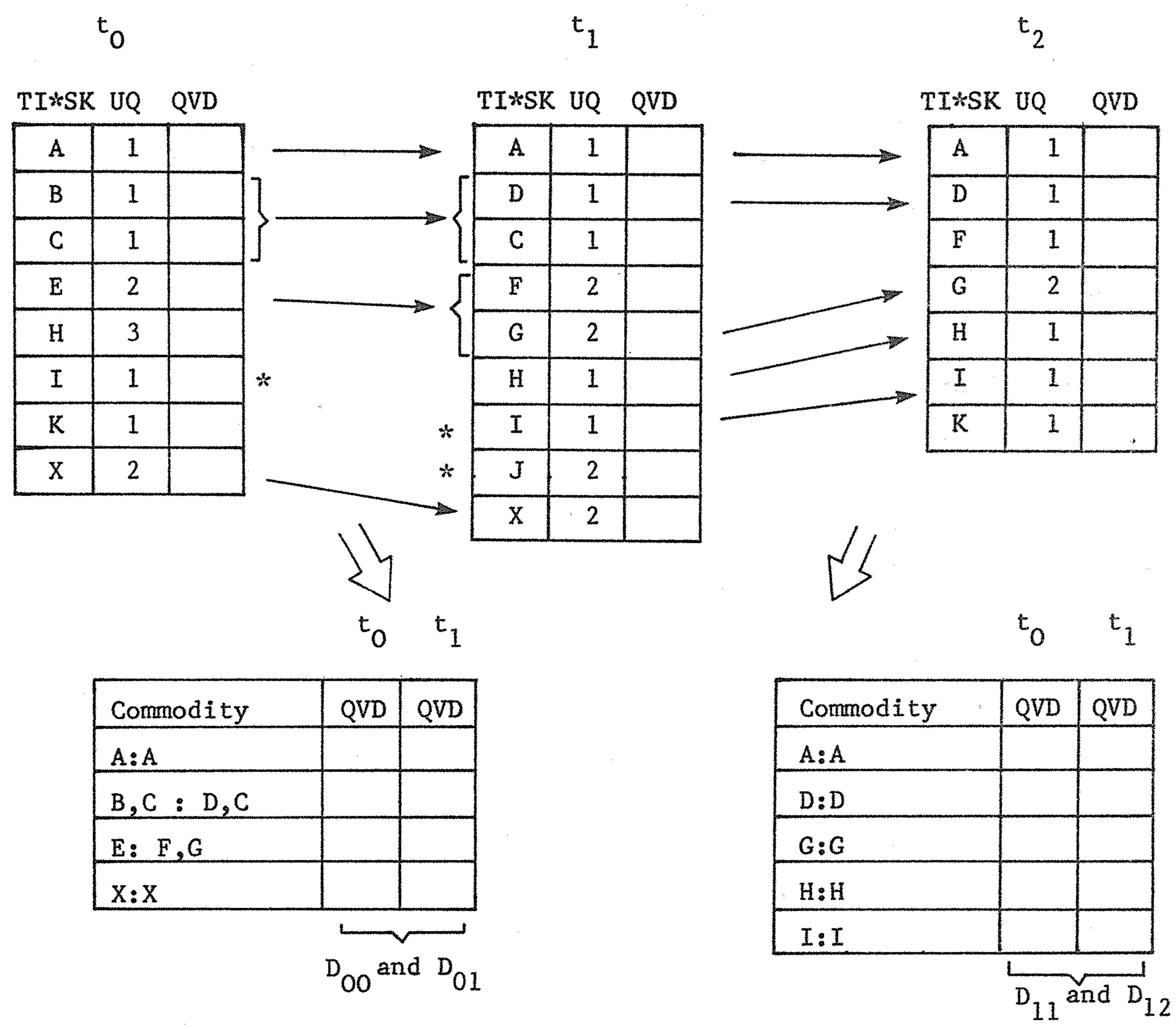
7.2 Linking the clearances data

The linking process is most readily explained by way of example. Whilst it may be difficult to follow it will serve well to highlight certain data characteristics and bring together the processes described in Section 6.

In Figure 4 let A,B,C etc. represent TI*SK in successive periods t_0, t_1, t_2. QVD represents quantity, value and duty information associated with the corresponding TI*SK. UQ is a standard metric unit of quantity.[24] Assume that the data stream we are considering is for ASIC (1). The code X represents an aggregation of TI*SK that crossed ASIC classifications when linked from t_0 to t_1, ie it is an aggregation derived from the clearances link (I, L) $\xrightarrow{t_1}$ (I, J) where I and J are from ASIC (1) and L is from ASIC (2). Such linkings were performed in the special aggregation for inter-ASIC links. Data on the inter-ASIC link file for ASIC (1) is I $\xrightarrow{t_1}$ (I, J). (Note that L $\xrightarrow{t_1}$ (empty) is used for ASIC (2).) Intra-ASIC links for ASIC (1) are (B, C) $\xrightarrow{t_1}$ D and E $\xrightarrow{t_1}$ (F, G). No links are required for the transition from t_1 to t_2. We construct commodity block pairs D_{ij} and $D_{i(j+1)}$ as follows.

24 All units (and corresponding quantity data) were converted to standard metric measures. This largely overcomes the inconsistent units of measure for the same commodity in different periods. For example, in one period clearances may be recorded as ounces, in the next they may be kilograms etc. There are 63 possible codes for unit of quantity.

FIGURE 4 : A DETAILED EXAMPLE OF LINKING FOR INDEX NUMBER CALCULATION



For period t_1

Use the inter-ASIC link file to flag I in t_0 and I, J in t_1, to be excluded from linking across t_0-t_1 since they are already accounted for in X.

According to the intra-ASIC links, B and C are linked to D at the transition from t_0 to t_1. Clearances for C lag for one time period, but we allow for this, and aggregate the lagged clearance with D.[25] Thus the single commodity formed by the aggregate of B and C is linked to the aggregate of D and C. Similarly E is 'explicitly' linked to F and G.

25 Mid-month changes are automatically accounted for by this mechanism provided that the link is coded as having occurred at the beginning of the month (ie clearances during the month are treated as lags from the previous month).

A and X have the same TI*SK code which identifies them as the same commodity in both periods. They are 'implicitly' linked. H has an irreconcilable unit of quantity in the two periods and K has no clearances in period t_1. The information for H and K cannot be used. Thus the Commodity block pair D_{00} and D_{01} is formed. Note that TI*SK identifiers and units of quantity are now redundant. The only information retained is QVD data for each commodity in both periods.

<u>For period</u> t_2

An identical process but note that the information is linked at different levels of aggregation in some instances. Also, information that was not usable in the preceding period (eg H $\xrightarrow{t_0}$ H) can now be used. The introduction of X in t_0 and t_1 does not affect the $t_1 - t_2$ commodity movement since X does not appear in t_2 and is therefore not linked in this time period.

It is important to note that successful linking demands that the units of quantity are the same in both periods. For certain commodities the unit of quantity is confidential and the record carries zero quantity data. The value information can still be used in the calculation of certain types of indexes.[26] This points to the need for another coverage ratio when we construct indexes from only those linked commodities that have quantity data in both periods.[27]

The price or quantity relative R_{01} is formed from the pair of linked sets of commodities D_{00} and D_{01}. Similarly R_{12} is formed from D_{11} and D_{12} etc. Note that in the illustration D_{00} and D_{01} represent the same set of commodities even though the composite TI*SK may differ. D_{01} and D_{11} have no commodities in common, whereas D_{12} and D_{22} have at least an intersecting set of TI*SK although this level of aggregation (due to explicit linking) <u>may</u> differ and hence they may have no 'commodities' in common. It is more usual for successive commodity block pairs to intersect in the sense described above, but clearly it is not a necessary condition for the index formulation.

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26 The types of indexes used are discussed fully in Section 8.
27 For some ASIC classes, the proportion of linked data that has usable quantity information is consistently less than one-third of total value (for reasons of confidentiality). For most ASIC codes quantity data exists for well over 90 per cent of linked commodities but coverage of less than 10 per cent has been detected in some isolated time periods.

The reliability of the indexes formed from the price (quantity) relatives obtained in this manner depends heavily on the degree to which the linked commodity pair for two successive time periods is representative of all TI*SK in those periods. That is, we assume that D_{00} and D_{01} is representative of <u>all</u> TI*SK in both periods t_0 and t_1. Similarly, we assume that D_{11} and D_{12} is representative of all TI*SK in t_1 and t_2. For this reason it is necessary to obtain various estimates of the coverage that D_{ij} and $D_{i(j+1)}$ blocks provide for all TI*SK appearing in periods t_j and t_{j+1}.

Table 3 provides, for a sample ASIC industry, information on the number of TI*SK that appear on the clearances file in two successive quarters as a proportion of TI*SK appearing in either period. The table illustrates that the proportion of TI*SK common to each pair of successive quarters varies over the data period. The table was produced from data prior to linking using the clearance histories and emphasises the need for an accurate set of clearances links. For example, the small number of TI*SK common to the second and third quarters of 1971 is due to the tariff simplication which occurred in July 1971. After linking, the proportion common for these particular quarters rises to nearly 90 per cent.

The information contained in the table is broadly representative of the behaviour of most ASIC industries. For several ASIC classes the number of TI*SK occurring in at least one of the adjacent periods is as low as 4 or 5, even for quarterly data. In some instances, without linking, the number of common TI*SK falls to zero.

TABLE 3 : NUMBER OF TI*SK APPEARING IN TWO SUCCESSIVE PERIODS AS A PROPORTION OF TI*SK APPEARING IN EITHER PERIOD (sample only)

ASIC 3312 Measuring apparatus; professional and scientific equipment			
Successive quarterly periods	TI*SK in either period	TI*SK in both periods	Proportion common
	No.	No.	%
1968/3 - 1968/4	227	208	91
1968/4 - 1969/1	230	209	90
1969/1 - 1969/2	237	212	89
1969/2 - 1969/3	269	203	75
1969/3 - 1969/4	292	234	80
1969/4 - 1970/1	287	233	81
1970/1 - 1970/2	249	233	93
1970/2 - 1970/3	273	176	64
1970/3 - 1970/4	214	190	88
1970/4 - 1971/1	205	192	93
1971/1 - 1971/2	207	187	90
1971/2 - 1971/3	304	78	25
1971/3 - 1971/4	189	176	93
1971/4 - 1972/1	187	169	90
1972/1 - 1972/2	184	167	90
1972/2 - 1972/3	197	163	82
1972/3 - 1972/4	192	175	91
1972/4 - 1973/1	191	176	92
1973/1 - 1973/2	192	176	91
1973/2 - 1973/3	206	170	82
1973/3 - 1973/4	202	189	93
1973/4 - 1974/1	212	188	88
1974/1 - 1974/2	210	186	88
1974/2 - 1974/3	226	167	73
1974/3 - 1974/4	209	196	93
1974/4 - 1975/1	215	193	89
1975/1 - 1975/2	210	195	92

7.3 Continuity of the data

It has already been mentioned that clearances for particular TI*SK show marked discontinuities in time. For many TI*SK, clearances occur less frequently than once a year. For this reason the degree of industry or temporal dissaggregation will often determine whether or not we can produce a continuous sequence of linked commodity block pairs. Clearly, where there are discontinuities, unit value (quantity) relatives describing movements in unit values (quantities) between consecutive periods can not be calculated. Consequently, if a break occurs in the data stream, indexes cannot be constructed using the present method.[28]

The percentage of the 173 Manufacturing ASIC industries with continuous data series at various levels of temporal aggregation are:

Monthly	:	75%
Quarterly	:	90%
Annually	:	95%

At an ASIC*EC level of industry aggregation, less than 30 per cent of industry series have continuous monthly data. There are, on average, less than 20 TI*SK existing in any time period for this industry sub-classification.

7.4 Heterogeneous commodity groupings

Having linked the clearances data to produce successive commodity block pairs, we must consider whether or not the unit value movement for each commodity represents a genuine price change or reflects a shift in commodity composition. Even at the most detailed level of commodity classification, commodity A in time t_0 can be quite different from commodity A at time t_1. In such cases, despite the units of quantity being the same, the comparison of unit values may contain no information about price change. The unit values of certain commodities (particularly those in the "not elsewhere included" industry groupings) were observed to exhibit dramatic fluctuations from month to month.[29] It was obvious that those fluctuations represented compositional and quality differences, not price movements.

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28 Alternative schemes for index calculation which take isolated data discontinuities into account are available. For the time being, however, the methods outlined in Section 8 are regarded as sufficient.
29 See Appendix 5 for an illustration of these effects.

With quarterly movements, the problem of heterogeneity was found to be less severe. The observed improvement is because, in general, over a three-month period the 'average quality' of a commodity is more stable than over a one-month period. However, annual data did not prove to be significantly more stable than quarterly data. The example in Table 4 shows for a sample ASIC industry the share in total value of the commodities whose unit values more than doubled or fell to less than one half.

TABLE 4 : EXTREME UNIT VALUE MOVEMENTS[a]
ASIC 2912 Iron and Steel Basic Products[b]

	Monthly[c]	Quarterly[c]
1968-69	no data available	no data available
1969-70	4	6
1970-71	9	4
1971-72	8	8
1972-73	8	8
1973-74	6	3
1974-75	8	4

a The numbers in the body of the Table are the percentage of total value for each period for which unit values more than doubled or fell to less than half.
b There are about 150 commodities in this ASIC class existing for any time period.
c Derived without reference to the tariff histories.

Consideration has been given to the treatment of quality shifts for the purposes of index calculation (See Section 9). An immediate intuitive solution is to exclude those price relatives which lie outside some arbitrary range. The problem with such a solution is to determine which criterion would be most appropriate to a particular industry in a particular time period. That the criterion chosen is not inconsequential is confirmed by experiments which showed that indexes for certain industries are highly sensitive in trend to the data vetting constraints imposed. However, an option has been provided to exclude those commodities which have 'unacceptable' unit value movements.[30]

30 Exercising the option of excluding such data that exhibits price movements in excess of doubling or halving, results in data discontinuities for about 25 per cent of all ASIC industries at a monthly level. In some time periods all unit values more than double or fall to less than one-half for these ASIC industries.

7.5 Reliability

Information is available to assist in determining the reliability of the indexes. We may, for example, relate a sudden change in an index to a change in tariff history or to the cessation of clearances for a particular commodity which previously appeared regularly. Another important measure of the reliability of the indexes produced is the degree to which they are representative of all TI*SK in the industry. For this reason, various 'coverage ratios' are produced. These ratios are described with reference to Table 5.

TABLE 5 : NOMINAL VETTING : 0.5 TO 2.0 UNIT VALUE CHANGE
ASIC 2914 Steel Pipes and Tubes

Indexes		Coverage ratios				Values x 1000	
Price	Quantity	Linked[a]	Incl.[b]	Q edit	V edit	Incl.	Total
		%	%	%	%		
100.78	101.59	100	99	1	8	2812	2818
92.63	129.92	99	99	0	0	2879	2886
100.56	123.72	100	99	1	7	3384	3392
100.48	129.80	99	99	0	0	3498	3507
88.15	120.38	100	98	2	6	3667	3715
94.53	131.48	100	98	2	0	2984	3034
98.97	141.56	98	97	1	6	3490	3568

a Linked data (link): This is the proportion of total value of all TI*SK appearing in t_0 that are represented in the linked commodity block pair D_{00}^0 and D_{01}^0.

b Included data (Incl): The proportion (by value) of all TI*SK appearing in t_0 that are successfully linked less any commodities discarded due to quantity or unit value edits (below).

c Quantity edit (Qedit): The proportion of total value in t_0 that has no quantity data (and can therefore not be used explicity in the construction of price or quantity indexes).

d Value edit (Vedit): The proportion of total value that would have been excluded because it corresponds to unit value movement outside the range specified.[31]

31 The edit corresponding to this coverage ratio is currently nominal (ie data is not excluded) but can be actual if so desired.

8. INDEX NUMBERS : PURPOSE, FORMULAE AND INTERPRETATION

8.1 Purpose and coverage

The IMPORT study requires price and quantity indexes of imports and exports for a number of different purposes. The appropriate basis of valuation and level of temporal and industry aggregation appropriate to indexes for one purpose need not be appropriate for indexes to be used for another purpose.

For example, comparisons of movements in the prices and volumes of Australian import and export flows with the import and export flows of other countries should be made in terms of (fob) prices. In contrast, econometric analysis of the sensitivity of the volume of imports to changes in activity levels and relative prices requires price indexes which refer to prices in the domestic market, that is including duty and transport costs.[32] Indexes have been prepared on both a vfd plus duty basis and on a vfd excluding duty basis.

There is the further question concerning the treatment of dumping duty. By their nature dumping duties are imposed some time, say 3-6 months, after the imports have been cleared by Customs. In many cases payment of dumping duty is not foreseen by the importers and inclusion of dumping duty in import price indexes is not appropriate where the indexes are required for demand analysis. On the other hand, dumping duty may be a regular occurrence for some imports, for example, chinaware from China. In such cases the price on which the decision to buy imported goods depends almost certainly includes dumping duty. The treatment of dumping duty in the indexes should therefore be based on a case by case assessment. In this study all indexes exclude dumping duty.

There is a second difference in the requirements of indexes to be used for demand analysis and indexes to be used for other more general purposes such as inter-country comparisons of trade flows. Since the main purpose of demand analysis is to estimate precisely the elasticity coefficients

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32 As noted on page 7, footnote 13,the Customs data used in the current study value imports in vfd terms and the available data on cif/vfd ratios is not considered reliable enough to estimate indexes on a cif basis.

describing the relationships between changes in price and quantity indexes, it is important that these indexes refer to exactly the same group of commodities. This avoids introducing a bias into the estimated coefficients which might arise from relating price movements for one set of commodities to a volume movement of a significantly different set of commodities. Accordingly, for the purposes of demand analysis, indexes based only on the commodities, for which both quantity and value data were recorded, were calculated for each industry. For more general purposes, requiring best estimates of the aggregate price/quantity movements for each industry, indexes based on the aggregate value of all commodities in the industry were calculated implicitly, ie by dividing movements in the aggregate values by the movement in the price/quantity index for the commodities for which quantity data were available. This step assumes that the commodities for which quantities were not recorded show the same price/quantity movement as the commodities whose quantities were recorded.

8.2 Formulae

Price and quantity index numbers describing movements between consecutive periods were calculated using 'Fisher's ideal' index formula. This 'ideal' index number is the geometric mean of the Laspeyres and Paasche index numbers.[33] For example, the Fisher price index movement in import prices between periods 0 and 1 (P_{01}) is given by

$$P_{01} = \sqrt{PL_{01} \cdot PP_{01}} \qquad (1)$$

where PL_{01} and PP_{01} are the corresponding Laspeyres and Paasche indexes respectively

$$PL_{01} = \frac{\Sigma p_1 \cdot q_0}{\Sigma p_0 \cdot q_0} \quad \text{and} \quad PP_{01} = \frac{\Sigma p_1 \cdot q_1}{\Sigma p_0 \cdot q_1} \qquad (2),(3)$$

The terms p_0 and p_1 are the unit values of the i-th commodity in periods 0 and 1, respectively, and similarly q_0 and q_1 are the quantities of the i-th commodity in each period. Since the index is based on unit values, the summation is restricted to those commodities in the given ASIC class for which both value and quantity data are recorded.

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33 For a discussion of a second 'ideal' index formula, see Sato (1976).

For computational convenience the Laspeyres indexes can be redefined in terms of the arithmetic mean of the price (quantity) relatives weighted by value shares in the base period. Thus,

$$PL_{01} = \Sigma(p_1/p_0) \cdot W_0 \qquad (4)$$

where $W_0 = p_0 q_0 / \Sigma p_0 q_0$ and $\Sigma p_0 q_0$ is the value of imports of the commodities in each ASIC for which quantity data are recorded. Also for reasons of computational convenience, the current weighted Paasche indexes for the same group of commodities were obtained implicitly rather than by direct computation of equation (3).

The Fisher indexes provide the preferred estimates of price and quantity movements from period to period since the Fisher formula overcomes the bias induced by shifting weighting patterns into the Laspeyres and Paasche indexes. Given the frequently observed negative correlation between price movements and quantity movements, shifts in weighting patterns between periods will give the Laspeyres price index an upward bias and the Paasche price index a downward bias relative to one another.[34] Initial comparisons of the movements in the Laspeyres and Paasche price indexes confirmed the substantial divergence between these indexes and the need for the Fisher indexes.[35]

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34 For some ASIC classes, the Laspeyre's price index calculated from monthly data climbed to in excess of 1000 after 12 months while the corresponding Paasche index fell nearly to zero, in the same number of months.

35 See footnote 37 on page 34.

The set of implicit price (quantity) indexes, intended to provide best estimates of the aggregate movements in price (quantities) at industry level, is based on the preferred Fisher indexes. That is, this set of implicit price (quantity) indexes is obtained by dividing the movement in the aggregate value of all commodities in the industry by the Fisher quantity (price) indexes.[36]

8.3 Chaining

The frequent changes in the definition of commodity items, particularly TI*SK, impose an important constraint on the types of index number formulae which can be calculated. Because of the need to trace histories over a number of periods, the use of fixed weight indexes would lead to a progressively lower coverage because of the need to chain the clearance histories.

Index movements between non-consecutive periods were therefore obtained multiplicatively by chaining the movements between consecutive periods. For example, the movement in prices between periods 0 and 3 is given by:

$$P_{03} = P_{01} \cdot P_{12} \cdot P_{23} \qquad (5)$$

Where P_{01} is the Fisher index movement between periods 0 and 1 and P_{12} is the Fisher index movement between periods 1 and 2, and so on. Note that not only is the index movement between periods 0 and 3 obtained by chaining but that the weighting pattern also changes from period to period. These indexes are to be contrasted with fixed weight indexes and chained indexes where the weights are revised periodically, say every five years. As already implied above, continually rebased, chained indexes may be based on any of the conventional index formulae describing movements between consecutive periods and it is useful, for example, to distinguish between chained indexes

36 In this case the aggregate value includes the value of all commodities irrespective of whether they can be linked from period to period or whether they have quantity data.

of the Laspeyres type and of the Fisher types.[37]

8.4 Interpretation

The chaining of index movements between consecutive periods is necessitated by the frequent changes in the commodity definitions. Although the chained indexes of price and quantity movements of imports and exports described here differ markedly from the familiar fixed or current weight indexes, they meet most of the conventional tests applied to index numbers.

First, in contrast to the official (fixed weight) price and quantity indexes, the weighting patterns do not become outdated. In this respect continuously rebased, chained indexes are superior to all other indexes.

Second, a chained index meets, by definition, the circularity test which requires consistency between indexes of adjacent periods and index movements between non-adjacent periods. For example, with three time periods (0,1,2) the requirement is that the product of the 0/1 and 2/1 indexes should be equal to the 2/0 index.

Third, chained indexes based on Fisher's ideal formula meet, by definition, the factor reversal test which requires that the product of the price and quantity indexes should equal the index of values in current prices.[38] In

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37 Where there is a negative correlation between unit value and quantity movements a Laspeyres index tends to have an upward bias and a Paasche index a downward bias relative to the other. There is no general rule as to whether a continuously rebased, chained index will reduce the difference between Laspeyres and Paasche indexes. If the structural changes are proceeding smoothly without major fluctuations from their trends, then the difference between Laspeyres and Paasche chained indexes is smaller than the difference between the directly compiled fixed base Laspeyres and Paasche indexes and vice versa where fluctuations dominate the trend. A priori it seems likely that the chained indexes of the Laspeyres or Paasche type will be superior to fixed base indexes at higher levels of industry and temporal aggregation, say for quarterly indexes at the ASIC level and above. At lower levels of temporal and industry aggregation fluctuations due to the smaller number of commodities imported/exported in each period will probably outweigh long term trend movements. For this reason the preferred indexes are continuously rebased chained indexes of the Fisher type.

38 With conventional indexes the factor reversal test requires that if the price index is a fixed weight index then the quantum must be a current weighted index - and vice versa. Similarly with chained indexes, the chained Laspeyres quantity index must be combined with the chained Paasche price index in order to meet the factor reversal test.

other words, the index movement of quantity (price) should be obtainable implicitly by dividing the index movement of price (quantity) into the index movement of the values.

Continuously rebased, chained indexes are not, however, internally consistent at different levels of aggregation.[39] This is to be expected because no one index can simultaneously satisfy the circularity and internal consistency tests and the requirement that the weighting pattern is never obsolete.[40]

Internal consistency is particularly important for constant price estimates of national accounts since it is essential that the sum of the components of consumption in constant prices, for example, add to aggregate consumption in constant prices. For price indexes, the test implies that an index of an aggregate must not be higher than the highest sub-index and not lower than the lowest sub-index. For example, the price index movement for the 2 digit ASIC industry must not exceed the largest price index movement observed for the component (4 digit) ASIC classes or be smaller than the smallest price index movement observed for the component ASIC classes. With chained indexes consistent estimates can be compiled only for consecutive periods, since new weights are introduced every period.

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39 Chained indexes based on Fisher's ideal formula fail the internal consistency test for two reasons. First, for the general reason that the weighting pattern changes continually. Second, for the reason that the use of geometric mean in Fisher's formula is incompatible with the additivity required to give internal consistency.

40 The increasing use of consumer prices for measuring changes over periods such as a year has drawn attention to the advantages of the chain index with weights changed every year. The United Kingdom Index of Retail Prices has been compiled since 1962 as a chain Laspeyres with weights changed every year. The new French monthly and quarterly indexes of consumer prices, introduced in 1972, are also compiled as chain Laspeyres indexes with weights changed every year.

Failure of chained indexes to meet the internal consistency requirement means, for example, that the quantity indexes compiled here are not ideal for a detailed analysis of changes in the composition of imports or exports. Similarly, the price indexes are not ideal for the analysis of price variability within broad industry groupings. However, failure to meet the internal consistency requirement does not significantly affect the immediate purpose of the IMPORT study which is to analyse the sensitivity of import flows at the industry level.[41]

8.5 Indexes of average rates of duty collected

Information on the value for duty and duty paid for each TI*SK were used to calculate measures of the average rate of duty collected and changes in tariff rates at the industry level.[42]

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41 Because of the failure of chained indexes to meet the internal consistency requirement, they rest awkwardly with modern demand theory since the sum of the value of purchases at constant prices for each good need not add to the budget total in constant prices. The empirical significance of this problem is uncertain. However, it is probably of least importance where the demand analysis is concerned with finely disaggregated commodity groupings, each of which represents only a small proportion of the total budget. On the other hand, the failure of chained indexes to meet the internal consistency requirement may have a significant adverse effect in demand analyses where each group of commodities represents a significant proportion of the budget total and/or where the budget constraint is employed explicitly in the estimation of the demand parameters.

For an example of an analysis where the use of chained indexes would in principle, have been inappropriate, see Goodman's (1975) application of the Armington (1969) model to analyse substitution between sources of steel imports into the US. The coefficients of that model (which assumes that the aggregate demand for steel is predetermined but there is substitution between sources of supply) are obtained by using systems estimation procedures.

Although it is true that, in principle, chained indexes would have been unsuitable for the type of analysis reported by Goodman, they still, as in the current case, - represent the best type of indexes to use when other criteria are considered.

42 The measures of average rate of duty collected compiled here should not be confused with measures of the average nominal rate of protection. The latter are averages of tariff rates (shown in the Customs Tariff) weighted by the value of domestic production. In contrast, the average rate of duty collected for each industry is an average weighted by the value of imports in each period.

For each ASIC industry, the average rate of duty collected (AD_t) was calculated by

$$AD_t = \Sigma D_t / \Sigma V_t \tag{6}$$

where D_t is the amount of duty paid with respect to imports of the i-th commodity in period t and V_t is the value for duty of imports of the same commodity in the same period. Thus for the ith commodity $D_{it} = r_{it} \cdot V_{it}$ where r_{it} is the ad valorem tariff rate. The summation is over the total number of TI*SK in the ASIC code which can be linked from period to period.

An index of the change in the rate of duty paid across the TI*SK in each industry was calculated using the Fisher formula with value for duty weights setting the base period to 100. A tariff index is then derived for each industry over the period 1968-69 to 1974-75.

$$R_{t,t+1} = \left(\frac{\Sigma r_{t+1} \cdot V_t}{\Sigma r_t \cdot V_t} \cdot \frac{\Sigma r_{t+1} \cdot V_{t+1}}{\Sigma r_t \cdot V_{t+1}} \right)^{\frac{1}{2}} \tag{7}$$

Again the summation is over the total number of TI*SK in the ASIC code which can be linked from period to period.

8.6 Presentation of the indexes

Indexes were calculated from the linked clearances data according to the formulae given above. They were prepared at monthly and quarterly levels of data aggregation and for both ASIC industry and Input-Output groupings. The indexes are stored on disk files and reproduced in both tabular and graphical form on microfiche. Sample output is provided in Figure 5 and Tables 6 and 7 for ASIC 2322 Household Textiles aggregated to quarterly level.

The graph is a plot of the Fisher price and quantity indexes. The columns in the table are:

Period:	year followed by quarter.
Laspeyres index:	quantity and price indexes calculated according to the Laspeyres formula.
Fisher index:	quantity and price indexes calculated according to the Fisher formula.

Implicit index:	indexes obtained by chaining the implicit index movement, where the implicit movement is calculated by dividing the movement in aggregate value of all commodities in the industry by the movement in the appropriate Fisher index.
Dispersion measure:	the number of standard deviation units that the corresponding Fisher index (movement) is removed from the mean of the period to period movements.
Coverage ratios:	as explained in Section 7, these provide a measure of the proportion of the data (by value) that has been used in the construction of the indexes.
Number:	the number of data items (eg TI*SK) that have been used in the index calculation.
Value included:	the value of the data items included in the index.
Total:	the total value associated with the data (eg total value of import clearances in the period) prior to linking the data, to obtain the subset used in the indexes.

TABLE 6 : IMPORT INDEXES[a] : NOMINAL VETTING 0.5 TO 2.0 (QUARTERLY)
ASIC 2322 - HOUSEHOLD TEXTILES (1968-3 = 100.0)

	Laspeyres		Fishers		Implicit		Coefficient of variances		Coverage ratios					Value	
	Price	Qty	Price	Qty	Price	Qty	Price	Qty	Link	Incl.	Qedit	Vedit	No	Incl.	Total
														$m	$m
1968-3	100.0	100.0	100.0	100.0	100.0	100.0	.00	.00	.999	.822	.177	.000	0	.9	1.1
4	102.3	107.9	100.2	105.7	97.6	102.9	.20	.30	.995	.845	.150	.000	16	1.0	1.2
1969-1	103.5	87.6	99.9	84.5	91.6	77.5	.13	.36	1.000	.897	.103	.000	15	.5	[illegible]
2	108.6	84.9	104.7	81.9	102.6	80.2	.08	.64	1.000	.840	.160	.000	16	.8	1.0
3	97.2	127.5	92.5	121.4	90.0	118.1	.25	.67	1.000	.846	.154	.008	17	1.1	1.3
4	111.1	121.0	100.7	109.6	101.6	110.6	.37	.42	.998	.815	.183	.000	20	1.0	1.3
1970-1	116.7	88.7	100.6	76.5	95.6	72.7	.20	16.08	.993	.864	.129	.014	17	.7	.8
2	140.0	82.3	116.8	68.7	114.4	67.2	.22	.37	.999	.839	.160	.000	16	.8	.9
3	135.7	150.8	108.7	120.8	105.3	117.0	.22	1.02	1.000	.849	.151	.003	18	1.2	1.5
4	147.6	139.0	115.9	109.1	111.8	105.2	.28	.30	.999	.853	.147	.001	21	1.2	1.4
1971-1	146.6	99.8	112.3	76.5	106.0	72.2	.41	2.57	.996	.871	.125	.004	22	.8	.9
2	164.9	117.3	124.0	88.3	115.1	81.9	.20	.34	.951	.850	.101	.030	18	1.0	1.2
3	160.9	193.8	120.5	145.1	129.7	156.2	.20	.35	.997	.903	.094	.000	14	2.0	2.2
4	151.3	209.8	111.6	154.7	117.4	162.8	.17	.37	1.000	.923	.077	.013	20	1.9	2.1
1972-1	182.4	155.6	132.9	113.3	136.4	116.3	.21	.63	1.000	.946	.054	.000	20	1.7	1.8
2	183.8	174.8	131.2	124.7	134.1	127.5	.17	1.20	.985	.936	.050	.000	20	1.8	1.9
3	172.2	236.7	119.4	164.1	123.7	170.0	.23	.48	1.000	.924	.076	.001	20	2.2	2.3
4	184.6	226.2	124.6	152.6	132.2	161.9	.23	.41	1.000	.914	.085	.013	21	2.1	2.3
1973-1	164.2	258.5	109.1	171.8	110.4	173.9	.20	.40	.998	.947	.042	.001	21	2.1	2.2
2	154.9	265.2	100.6	172.3	103.4	177.0	.41	.49	1.000	.933	.067	.244	20	1.9	2.0
3	222.9	299.2	135.4	181.8	151.9	204.0	.41	.66	1.000	.860	.140	.000	24	2.7	3.2
4	203.6	367.5	124.2	224.2	142.5	257.1	.30	1.33	1.000	.841	.159	.098	26	3.1	3.7
1974-1	209.0	592.5	112.9	320.0	122.8	348.1	.47	1.00	1.000	.887	.113	.068	27	4.0	4.5
2	268.9	651.0	133.6	323.3	153.8	372.3	.64	.57	1.000	.838	.162	.001	27	4.8	5.7
3	298.5	678.6	142.3	323.4	170.3	387.2	.30	.53	.999	.805	.194	.000	26	5.1	6.3
4	319.5	652.1	151.9	310.1	176.1	359.6	.16	.38	1.000	.832	.168	.015	26	5.2	6.3
1975-1	379.4	321.3	178.8	151.5	211.7	179.3	.23	.44	.999	.815	.184	.079	26	3.0	3.7
2	399.3	396.3	171.5	170.2	188.8	187.5	.54	1.07	.932	.810	.122	.165	26	3.0	3.7
3	471.1	570.8	152.1	184.4	163.0	197.6	.98	1.60	.999	.926	.074	.002	24	3.2	3.4
4	504.8	592.9	157.3	184.7	169.9	199.5	.34	.99	.999	.918	.081	.015	32	3.3	3.6
1976-1	503.3	657.6	155.1	202.6	165.0	215.6	.24	1.75	.997	.933	.064	.007	32	3.6	3.8
2	593.6	583.1	178.5	175.3	193.3	189.9	.27	.56	.999	.917	.083	.007	32	3.6	3.9
Min	97.2	82.3	92.5	68.7	90.0	67.2	.08	.30	.932	.805	.042	.000	14	.7	.8
Max	593.6	687.6	178.8	323.4	211.7	387.2	.98	16.08	1.000	.947	.194	.244	32	5.2	6.3

a Weighted by value

FIGURE 5 : PRICE AND QUANTITY INDEXES FOR ASIC 2322, 1968-69 TO 1974-75
ASIC 2322 HOUSEHOLD TEXTILES (Data Aggregated to Quarterly Level)

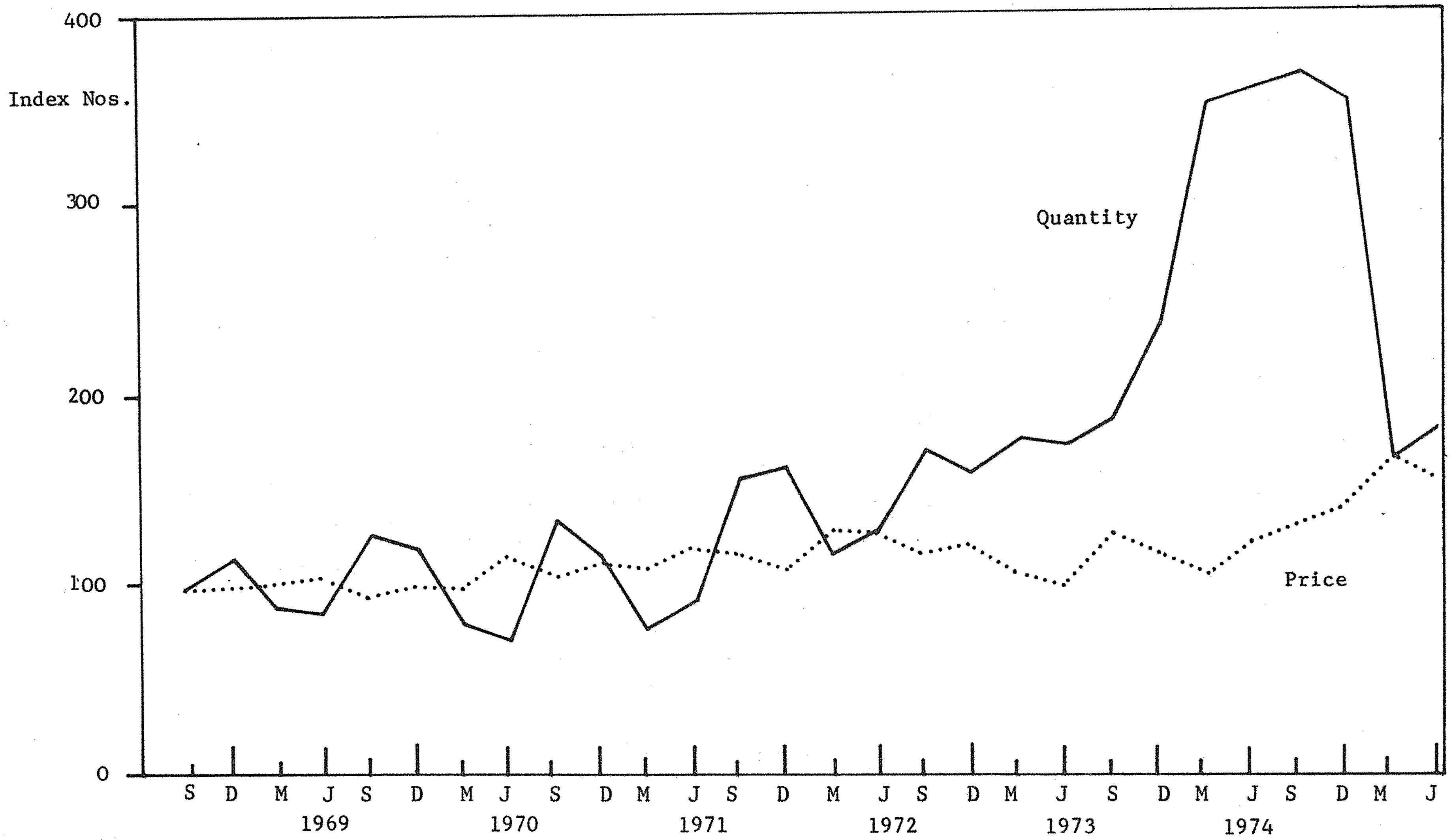

TABLE 7 : AVERAGE DUTY PAID ON IMPORTS AND INDEX OF RATES OF DUTY (QUARTERLY)

ASIC 2322 HOUSEHOLD TEXTILES:

	Average Duty %	Rate of Duty Index
1968-3	28.725	100.000
4	28.699	105.653
2969-1	26.651	107.326
2	26.278	107.168
3	28.021	102.963
4	28.405	104.799
1970-1	26.100	105.945
2	26.146	102.925
3	27.710	103.551
4	24.864	99.367
1971-1	21.932	102.956
2	20.601	103.337
3	24.856	103.307
4	21.976	105.072
1972-1	20.590	106.517
2	20.026	103.238
3	22.492	104.963
4	21.620	102.214
1973-1	19.845	103.054
2	19.572	102.803
3	19.327	81.365
4	21.578	76.735
1974-1	24.902	77.278
2	25.360	77.213
3	27.870	77.151
4	29.345	78.056
1975-1	24.758	76.659
2	18.324	72.715
3	16.531	97.793
4	16.383	100.735
1976-1	14.056	95.893
2	14.758	96.575

9. FISHER IND XES AND EXTREME MOVEMENTS IN UNIT VALUES

9.1 Vetting o unit values

One of the issues in the construction of price indexes using unit values is whether movements in the unit value of each commodity (ie the price relative) are acceptable under some criterion and whether extreme movements should be omitted from the index number calculation.

The criteria used to assess the reasonableness of the price relatives are essentially arbitrary and vary in their degree of sophistication. For example, commodities with unit value movements of plus or minus 50 per cent in any particular period might be (temporarily) omitted from the index. The Reserve Bank Import Price Index uses a more sophisticated criterion to assess the unit value movements used in part of the index.

> "In the construction of the import price index, a rule of thumb based on variability in the unit value has been used to determine whether that unit value could be regarded as an adequate measure of prices. Where the unit value (after allowance for seasonal and trend) fluctuated significantly (the precise rule was a standard deviation of 10 per cent) during the four year period ending 1968-69, it was rejected as a reasonable price indicator. Where the fluctuations were less than this, the unit value was accepted as adequate. Of course unit values which qualified under this test may subsequently become unsatisfactory because of changes in the composition of the import item." (Reserve Bank (1973))

Despite its apparent statistical sophistication, it is not clear that a procedure which determines whether commodity items are always excluded from the indexes on the basis of the dispersion in unit values around trend is superior to the simpler alternatives which exclude commodity items from inclusion in the indexes only in periods where the movements are judged too large to have been due to price movements. The preference for the simpler approach is reinforced by practical considerations.

Implementation of the more sophisticated approach requires a detailed examination of the time series of unit values for each commodity code and such a procedure is practicable only where the number of commodity items is small and the definition of these items is relatively constant. For the case at hand, however, such procedures are clearly unmanageable. If vetting is required, we have a strong preference for simpler procedures which exclude 'unit values' from time to time rather than procedures which exclude 'commodities' for all time periods.

Initially, two criteria were selected to vet at each point of time movements in unit values. Because the judgement on what magnitude of movement in a unit value can reasonably be attributed to a price movement is arbitrary and is dependent on the type of commodity and level of temporal aggregation, a range of limits was employed. The criteria and limits were:

(i) the simple criterion (already mentioned) whereby commodities with unit value movements of greater than or less than specified limits were excluded. It seemed reasonable to treat a doubling of a unit value in the same way as a halving. Hence the limits were upward movements of 100, 50 and 25 per cent and downward movements of 50, 33 and 20 per cent, respectively.

(ii) the coefficient of variation criterion, whereby commodities whose unit value movements from one period to another are more than, say, two standard deviations from the (unweighted) mean movement in the unit values of all commodities are excluded from the index in that period.

The second criterion recognises that the acceptable range of unit value movements may vary from period to period as the mean movement varies in magnitude. As applied here, the coefficient of variation criterion assumes that the frequency distribution of unit value movements between one period and another is approximately normal. In contrast, the simple criterion with the 'reciprocal' limits assumes that the distribution of unit value relatives is positively skewed.

The evidence indicates that the simple criterion is more valid. That is, for each ASIC the frequency distribution of unit value relatives tends to be skewed with a long tail to the right. Appendix 5 shows the frequency distribution of unit value relatives for two sample ASIC classes based on monthly data over 84 periods.

Although the empirical evidence gives guidance as to which vetting criterion is to be preferred it gives no indication of the appropriate vetting limits. This is most unsatisfactory since the trend behaviour of the calculated indexes is sensitive to the particular vetting limits applied. In general, the tighter the limits the lower the trend rate of growth of the unit value index. However, cases were observed where the chained movement in the indexes actually rose as tighter limits were imposed.

9.2 Fisher indexes and temporary shifts in quality or composition

Discussion within the project team on the appropriate limits led to consideration of the interaction of (the vetting of) extreme unit value movements with indexes based on the Fisher formula. In particular we have recognised the relevance of a basic property of the Fisher formula.

In contrast to indexes based on the Laspeyres and Paasche formulae, movements in unit values due to fluctuations in quality or composition have no substantial effect on the trend movement of a Fisher index. Movements from period to period may be biased, however. This conclusion follows directly from the definition of a Fisher index as the geometric mean of the Laspeyres and Paasche indexes.

Given a negative correlation between movements in unit values and movements in quantities, a large upward movement in a unit value between period 0 and 1 will bias upwards the Laspeyres price index number for period 1. The fall from that extreme unit value to more normal levels in period 2 biases downwards the Paasche index number for period 2. The upward and downward biases almost completely offset one another when the Laspeyres and Paasche indexes are combined to form the Fisher index. The resulting index number for period 2 does not generally contain an accumulated bias due to any extreme movements there may have been in previous periods.

To illustrate the point, consider an extreme example of an industry which has imports classified to two TI*SKs only. Item A is the standard product which is imported regularly in fixed quantities. Item B is an "n.e.c." item which records the irregular imports of both the 'economy' model and the 'deluxe'. Item A's imports each period are always $10 000 in value with 100 units of quantity. Imports of the economy model (classified to Item B) arrive every second month and are also valued at $10 000 with 100 units of quantity. There is no trend in the value of either good over time.

Imports of the deluxe (also classified to Item B) arrive from the second overseas firm every alternate month and are valued at $1000 with 5 units of quantity. The unit value of Item B therefore fluctuates from $100 to $200 to $100 and so on. The movement in the Laspeyres and Fisher price and quantity indexes for this industry is shown in Table 8. Detailed calculations are shown in Appendix 6.

Note that the Fisher price index fluctuates between 100 and 125 and that there is no trend in the index.[43] Consider next the Fisher quantum index which similarly shows no trend movement fluctuating between 100 and 44. In marked contrast to the Laspeyres and Paasche indexes no trend movement is included in either the price or quantity indexes by temporary fluctuations in composition or quality.

It should also be noted that although there is no trend in either the Fisher price and Fisher quantum index there is - in the example - a perfect negative correlation between the movements in each index. It is important to recognise that the correlation between the spurious movements (induced by random changes in composition and quality) in the price and quantum indexes in general will not be perfect and need not be negative.

Where the values of the goods trend over time and there are large movements in the Laspeyres and Paasche indexes due to extreme movements in unit values from period to period (as in the previous example), the complimentary movements in the component indexes do not completely offset one another. This leaves a small residual bias in the trend in the Fisher price and quantity indexes.[44]

Where large movements in composition/quality have occurred, the vetting of unit values results in a Fisher index with a biased trend whereas the unvetted Fisher indexes generally have no significant bias in their trend but have spurious movements from period to period. Accordingly, there is an expectation that the vetted indexes will be less subject to spurious movements between periods.

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43 The example illustrates dramatically the upward bias which occurs when index movements are calculated by the Laspey~es formula and there are sharp shifts in weighting patterns between periods and a strong negative correlation between unit value and quantity movements. The upward bias of the Laspeyres formula is, of course, accentuated by the chaining of between period movements to produce a continuous series.

44 The residual bias occurs because the trend in values causes a shift between periods in the relative weights of the commodities in the indexes. The magnitude of the bias is related to the size of both the fluctuations in unit values and the trend. For the trade data for which the indexes have been prepared the residual bias for any one period is generally less than one per cent. Further work on this issue is proceeding within the Commission.

If this were so there would be the question of a trade-off between achieving indexes with unbiased trends or unbiased period to period movements.[45]

TABLE 8 : COMPARATIVE BEHAVIOUR OF FISHER AND LASPEYRES INDEXES WHEN UNIT VALUES FLUCTUATE DUE TO QUALITY CHANGES

	Laspeyres Indexes		Fisher Indexes	
Period	Price	Quantity	Price	Quantity
1	100.00	100.00	100.00	100.00
2	150.00	52.50	125.36	43.87
3	143.18	143.18	100.00	100.00
4	214.77	75.17	125.36	43.87
5	205.01	205.01	100.00	100.00
6	307.52	107.63	125.36	43.87
7	293.54	293.54	100.00	100.00
8	440.31	154.11	125.36	43.87
9	420.29	420.29	100.00	100.00
10	630.44	220.65	125.36	43.87
11	601.78	601.78	100.00	100.00
12	902.67	315.94	125.36	43.87
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
48	577447.28	202106.55	125.36	43.87
49	551199.67	551199.67	100.00	100.00
50	826799.51	289379.83	125.36	43.87
51	789217.71	789217.71	100.00	100.00
52	999999.99	414339.30	125.36	43.87

9.3 Practical effects

Figure 6 which shows the Fisher price and quantity indexes for ASIC 2322 Household Textiles illustrates the saw tooth effect that large movements in unit values, due to changes in quality or composition, can have on the indexes.[46] In this case (and in most cases) the extreme movements in the price index are negatively correlated with extreme movements in the quantity index.[47]

45 Do we, in fact, observe a smoother index when we vet? In general we do not. The explanation lies in the strength of the negative correlation between unit value movements and quantity movements. This correlation may differ between commodities whose unit values are rejected and those whose unit values are included in the indexes. If the negative correlation is weakest for commodities whose unit value movements are rejected by the vetting criteria then the Laspeyres index will rise faster and the temporary aberrations in the Fisher index will be larger when vetting is applied.

46 The figure also illustrates significant seasonality in both the price and quantum indexes. The seasonal peak in quantities imported in the September quarter is particularly marked.

47 Comparison of Figure 6 (monthly indexes) with Figure 5 (quarterly indexes) illustrates clearly the smoothing effect that temporal aggregation has on the behaviour of the indexes.

Figures 7 and 8 illustrate other effects that the temporary changes in composition and quality have on the indexes. The price and quantity indexes for ASIC 2432 Footwear n.e.c., show a distinct seasonal pattern since shoes imported for summer have a lower unit value than shoes imported for winter. In contrast, the indexes for ASIC 2728 Chemical Products n.e.c., show little or no saw tooth effect or seasonal pattern. However, the single aberration in the indexes is clearly observed. This particular extreme movement is associated with a low coverage in the particular period.

Although the source of the temporary fluctuations in the unit values (and hence the indexes) differs in the three examples, in all cases they result in spurious movements in the indexes from period to period. In all three cases the spurious movements in the price index are negatively correlated with movements in the quantity index. However, the trend movements in the indexes remain unbiased.

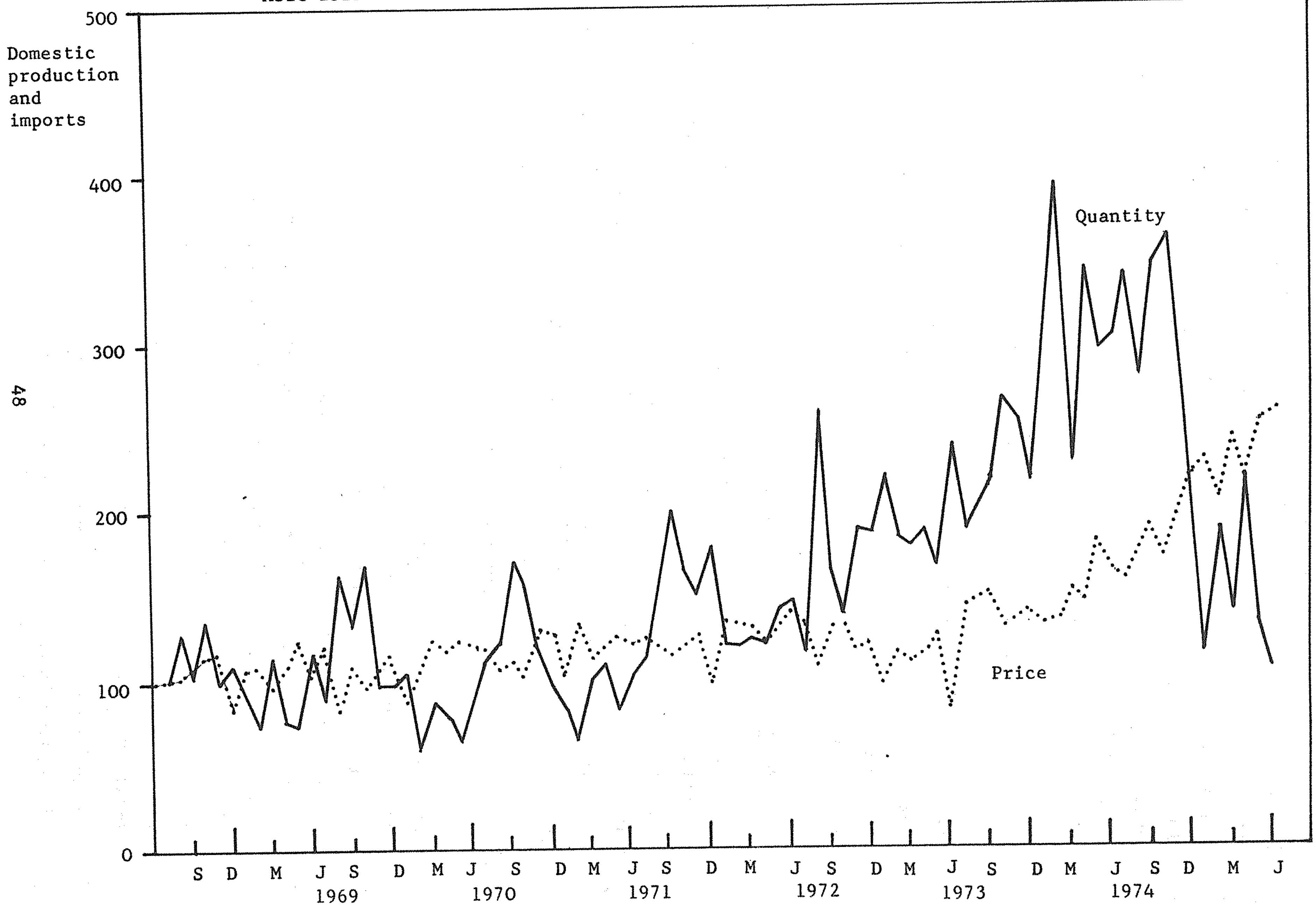
9.4 Relevance of period to period errors

The conclusion that the trend movements in the Fisher unit value and quantity indexes are not significantly affected by temporary fluctuations in the composition or quality of the goods is a result of considerable interest, since for many analytical and descriptive purposes we require a knowledge of trend movements only. For example, the statement that the price of imports relevant to a particular ASIC doubled between 1968-69 and 1974-75 can be made virtually without qualifications insofar as bias from fluctuations in composition and quality are concerned.[48]

For other analytical purposes we require a knowledge of price and quantity movement between periods. Analysis of time series data to estimate the sensitivity of changes in quantities demanded (or supplied) in response to changes in price (as measured by Fisher indexes of quantities and unit values respectively) will continue to be subject to some potential bias in the estimated coefficients due to the effects of temporary fluctuations in the unit values and the indexes. As observed in the preceding paragraph this bias does not arise from cumulated biases in the trends of the price and quantity movements. Rather the bias arises from extreme index movements from period to period around the trend or long term movement.

48 Systematic shifts in unit values due to permanent changes in composition and quality remain, of course, as a source of bias.

FIGURE 6 : IMPORT PRICE AND QUANTITY INDEX FOR ASIC CLASS 2322, SEPTEMBER QUARTER TO JUNE QUARTER 1975.
ASIC 2322 HOUSEHOLD TEXTILES (MONTHLY DATA)



Let us distinguish two sources of bias in the coefficient estimates to be obtained in an econometric demand analysis, the first arising from errors in the explanatory variable, the price index, and the second arising from the contemporaneous correlation of the spurious movements in the price and quantity indexes. The spurious movements in the explanatory variable, that is, the price index, induce a special type of error in the variable problem.

By definition, bias due to contemporaneously correlated errors in the indexes will only occur when current quantity movements are related to current price movements. For those econometric specifications which relate the quantity demanded in the current period to some function of prices in previous periods the contemporaneous correlation in the errors in the price and quantity indexes is unlikely in itself to bias the demand coefficients. For those specifications, the problem reduces to the errors in the variables case. For other specifications which relate the quantity demanded in the current period to price in the current period, the estimated demand coefficients may be biased. This bias arises because the negative relationship between unit value and quantity movements due to quality and composition changes cannot be distinguished from the economic relationship between price and quantity movements described by the demand schedule. It is relevant to note, however, that there is good evidence to suggest that a high proportion of the contemporaneous co-variation in the price and quantity indexes due to quality and composition change has a frequency of two months. Because least squares regression gives greatest emphasis to trend movements and because trend movements in both the price and quantity indexes are generally unbiased the scope for significant bias in the coefficient estimates would probably be small in most cases.[49]

9.5 Summary

To summarise the discussion so far on the vetting, we have rejected, for our purposes, vetting procedures which exclude commodities whose unit value movements are typically large by comparison with those of other commodities. We

49 In those cases where short term movements in the price and/or quantity indexes are suspected, the use of dummy variables to remove the offending aberrations from the regression is a simple method of avoiding bias in the coefficient estimates. For a relevant discussion and a second possible method of proceeding, see Engle (1974) and Hylleberg (1977).

FIGURE 7: FISHER PRICE AND QUANTITY INDEX FOR ASIC 2432. 1968 (iii) TO 1975 (ii).
ASIC 2432 FOOTWEAR N.E.C. (QUARTERLY DATA)

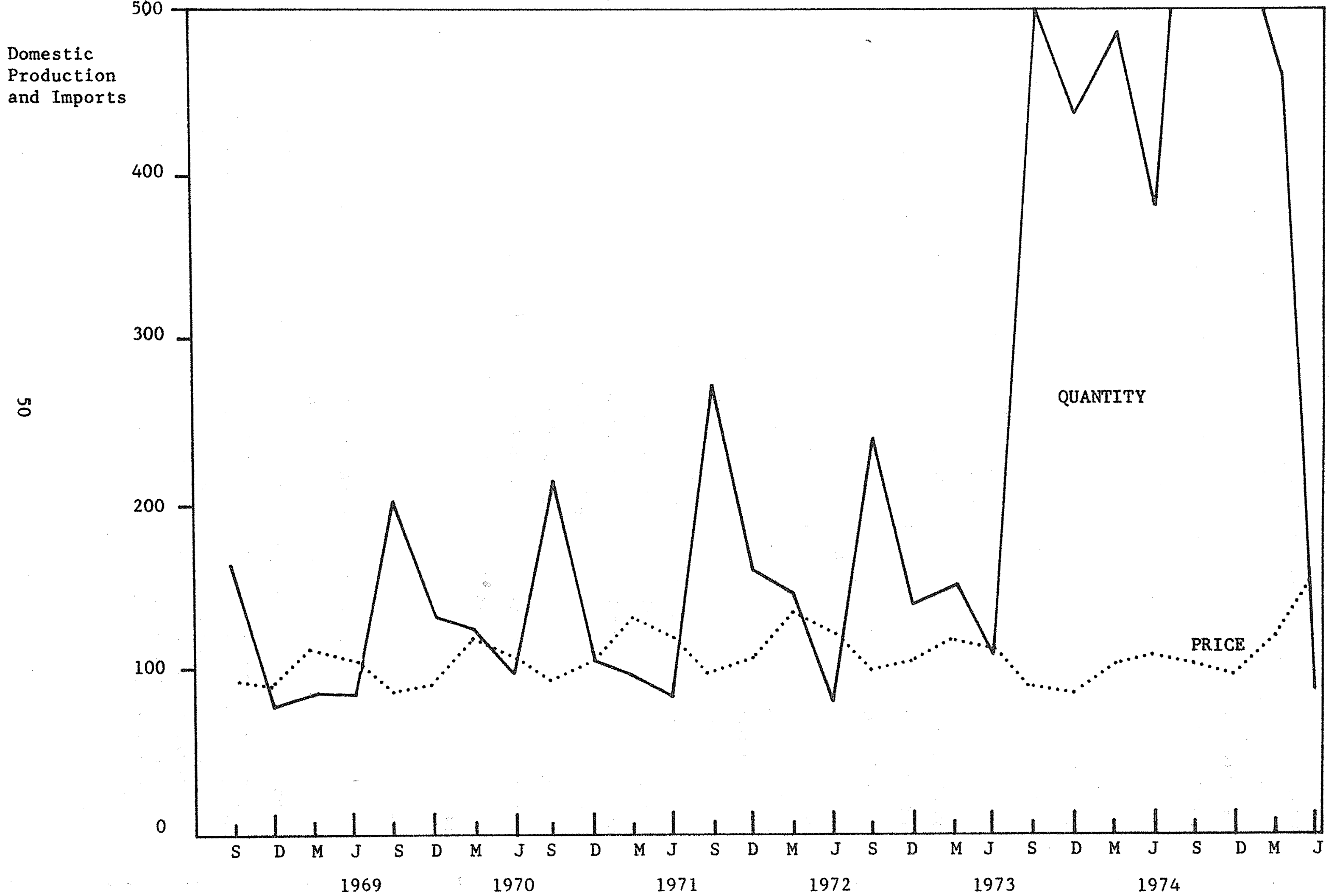
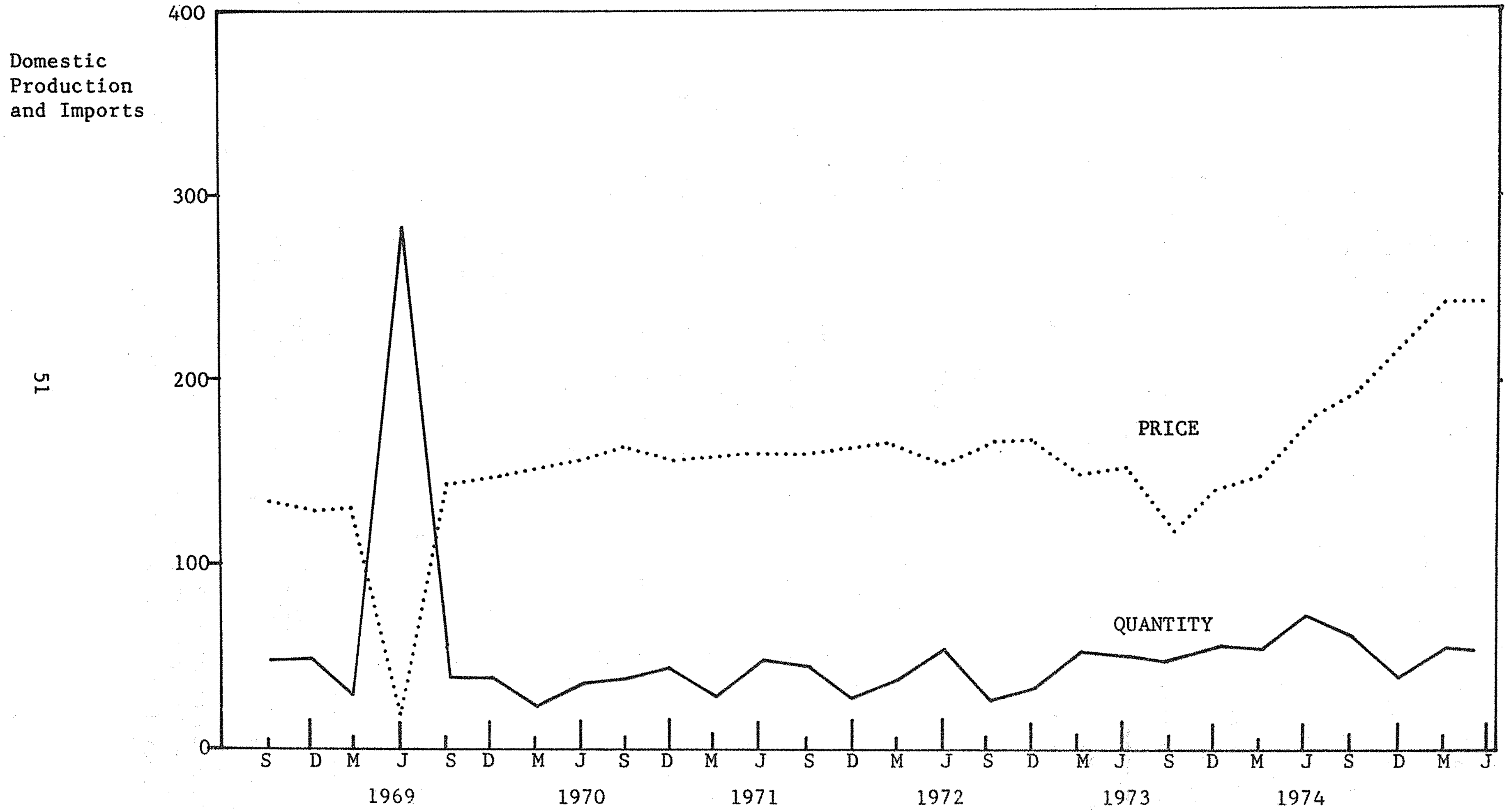


FIGURE 8 : FISHER PRICE AND QUANTITY INDEX FOR ASIC 2728, 1968(iii) to 1975(ii)
ASIC 2728 CHEMICAL PRODUCTS N.E.C. (QUARTERLY DATA)



favour procedures which reject extreme unit value movements on a period by period examination. The empirical evidence suggests that the distribution of unit value movements is unimodal and skewed to the right but gives no indication of specific limits to be set in the vetting procedure. This is unsatisfactory since the trend behaviour of the indexes is sensitive to the vetting limits employed. When the effect of temporary fluctuations in the unit values on Fisher indexes is considered we find that there is no trend in the indexes unless unit values and quantities also trend. This is in sharp contrast to the Laspeyres case. Generally, there is no significant bias in the trend movement of the Fisher indexes due to temporary fluctuations in composition and quality. Movements between individual periods may however be biased but the effect on the coefficients obtained in econometric analyses of demand/supply is probably small in most cases.[50]

We appear to have two choices: we can accept the indexes as they are, that is without vetting of any type and treat the spurious movements in the indexes between periods as problems for the analytical phase of the study; or we can vet and amend the final indexes. Inspection of Figures 6 to 8 immediately suggests the subjective vetting/interpolation procedures which might be adopted under this latter alternative. In an attempt to obtain an objective indicator as to which particular observations in an index should be questioned, we examined two indicators. First, we examined the dispersion of unit value and quantity relatives for each period. We concluded that the dispersion of price and quantity relatives - as measured by the coefficient of variation - is less useful than visual inspection for detecting extreme movements in the indexes.

Second, we examined movements in the indexes themselves. Specifically, we calculated the mean movement in the indexes from one period to another and the number of standard deviations that each period's index movement lies away from this mean. Defining an extreme observation as one where the price and

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50 Although the <u>potential</u> magnitude of temporary aberrations in the indexes due to extreme movements in unit values is higher for ASIC industries with fewer TI*SKs, ASIC industries with fewer TI*SKs will be less likely to experience extreme movements in unit values because their products tend to be more homogeneous. The obvious exceptions to this statement occur when the heterogeneity of the commodities is so great as to render further disaggregation to achieve homogeneity pointless.

quantity movements are in opposite directions and both movements further than, say, 1.5 standard deviations away from the mean, provides close agreement with the vetting pattern suggested by visual inspection. However, seasonal movements in the price and quantity indexes due to changes in composition or quality are not detected by this method.

We have opted - at this stage - to treat spurious movements in the indexes due to temporary fluctuations in the unit values as a problem for the analytical phase of the study. That is, the price and quantity indexes are chained indexes of the Fisher type. These indexes are calculated without vetting of either unit values, commodities or the indexes themselves to reduce extreme movements due to random shifts in the quality or composition of commodity items.

10 FUTURE DIRECTIONS

There are a number of extensions to the IMPORT study ranging from the updating of the indexes to 1975-76 to the use of the data for inquiry and research purposes. A first analysis, already commenced by the IMPACT team concerns the sensitivity of the demand for imports and domestic goods to change in relative prices.[51] In this section, comment is restricted to extensions of the indexes <u>per se</u>.

<u>Updating</u>: It is intended to update the price and quantity indexes for imports and exports, regularly, on an annual basis. The commodity/industry concordances and tariff histories will be maintained on a routine basis and have been completed for 1975-76. Index numbers for 1975-76 will be calculated shortly after the final clearances data for 1975-76 become available from ABS.[52]

Updating prior to receiving the final clearances data from ABS poses a difficulty. Most of the validation of histories and concordances is heavily dependent upon the reliability of the imports cleared data. Preliminary releases of the data are not sufficiently reliable for this purpose.

<u>Degree of fabrication</u>: For the immediate purpose of analysing the sensitivity of import flows to changes in activity levels and the relative prices of imported and domestic goods we have identified imports by end-use (eg consumption, investment and materials). These are the same end-use categories distinguished in the ORANI module of IMPACT.

Because substitution between domestic and imported goods may occur at different stages of fabrication, we intend to explore the degree of fabrication classification in the ABS economic class data with a view to applying it to the ABS import and export data.[53]

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51 See Alaouze, Marsden and Zeitch IAC, 1977.
52 ASIC will be applied immediately to the files from ABS when they arrive, eliminating the necessity to go through matching operations to assign ASIC codes.
53 For an analysis of pricing behaviour for different levels of fabrication, see Popkin (1973).

Country of origin/destination: Compilation of the price and quantity indexes for imports and exports by country of origin/destination can, in principle, be readily achieved. No work in this respect has so far been undertaken.

APPENDICES

ABS ECONOMIC CLASS GROUPINGS

	EC Class Codes		
	Crude	Simply transformed	Elaborately transformed
MATERIALS			
Producer's materials for use in-			
Building and construction	13	17	21
Rural industries	14	18	22
Manufacturing			
(i) Food, beverages, tobacco	15	19	23
(ii) Other manufacturing	16	20	24
(iii) Motor vehicle assembly	-	-	36
Fuels and lubricants-			
Fuels	-	25	-
Lubricants	-	26	-
Auxiliary aids to production-			
Advertising matter	-	-	27
Containers	-	28	-
Other auxiliary aids	-	-	29
INVESTMENT			
Capital equipment-			
Farm	-	-	11
Commerce	-	-	12
Transport equipment-			
Railway equipment	-	-	30
Complete road vehicles	-	-	31
Vessels	-	-	32
Aircraft	-	-	33
Munitions and war stores	-	-	35
CONSUMPTION			
Finished consumer goods-			
Food, beverages, tobacco	1	4	7
Clothing and accessories	-	-	34
Household equipment, jewellery, personal ornaments and time pieces, books and printed matter, amusement and recreation equipment, pharmaceutical and medicinal goods, other consumption	2	5	6,8,9

There are no class codes numbered 3 or 10.

ALLOCATION OF AECC ITEMS TO ECONOMIC CLASS GROUPINGS

Certain items in the Overseas Trade classification cannot be allocated entirely to one economic class. To enable allocation of these items to different economic classes, special codes have been allocated (by ABS) as follows:

Special EC code	Economic classes (Items divided equally between classes unless otherwise specified)
37	7,23
38	8,9
39	8,24
40	9,24
41	12,21
42	17,20
43	21,22
44	21,24
45	22,24
46	9,12
47	9,20,24
48	11,12
49	8,9,11,12,16,20,21,22,23,24
50	8,9,16,20,21,22,23,24
51	1,4,7
52	9,12,24
53	24,29
54	75% to 44 and 25% to 29
55	67% to 24 and 33% to 8
56	8,27
61	85% to 24 and 15% to 8
62	90% to 24 and 10% to 8
63	75% to 24 and 25% to 8
64	67% to 21 and 33% to 9
65	24
66	24
67	24
68	9
99[a]	Non merchandise

a All data for this classification were excluded from the index calculation.

COMPARISON OF ALTERNATIVE CONCORDANCES

This appendix outlines a preliminary check on the validity of the TI*SK/ASIC concordance and compares this concordance with the AICC/ASIC concordance which it supersedes.

There are enormous possibilities for human error in the manual assignment of 25 000 TI*SK to about 200 ASIC codes. Fortunately, a number of checks are available to reduce errors. One which was implemented (independently of later phases of the project) involved the Australian Import Commodity Classification.

For the purpose of allocating imports to a 4 digit ASIC, we require a concordance which allocates each TI*SK to the unique ASIC class to which it belongs. This cannot be achieved by use of the AICC/ASIC concordance despite each TI*SK having its corresponding AICC recorded with it on the data tapes. The reason is that an AICC may belong to several ASIC.[1] Previous studies within the Commission which used the AICC/ASIC concordance have (arbitrarily) allocated quantitative information for each TI*SK over the several ASIC codes to which they were allocated.[2]

Nonetheless, the AICC provides a useful - if weak - check on the directly obtained concordance. It will be recalled that the data tapes assign each of the TI*SK codes to a unique AICC code. (There are about 5000 AICC codes.) It is possible to check the TI*SK/ASIC concordance using the link between ASIC and AICC. Over recent years the Commission has compiled concordances between AICC and ASIC codes, based on an AICC/ASIC concordance compiled by ABS for the Australian Standard Commodity Classification project.

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1 The AICC (like the AECC) changes from year to year. An AICC/ASIC concordance must therefore be time dependent. In contrast the TI*SK/ASIC concordance is time independent.

2 For example, "Recent Trends in the Australian Manufacturing Sector", Staff paper prepared for the Committee to Advise on Policies for Manufacturing Industry, Industries Assistance Commission, Canberra, April 1975.

We are now able to test, for each TI*SK whether the single ASIC code shown in the TI*SK/ASIC concordance falls within the group of ASIC codes implied from the indirect route via the TI*SK/AICC and AICC/ASIC links. This checks the TI*SK/ASIC and the AICC/ASIC concordances for internal consistency.

Quite a high percentage of error signals were obtained initially; about 10 per cent of TI*SK assignments in the concordance were incompatible with those implied via the indirect route. The incompatible assignments generally involved little-used TI*SKs and represented a very small proportion of import clearances. The incompatibilities were eliminated. Often the error was traced to the AICC/ASIC concordance.

ASSIGNMENT OF ASIC TO CLEARANCES DATA

Since indexes are to be produced for commodities grouped into ASIC industries, each TI*SK on the clearances file must be assigned a unique ASIC classification. (Recalling that an Economic Class has already been assigned to each TI*SK at the data aggregation stage described in Section 5; permitting finer groupings into ASIC and EC industries if so required.) Some of the edits, to be described later, depend on knowledge of the ASIC code associated with each TI*SK, but the assignment process itself reveals some errors.

The concordance was used to allocate each TI*SK to an ASIC class. Any TI*SK appearing on the concordance but not on the clearances file, and vice versa, were queried. In this manner, coding errors and omissions from the concordance were revealed. This also led to the finding that some TI*SK, which according to the Customs Tariff were in existence for several months, did not have clearances recorded against them in any part of the seven-year period for which data were available.

The file showing the existence of clearances for each TI*SK but not quantitative information, was created at this ASIC allocation stage. An important feature of the clearances extract file is that it is highly compact. The clearances file has a separate record for each TI*SK/ASIC*EC/PERIOD combination. The extract file has a single record for each unique TI*SK. Every TI*SK has associated with it the ASIC to which it belongs, all EC in which there were clearances (a TI*SK can appear in several EC groupings) and an array of 84 flags corresponding to the 84 monthly periods from July 1968 to June 1975. A flag was set if clearances were recorded for a TI*SK in the corresponding month, irrespective of EC. The clearances extract file was used extensively in many of the editing procedures described in Appendix 4.

EDITING OF TARIFF HISTORIES

The editing and preparation of the tariff histories was the largest single task in the construction of the indexes, involving:

(i) validation of TI*SK codes

(ii) validation of the links, assignment of ASIC labels to each link

(iii) removal of uninformative links to a clearances history

This appendix describes these steps in detail.

(i) Validation of TI*SK codes

Both the concordance and links contain TI*SK codes which can be readily verified for correct structure. A typical TI*SK consists of 11 characters, the first 10 being necessarily numeric. If the 11th character, N_{11}, is in the range 0 to 9 or X standing for 10, it is a check digit which should obey the formula :

$$N_{11} = \text{mod}_{10} \left(\sum_{i=1}^{10} i.N_i \right)$$

where N_i is the i-th digit in the TI*SK code, and mod_{10} denotes the remainder upon division by ten. If N_{11} is not in the range above, it must be alpha and the remainder of the field numeric. This last situation arises from an unfortunate inconsistency in the use of N_{11}; however, the relative frequency of this occurrence is low.

All TI*Sk codes appearing in either the TI*SK/ASIC concordance or the link file were subject to tests for compliance with the above formula. The edit proved to be particularly successful in detecting interpretation errors where hand written source documents were not clear.

(ii) Validation of the links

Just as the clearances data requires an ASIC lable to be assigned to it, it is necessary to assign an ASIC code to each TI*SK of the link data. Some edits also will require knowledge of the ASIC to which each element in a link set is assigned. Perhaps the most time-consuming task (and that which needed the greatest care) has been in the devising of suitable editing and matching procedures for the clearances history. In many cases errors could only be detected by relatively weak tests which reveal a high proportion of false positives. All diagnostics from these procedures were confirmed or rejected by clerical examination. Only those procedures which were essential to the system and those edits which were found to be most effective will be described.

The following procedures were employed:

(a) Sequence checks

If, according to the histories, a set of TI*SK became an aggregation of another set of TI*SK in some time period, then in all probability the original TI*SK have discontinued. Their reappearance in subsequent time periods as part of a link provides cause for investigation. Legitimate reappearances, whilst infrequent, can occur. They may be due to a reintroduction of a TI*SK code (very rare) or because the aggregate of the original TI*SK is now recorded under only one of the former codes. Editing for this condition hopefully revealed most duplication errors and a significant number of interpretation errors incurred while coding from the source document.

(b) Assignment of ASIC*EC and associated edits

For correct sequencing at the linking/index calculation phase, it is necessary to assign an ASIC*EC to each TI*SK appearing on the link file. This cannot be achieved directly from the TI*SK/ASIC concordance since EC is not recorded there. The clearances extract file was successfully used for this purpose. The process revealed both TI*SK appearing on the link file but not on the clearances file and similarly TI*SK appearing on the clearances file (excluding all those which existed for the full 84 periods) but not on the link file. Since the histories usually reflect aggregation or disaggregation of existing commodity classifications,[3] miscoding or omissions from either file not detected by earlier checks became evident and were corrected.

(c) Time dependent checks/validating dates of links

For reasons outlined in the footnote, it is evident that if clearances for a TI*SK did not exist in July 1968 any subsequent clearance should have a link preceding it, ie there should be historical information indicating where it came from. A similar situation exists for TI*SK which do not appear in the last month of the data, ie there should be a link indicating where it went to. Matching the link file to the 84 flags on the clearances

3 The appearance of new TI*SK (and the removal of TI*SK)is usually the result of the refinement of an existing well-defined commodity grouping. Where this is not the case, the commodities indentified by the new TI*SK were previously included in 'other' or 'not elsewhere included' classifications.

extract file readily reveals these possible error types. Date errors on the links and certain omissions in coding were thus detected and rectified.

It is not unreasonable to expect that clearances for a TI*SK should not commence prior to a link signalling its creation. Similarly we would expect that clearances for a TI*SK would not appear after the date that a link signalled its cessation as a valid code. This reasoning led to another edit applicable to the dates appearing on the links. Although the test was not particularly successful in pointing to date errors, it made a very important revelation.

Quite often there is a substantial lag between the time a change is made to the formal tariff schedules and the time the changes become apparent in the clearances data. It is not unusual for a commodity to be recorded under both the new and the old TI*SK codes for several time periods, with diminishing values under the old code and increasing values under the new code. Recognition of this characteristic is necessary for correct linking of data at later stages. This lagging characteristic was most dominant in mid-year changes, the most frequent lag being a one month period although lags of up to 9 months have been detected.[4] Because of the low values associated with clearances lagging for more than one month, modification of the linking procedure to incorporate lags was restricted to a modification accounting for lags of one month only. Allowing a link to be current for more than one month after the date on which the change in TI*SK should have occurred would have induced unacceptably high levels of commodity

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4 Total link elements 28 500 100%

Data items lagging beyond cessation date implied by the history

(a) for 1 month or less	27 600	97%
(b) for over 1 month	900	3%

aggregation across most of the data. The problem was less significant at higher levels of temporal aggregation.

(d) Search for missing links

Most editing so far has been oriented towards validation of history information that had been coded from the source documents. It was vital that none of the history providing the links was overlooked. The following tests proved to be very successful at pinpointing not only transcription and omission errors from the source documents but errors in the documents themselves. The basic procedure was to examine the pattern of flags on the clearances extract file and to report any irregularities or discontinuities that could not be explained in terms of the links provided.

Some examples follow:

- We can determine the maximum time interval between successive clearances. We can also determine the time interval between a link and the first recorded clearance or the time interval between the last recorded clearance and the link. Where the time interval between the link and the first or last clearance is greater than the maximum time interval between successive clearances, there is reason to suspect the link. This type of error was usually a consequence of a TI*SK being aggregated into an incorrect commoditiy set that underwent some change at another point in time. Where exactly the same type of data stream appears but no link is found in any time period the link was apparently not coded through oversight.

- When there are regular clearances for a TI*SK in successive time periods followed by a substantial gap then again followed by regular clearances, there is a possibility that links are missing from both ends of this gap. This occurred when there was a temporary change in the level of refinement of the TI*SK groupings concerned. (This test was particularly important for exports data where the classification of data changed from confidential to non-confidential groupings and vice versa. There is no indication of this type of movement in the histories but links must be constructed in order to obtain a continuous data stream.)

- In the situation where there are regular clearances for some TI*SK and after a change in classification there are no clearances whatsoever under the new TI*SK but clearances under the old one persist, it is possible that the new classification is wrong. The more usual case is that the formal history does not coincide with reality. The policy adopted was to have links reflect reality (hence a change in date) when doing so would not introduce any ambiguity. For example, according to the history we expect a change in commodity name defined by the link $A \xrightarrow{t_0} B$ But clearances in A persist until t_5 with no clearances for B until t_6. For the link to be useful the date must be changed to t_6. Thus $A \xrightarrow{t_0} B$ became $A \xrightarrow{t_6} B$.

- Further tests of a similar type to the three above (based on rather subjective assessments of what 'reasonable' data behaviour should be like) were used to produce selective lists for clerical examination. A particular class of errors revealed by some edit would provide guidance for further development of editing procedures.

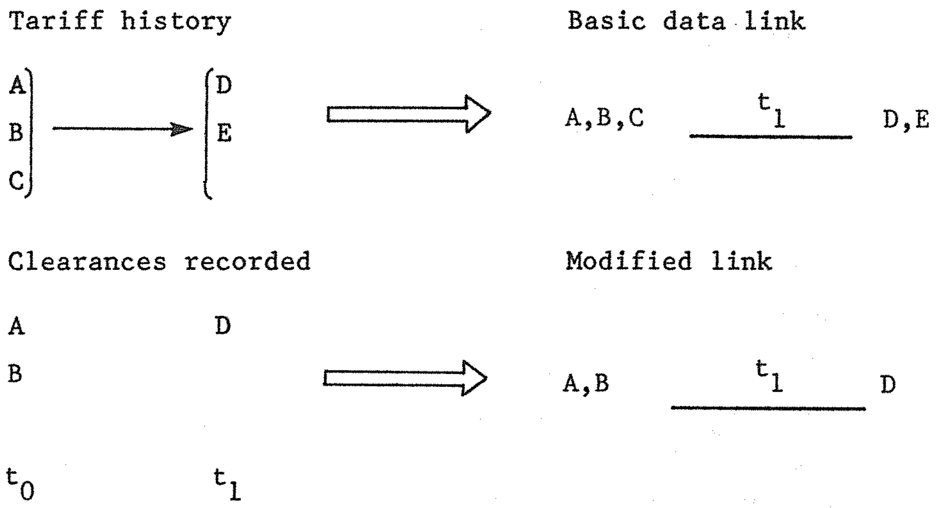
In total, the edits on the link file produced several thousand diagnostics. Each had to be individually evaluated since most were suspected errors, not definite errors. The yield of errors detected ranged from 75 per cent to 5 per cent (depending on the program) of the suspect situations reported.

(iii) Removal of uninformative links

Because of the irregular nature of clearances for certain TI*SK, the presence of some link elements for which no clearances were recorded in the corresponding time period is not really meaningful. That is, the final data series would remain unaltered whether or not those link elements were present. The link file was matched against the clearances extract file. When clearances did not appear for the entire set of TI*SK implied by the link it was modified to contain only link elements for which data were present. For example, for a particular ASIC*EC grouping in Figure 1, let A, B, C, ... represent TI*SK and let t_1 represent the i-th period. Then:

Figure 1

Comparisons of tariff history and clearance history.



Clearly the elements C and E, for which no clearances were recorded, are uninformative and should be discarded. The reduced set of links thus reflects a clearances history rather than a tariff history.

The breakdown of link elements is:

Total link elements	28 639
Link elements for which there were clearances data	23 989
Uninformative link elements (ie link elements for which data did exist were all type A or all type B)	854

THE FREQUENCY DISTRIBUTION OF UNIT VALUE CHANGES OVER A SEVEN YEAR PERIOD

Changes in unit value for all commodities were plotted for each ASIC industry[5]. The distributions are presented in both a cumulative (BI-2) and a non-cumulative (A1-2) form. Two representative samples are provided on the following pages.[6]

Change in unit value is defined for each commodity as

$$\Delta UV = \frac{UV\ (\text{period } j+1)}{UV\ (\text{period } j)}$$

The range of ΔUV was from zero to three or more.

The graph for ASIC 2422[7] illustrates that whilst only 1 per cent of commodities exhibited a unit value change of 3 or more, they correspond to 8 per cent of total value for the seven years. As expected, unit value changes cluster around one (marked by vertical lines). It is of interest to note that for all ASIC industries, a significant number of unit value changes (as defined above) are close to zero. Changes of several thousand per cent do occur from time to time for extreme cases eg, bull semen.

5 The distributions were derived from the commodity block pairs D_{ij} and $D_{i(j+1)}$ described in Section 7, for time intervals of one month.
6 Distributions for all ASIC industries are of a similar form.
7 ASIC 2422 Women's and girls' outer garments n.e.c.
ASIC 2314 Man-made fibres and yarns.

FIGURE A1 : ASIC 2314 NO. OF TI*SK = 7325

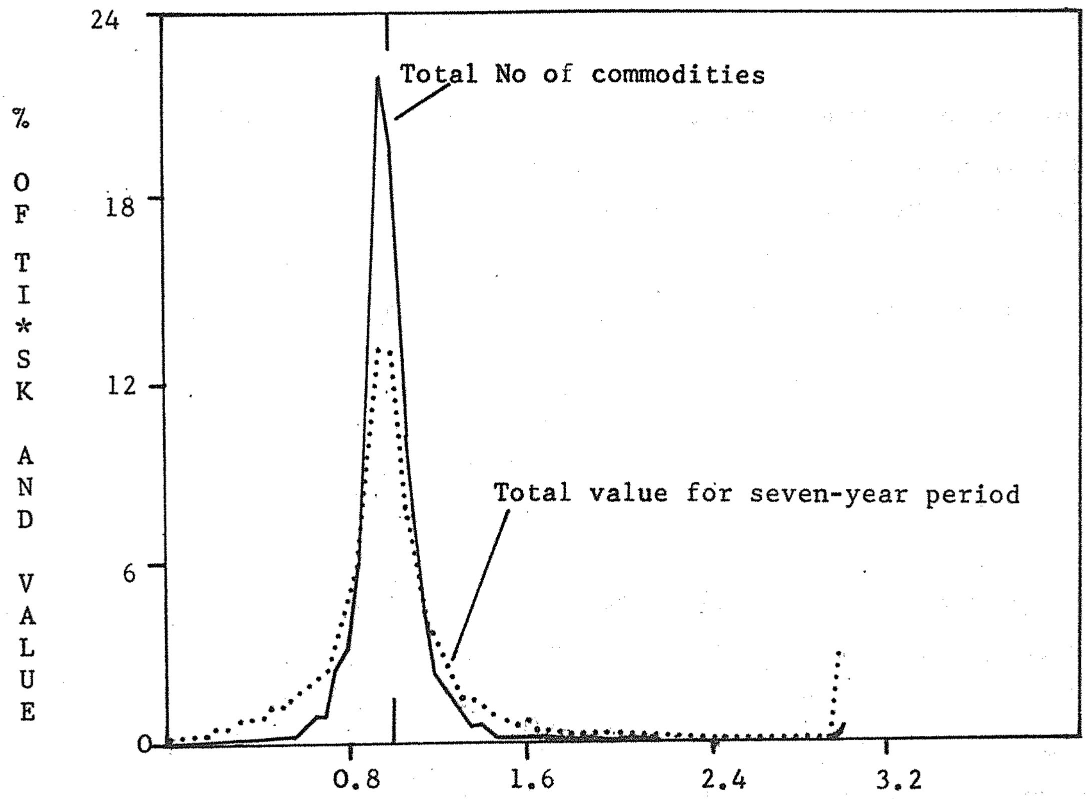


FIGURE A2 : ASIC 2422 NO. OF TI*SK = 1794

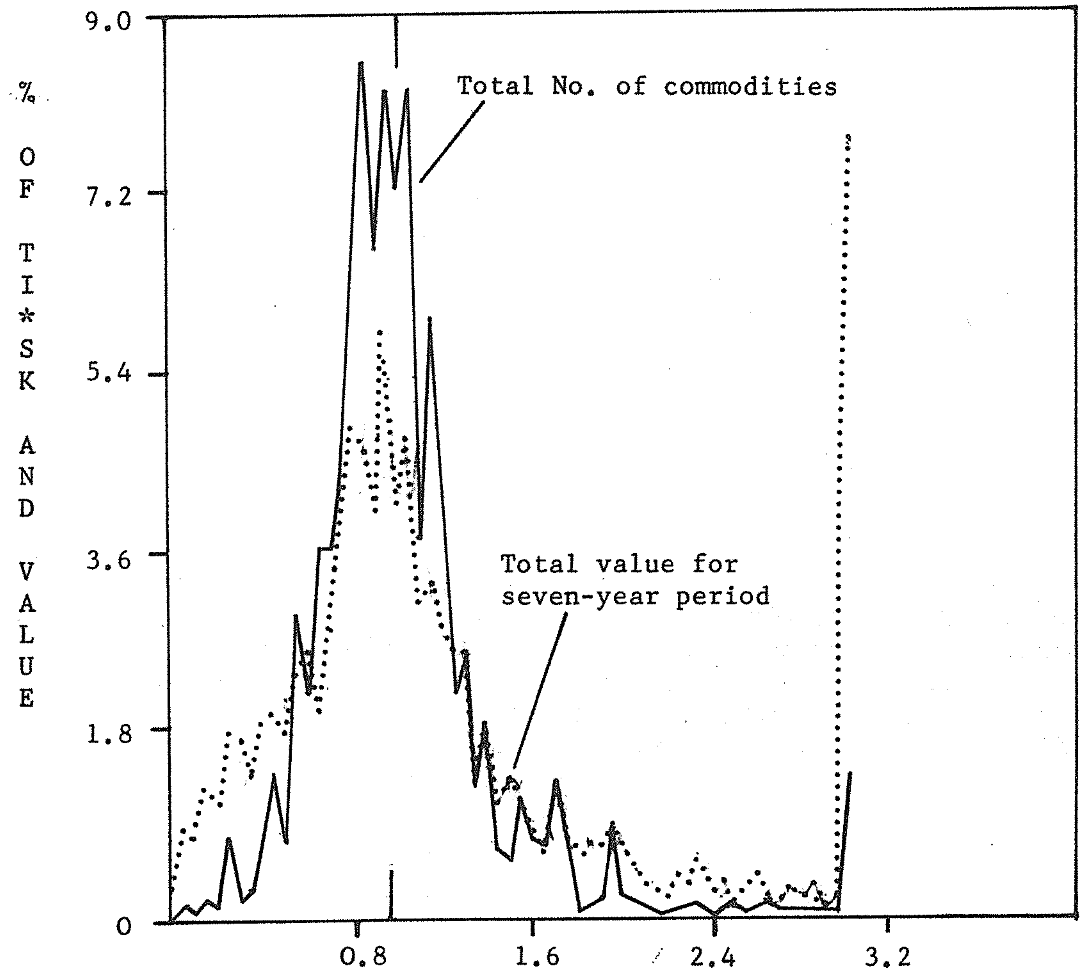


FIGURE B1: ASIC 2314 NO OF TI*SK 7325

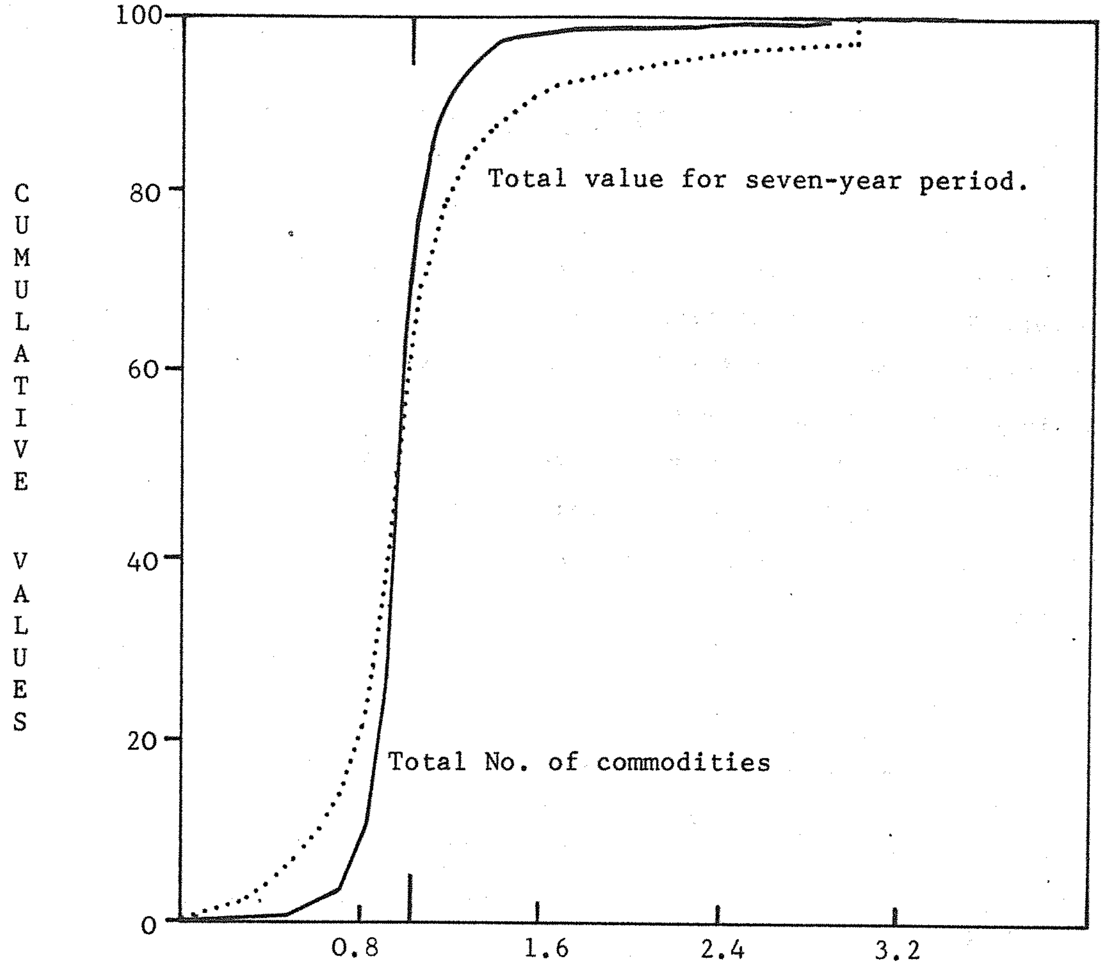
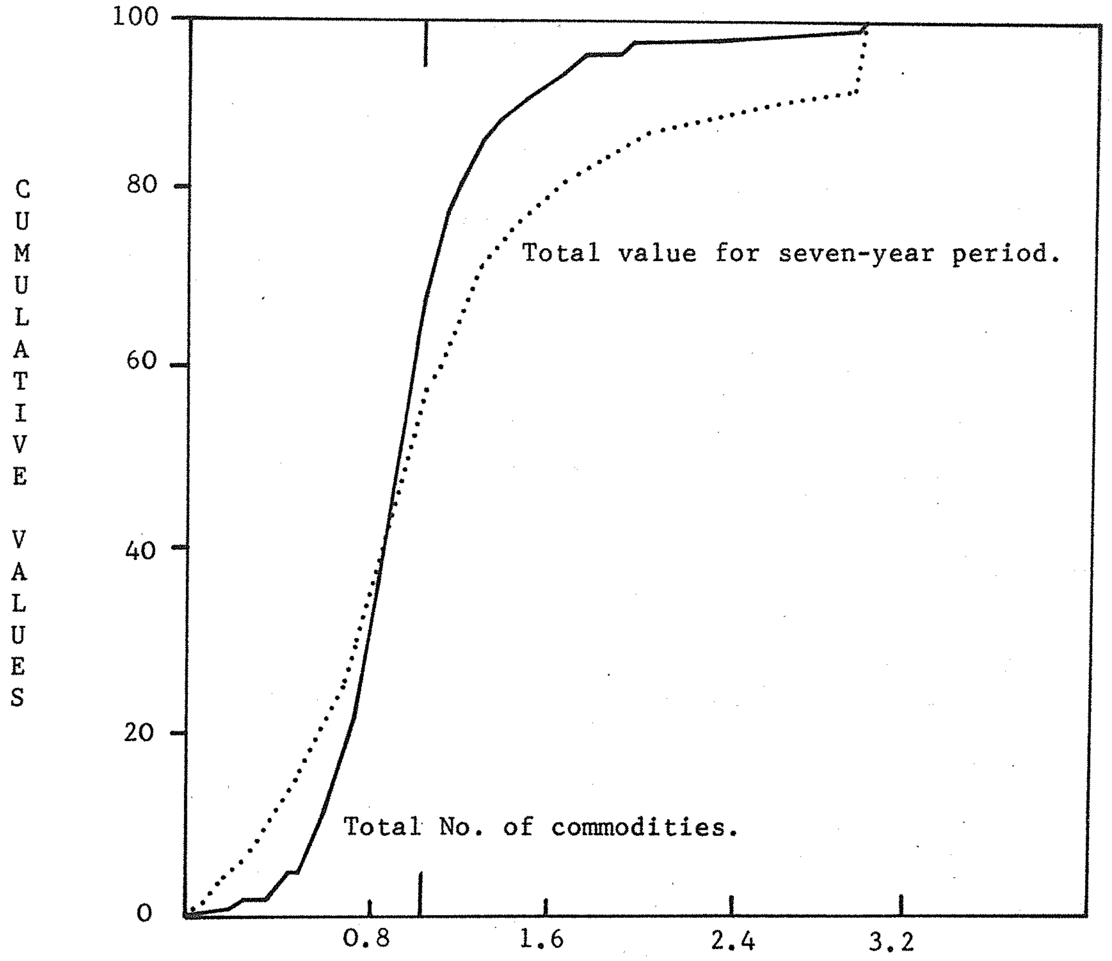


FIGURE B2: ASIC 2422 NO OF TI*SK 1794



COMPARISON OF BEHAVIOUR BETWEEN FISHER AND OTHER INDEXES

Consider an ASIC with 2 items of data such that the unit value of one item remains constant throughout the series of observations while the other item shows extreme fluctuations in unit value. Note, however, that despite the fluctuations in the second item there is no underlying trend. If we further assume a negative correlation between unit value and quantity movements then the resultant Laspeyres index (chained) would show a geometric upward trend. The Fisher index on the other hand fluctuates as the unit value fluctuates but shows no underlying trend.

Example of data

Period	Value	Quantity	Unit Value	Δ UV
1	10 000 10 000	100 100	100 100	
				$\Delta UV_1 = 1.0$ $\Delta UV_2 = 2.0$
2	10 000 1 000	100 5	100 200	
				$\Delta UV_1 = 1.0$ $\Delta UV_2 = 0.5$
3	10 000 10 000	100 100	100 100	
				$\Delta UV_1 = 1.0$ $\Delta UV_2 = 2.0$
4	10 000 1 000	100 5	100 200	

3. The formula for the Laspeyres price index is

$$P_{k+1} = \sum_{i=1}^{n} (\Delta UV_{ki} \cdot V_{ki}) \; / \; \sum_{i=1}^{n} V_{ki}$$

where P_{k+1} is the index value in period k+1

ΔUV_{ki} is the change in unit value for item i in period k $\longrightarrow$ k + 1.

V_{ki} is the value for item i in period k.

hence P_2 = ((1 x 10 000) + (2 x 10 000)) / 20 000

$\therefore\ P_2 = 1.500$

P_3 = ((1 x 10 000) + (.5 x 1 000)) / 11 000

$\therefore\ P_3 = 0.954$

$P_4 = 1.50$, $P_5 = .954$ etc.

It is obvious that the upward fluctuations are far larger than the downward fluctuations, so that if we give our Laspeyres index an initial value of 100 and chain the index such that

$$PI_n = PI_{n-1} \cdot P_n$$

we create a ficticious upward trend.

PI_1 = 100.00
PI_2 = 150.00
PI_3 = 143.18
PI_4 = 214.76
PI_5 = 205.01
PI_6 = 307.52
etc.

4. The corresponding values for the Paasche Price Index would be as follows:

PA_2 = 1.048
PA_3 = 0.667
PA_4 = 1.048
PA_5 = 0.667
etc.

If we chain this index we obtain a ficticious downward trend thus

$PAI_1 = 100.00$
$PAI_2 = 109.00$
$PAI_3 = 69.68$
$PAI_4 = 72.47$
$PAI_5 = 48.55$
etc.

5. By calculating the Fisher index as the geometric mean of the Laspeyres and Paasche indexes we obtain the following:

$PF_1 = 1.000$
$PF_2 = (1.5 \times 1.04)$
$= 1.250$
$PF_3 = 0.798$
$PF_4 = 1.254$
$PF_5 = 0.798$
etc.

Now if we chain the Fishers index we obtain the following:

$PFI_1 = 100$
$PFI_2 = 125$
$PFI_3 = 100$
$PFI_4 = 125$
$PFI_5 = 100$
etc.

Clearly the ficticious trends displayed by the Laspeyres and Paasche indexes are not evident. Despite the fact that the fluctuations in the data produce fluctuations in the Fisher index, the index displays the true trend of the data.

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