

Working paper

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FORECASTING TECHNOLOGICAL
COEFFICIENTS

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Bureau of
Industry
Economics

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SEVENTH CONFERENCE OF ECONOMISTS

Sydney - Macquarie University

28 August to 1 September 1978

Working paper no. 1

BUREAU OF INDUSTRY ECONOMICS, CANBERRA, 1978

ABSTRACT

Forecasts are made of technological coefficients (defined as a breakdown of the factor requirements, intermediate goods, labour and capital per unit of output) of Australian industries to the year 1990/91.

The approach is to update historical sets of coefficients largely on the basis of comments provided by industry experts. An assessment is made of all input-output industries, however effort is concentrated on those industries whose technological changes are expected to be most significant.

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1. INTRODUCTION

The work described in this paper is an attempt to assess the technological scenario that is likely to relate to Australian industries in the year 1990/91. Technology is interpreted in the input-output sense as the breakdown of factor inputs (direct purchases, labour and capital) required by each industry in order to produce a given level of output.

These forecasts are intended as exogenous input to SNAPSHOT¹, a long term model of the Australian economy being developed by IMPACT.² However the technological scenario developed has much broader application possibilities, it can be used either in other input-output based models, or purely as an information source identifying possible future developments within Australian industries.

Naturally such a task involves considerable detailed work, far in excess of that which can be related here. The scope of the paper is restricted to providing an outline of the project; the nature of the task, the approach used and an indication of the results obtained. It should be mentioned that those forecasts which are presented, are preliminary and may be revised in the light of subsequent work. For further details of the work outlined in this paper the reader is referred to forthcoming working papers³ which deal with more specific aspects of the project.

The content in this paper is divided into a number of sections. Section 2 indicates how the technological coefficients are defined and what is involved in making forecasts of such coefficients. Section 3 is devoted to a description of the methodology and problems encountered in the project. The problems discussed are of a fairly

general nature and do not include problems specific to individual industries. Forecasts of specific industries are included in an appendix.

The present paper does not attempt to use the technological forecasts to make projections regarding other aspects of the Australian economy in 1990/91. Conclusions are restricted to features of the approach used and some general comments on the determinants of technological coefficients and their behaviour over time.

2. THE TECHNOLOGICAL COEFFICIENTS

The specification of technology over all industries takes the form of three matrices, a direct requirements matrix, a labour requirements matrix and a capital requirements matrix. The level of industry detail considered in each is the 109 industry classification defined and used in the 1968/69 Input-Output tables published by ABS (3). In the labour matrix nine occupational categories are defined; these are listed below.

OCCUPATIONAL GROUPS USED.

1. Professional White Collar
2. Skilled White Collar
3. Semi and Unskilled White Collar
4. Skilled Blue Collar (Metal and Electrical)
5. Skilled Blue Collar (Building)
6. Skilled Blue Collar (Other)
7. Semi and Unskilled Blue Collar
8. Rural Workers
9. Armed Services.

These categories are the same groupings currently used in other IMPACT models. They are ultimately defined as groupings of occupations used in ABS population censuses.

Armed Services are included for completeness of coverage but as they are usually modelled exogenously, are not relevant to the technological coefficients defined here.

2.1 Direct Requirement Coefficients Matrix

This 109 industry by 109 industry matrix shows the intermediate inputs of goods and services required (on average) to be supplied by every other industry in order for an industry to produce one unit of output. That is the j th element of the i th row indicates the quantity of intermediate inputs to be supplied by industry i in producing one unit of the j th industry's output. The matrix corresponds to that published by ABS (3) and titled "direct requirements coefficients matrix, basic values with indirect allocation of imports". This version of the table is specifically chosen because of the way in which imports are allocated. The indirect allocation of competing imports means that the coefficients obtained reflect more accurately the process being used, do not depend on the penetration of imports and therefore have relative stability.

2.2 Capital Requirement Coefficients Matrix

This is also a 109 industry by 109 industry matrix. The elements show the quantity of capital stock of each type required for each unit of an industries output capacity. That is, the j th element of the i th row shows the quantity of capital goods originating from industry i necessary for each unit of industry j 's output capacity. The numbers do not relate to any particular plant but represent industry averages.

In practise there are only about 20 industries which supply capital equipment items, so, although the matrix notionally has 109 x 109 elements, many of these are zero.

To clarify the concept of capital stock and to distinguish it from other inputs the following definition is used.

Capital stocks are inputs which are fixed in the short run, i.e., they are not easily replaced and can limit output in the short-run. Furthermore capital inputs are not used up in the production process within one year; they are durable over time. Capital items are defined here as non-human, tangible, man-made and reproducible. Therefore land, livestock, human skills and intangible assets do not constitute capital. The value of capital used in each industry is the item of interest irrespective of ownership, therefore leased items are also included in estimates of capital stock.

2.3 Labour Requirements Coefficients Matrix

This 9 occupation by 109 industry matrix shows the number of persons from each occupational group required to produce one unit of annual output in each industry. That is, the j th element of the i th row shows the number of persons, having occupations in category i , required on average for each unit of annual output from industry j . The numbers do not correspond to employment in any particular firm but are simply an average of the number of persons of each type employed by the industry over a particular year, divided by the total value of the industry's output produced in that year.

2.4 Estimates of Matrices for Previous Years

Existing estimates for each of the matrices described above are used as a starting point for making forecasts of the coefficients to 1990/91. Most information regarding historical coefficients is available for the year 1971/72, consequently this is selected as the base year from which projections for future years are to be made.

The matrices compiled for past years and used in this study are discussed below.

Direct requirements matrix -

The 1968/69 input-output table compiled by ABS is used in this study. This is the most recently compiled table of its kind. Although it does not represent the year 1971/72, the differences in direct requirements coefficients between 1971/72 and 1968/69 would be slight. Relative price changes were small and changes to the coefficients in real terms are normally negligible over such short periods. The few changes of significance (e.g., increases in domestic oil and gas production) are fairly easily taken into account when making updates of the coefficients.

Capital requirements matrix -

Information on the breakdown of capital stock by industry is extremely difficult to obtain for Australian industries. Fortunately a capital stock matrix has been compiled by the IMPACT team (4) for the year 1971/72, for use in their ORANI model. This matrix has been compiled using the 1968/69 input-output classification for both the industry utilising the equipment and the supplying industries. The estimates are based on investment data from ABS economic census publications combined with data available from other sources such as from individual firms, research organisations and so on.

The capital requirements matrix is obtained by dividing elements of the above capital stock matrix for each industry by the estimated domestic production for that industry in 1971/72. The domestic production figures used were those compiled⁽⁵⁾ by IMPACT for their

1968/69 to 1971/72 RAS Update of the input-output table. The capital requirements matrix so produced forms the basis from which forecasts of the corresponding matrix for 1990/91 are made. Although it is defined in terms of output capacity, the 1971/72 capital matrix does not necessarily relate to a 100% capacity utilization situation. We abstract from the problem by assuming a similar rate of capital utilization in 1990/91 as in 1971/72.

Labour requirements matrix -

Employment by occupation and industry are available from the 1971 Population Census. In that Census 370 occupational groups and 504 industries are identified. Using this data, employment according to the industries defined in the input-output tables were estimated. Both the census industry classification and the input-output industry classification are based on ASIC, so in most cases the concordance to the input-output industries is straight forward. In the few cases where the input-output industry did not correspond to ASIC or the census classifications, persons were allocated on the basis of other information available. In most cases this was done using industry wages and salaries data.

Some additional ad hoc adjustments were also made to maintain sensible occupational composition. For instance, in the motor vehicle repair industry, which is a redefinition of retail trade classifications (e.g., service stations), persons in occupational groups relevant to repair work such as mechanics, metal workers, etc. were allocated to motor vehicle repair while others such as bowser attendants were left within retail trade.

Although only 9 occupational groups are defined for the

eventual matrix, the labour matrix was initially condensed (from the 370 census categories) to give 39 occupational groups. This additional detail provided flexibility, showing how each group is defined and assisted in making forecasts as to actual compositional changes.

While the Population Census data formed the basis for estimating occupational composition within each industry, the total labour figures for 1971/72 were obtained from economic census data wherever this was available. This not only avoided problems of allocating persons in undefined population census categories but also allowed employment in other years to be obtained on a consistent basis (for the purposes of identifying trends and checking on short term fluctuations).

To estimate labour by occupation requirements for each \$ million of output, the employment figures obtained as above were divided by domestic production of each industry for the year 1971/72.

There are several additional difficulties associated with defining labour requirements. For instance, variations in overtime, part-time workers or even the standard number of hours in a work week would all change the relevant labour requirements in terms of the number of persons. For the purpose of the forecasts we abstract from this problem by assuming that the 1990/91 situation is similar to that in 1971/72. That is, for each industry the percentage of overtime, part-time work etc., remains unchanged. Variations to the labour coefficients to accommodate alternative assumptions can be made fairly readily at a later stage if desired.

2.5 Estimates of Matrices for 1990/91

The task of forecasting the technological matrices is essentially one of "updating" or assessing how the existing coefficients are likely to change by 1990/91.

Extrapolation of past trends is a useful first approach, however the results must be considered with some caution. For instance the coefficients may not continue to move in the same way as they have done in the past. Of course, if the determining factors for the past changes are identified, then the future likely behaviour can be assessed in the light of the likely future changes of these same factors. However, the likelihood of new influences must also be considered. Another limiting factor arises from the paucity of historical data required for making extrapolations. In most cases the base year matrices represent the only historical coefficient estimates currently available and also the adoption of the ASIC in 1968/69 means that only a limited time series of related data is available.

Overseas studies provide additional information on the behaviour of technological coefficients over time. Perhaps Carter's study of technological change in the US economy (6), is the most comprehensive in this regard. She found that direct requirements coefficients tend to be quite stable over considerable periods of time; capital coefficients are more varied in their behaviour but in most cases the rate of change is fairly slow. Labour requirements coefficients, on the other hand, are continually decreasing as a result of labour productivity gains.

Such studies are useful in that one would expect that the broad principles applying to coefficient change to be applicable (e.g., the stability of the matrices) also to

the forecasts. However these studies do not relate to Australian conditions hence their industry specific results are of limited value. Thus the information available on which to base coefficient forecasts remains fairly scant. The update procedure therefore must be relatively ad hoc in nature, relying on whatever information is available and will differ from industry to industry and from one factor to another. The approach used is described in section 3.

3. THE UPDATE METHODOLOGY

The updating of technological matrices for historical periods has a large range of associated methodology (7). These methods tend to depend on the use of related historical data which constrain the way in which the matrices could have changed to provide the observed values. Collectively these techniques could be referred to as the statistical (or ex post) approach. The alternative described here would be referred to as the judgmental (or ex ante) approach. This approach has been used at Battelle-Columbus by Fisher and others in estimating direct requirements and capital matrices for both recent and future years.(8).

Only the ex ante approach is applicable to future years. Unlike other methods of technological forecasting that usually try to date the likely future occurrence of a specific technological event, the required task is to forecast not only the kind of technology a given sector would be using in a given year but quantitative estimates of factor inputs involved. This is a significant distinction, since the forecasts cannot be easily played back for forth between a panel of experts and a secretariat (e.g. the Delphi method).

A second important consideration is introduced by the

immensity of the forecasting task. Each of the three matrices describes 109 industries and in principal this means there are approximately 25,000 cells to be considered.

3.1 The Approach

To actually consider all the determinants and the likely value of a coefficient appropriate to each of these cells would be an enormous task, well beyond the resources available to this project. Instead we rely heavily on the observed historical fact that many of the coefficients vary only slowly over time and concentrate most of our efforts on those industries where the more important changes are likely to take place.

In fact, detailed studies were undertaken for only a fraction (about 10%) of all the input-output industries. Industries for such detailed updates were chosen on the basis that they must not only be important industries in the economy in 1990/91 but significant technological change must be expected to take place in them as well.

A number of distinct phases within the update procedure are identifiable. The first is a survey of persons having reasonable knowledge of the various sectors of the economy. This is to obtain a more general view of likely developments to 1990/91 and in particular identify those industries where detailed updates may be warranted.

The second stage involves the detailed updating of coefficients for the selected industries. The crucial aspect of this stage is the consultation with an expert, to update the industry coefficients based on his knowledge of the industry and ideas of future developments. The number of experts were deliberately limited so as to make the task manageable.

In parallel with the second stage some assessment is made of those industries not considered large enough or likely to undergo sufficient change to warrant detailed study. Such refinements will be referred to as less detailed updates. While in many cases (as indicated both by overseas studies and our own preliminary results) both direct requirements and capital requirements are expected to remain fairly constant, the labour coefficients tend to change fairly rapidly with time as the labour productivity improves. The latter coefficients therefore are probably the most important and certainly demand some attention. To ignore such changes may not only give misleading results in any model as to overall labour requirements and wage costs, but also distort the outputs of industries subjected to detailed updates relative to the non-updated industries.

A third stage, which in fact becomes an ongoing task, is to modify the forecasts as additional information or more up to date information becomes available. This third stage, which to some extent rectifies faults due to limited coverage in phase two, is currently in progress. The preliminary forecasts summarised in this paper have been circulated to relevant private and government firms and agencies for their comments. Queries and additional information will be considered with the forecasts revised accordingly.

3.2 Detailed Industry Forecasts

Considerable information regarding the industry and comprehensive guidelines were given to the expert to assist him in making his forecasts. This information was usually presented in advance of an interview, where possible changes are discussed and finalised. The main purpose of the interview is to ensure proper interpretation of the coefficients, internal consistency within industries and consistency with other forecasts.

Industries which have been considered in detail include

<u>IO Industry Codes</u>	<u>Description</u>
11.01	Iron Ore Mining
11.02	Other Metallic Minerals Mining
12.00	Coal and Crude Petroleum
27.08	Petroleum and Coal Products
29.02	Other Basic Metal Products
32.01	Motor Vehicles and Parts
34.03	Plastic and Related Products
41.01	Residential Building
41.02	Other Building and Construction
48.02	Motor Vehicle Repairs
51.01	Road Transport
55.01	Communication

In most cases only one expert (or organisation) has been used for each industry. However, wherever other forecasts relating to the industry are available these were also used either to supplement information available from the expert or for the expert to consider in making his forecast.

Preliminary forecasts of the direct intermediate input, labour and capital requirement coefficients for the selected industries are shown in Appendix A1.1, tables 1, 2 and 3 respectively. Full details of how these forecasts were derived cannot be repeated here⁴. However brief qualitative descriptions of the major developments occurring within each industry and contributing to the changed situation in 1990/91 for the selected industries are also included in the appendix.

3.3 Update Considerations

In addition to the current estimates of the relevant technological coefficients, information was also provided to the industry experts on :

- (i) the value of domestic production for components of the industry, usually at the 4 digit ASIC level and for a range of years when available
- (ii) although capital coefficients or direct requirements coefficients were not usually available at the sub-industry detail level, certain sub-industry information was provided. This included occupational composition (available at 4 digit ASIC level). Also aggregates such as estimates of total direct requirements, wages and salaries and total employment and domestic production were provided at the more detailed level. This information was provided wherever economic census data made it possible (manufacturing and mining).
- (iii) this economic census data was given for years 1968/69, 1971/72 and 1974/75 to help indicate changes or trends over recent years.
- (iv) a general overall economic scenario for 1990/91 to be used as a context in which to make the forecasts. The scenario used was one prepared for the Australian Institute of Management Corporate Planning Conference (12).
- (v) each consultant was also given prepared notes on the interpretation of the matrices and what factors should be considered in making the updates.

Briefly factors which are considered as capable of causing the technological change include :

- (i) market trends which alter the composition or nature of the industry's output,

- (ii) the introduction of new product lines,
- (iii) the introduction of a technological innovation in production,
- (iv) changed composition of possible factor inputs induced by
 - changed relative prices causing substitution between inputs
 - changed availability of inputs
 - changed scale of operation
 - etc.
- (v) changes in social environment, e.g., shorter working hours, environmental considerations, governmental controls etc.

As can be seen from these points we interpret "technological change" in a very broad sense - basically anything causing the coefficients of the matrices to change.

Many assumptions are required in making forecasts of coefficients (e.g. the relative pricing of substitute products⁵, government policy regarding depreciation allowance on capital equipment, the cost of wages relative to capital equipment costs), many of which bear little relationship to scientific possibilities.

The general scenario put forward for 1990/91 was not explicit in these areas which influence the level of technology. To aid the experts in the formation of their estimates the additional economic parameters were adopted

- continued government assistance for investment

based on present schemes

- the maintenance of high wage levels relative to other costs
- large increases in the real price of crude oil and related products.

The experts' forecasts seemed fairly insensitive in terms of possible relative price scenarios. They gave what were considered the most likely forecast value but were not usually able to assess, quantitatively, the effect of different relative prices for the various inputs.

3.4 Industry Composition and Coefficient Change

Most of the industries considered manufacture many different products, and the coefficients for an industry reflect an "average" technology for the combination of products rather than a defined technology for a single product. In many cases it is necessary to alleviate problems arising from this feature by a further disaggregation of the industry involved.

Changes in coefficients are caused therefore, either by

- (i) a change in the technology (inputs, labour, capital) of production for one or more of the industry's products
- (ii) a change in the output composition of the industry causing the weights of each product and thus the "average" coefficients to change.

Evidence (from the overseas studies and our own work) suggests that changing industry composition is often the

major cause of technological change in the input-output sense. In fact the input-output coefficients have to date tended to be remarkably stable over time for industries where the composition does not alter or where the inputs to each sub-sector are very similar. Even where the substitution of inputs and capital equipment takes place the new items tend to be supplied by the same industry (e.g. (a) oil by coal and (b) manual lathes by computer controlled lathes).

As mentioned earlier, the main exception to this stability rule occurs in the labour matrix where labour productivity tends to increase on a fairly consistent basis over time. This is due, not only to the investment in more sophisticated equipment requiring less labour input, but also to structural adjustment within an industry. The latter includes such factors as expanding scale of operations, inefficient firms going out of business, increased specialisation in production of goods with lower labour content, organisational factors and so on. Increasing import competition from low wage cost countries has been one important influence, stimulating these types of change in recent years.

The update procedure attempts to identify each type of effect specifically, by disaggregation of an industry prior to the update. Where there is insufficient data to support detailed updates for each industry sub-sector (e.g. in the case of the direct requirements and capital coefficients only overall industry coefficients are available) then at least changes are made with compositional aspects in mind; the coefficients were adjusted to reflect a sub-industry's larger/smaller share of overall output.

3.5 Industry Aggregation

As alluded to above, a more desirable industry classification is one where all of an industry's products have identical technological coefficients which will always change in the same way. Of course such a situation is impractical so care must be taken in the computation of aggregated coefficients. In 1968/69 weights have been implicitly applied to each sub-industry in the calculation of the direct requirements coefficients (through the use of the flow table).

For future years the problem is not so simple. While it is not necessary to calculate absolute levels of production in the future year for each industry to be included in the aggregation, it is necessary to at least estimate the relative outputs of component sub-industries. The appropriate weighting on sub-industry coefficients, to compute an average coefficient, is its share in overall output for the input-output industry, expressed in real terms.

This has implications for aggregation of industries for use in modelling. If it is desired to aggregate certain input-output categories (e.g. to reduce computing costs) then aggregated coefficients should be based on output shares applying in 1990/91 rather than those in 1968/69.

3.6 Consistency of Updates Across Industries

In many cases new technologies will have a similar impact on many industries. Some examples could include

- (i) a change in relative oil prices causing a switch to alternative fuels,
- (ii) the availability of new products, such as light-

weight, high capacity batteries which would be utilised in a range of products ranging from motor vehicles to lawnmowers.

Whatever the cause of the change, if such a change is forecast for one industry then a consistent type of forecast must be made for other industries likely to be affected by the same factors. To some extent this potential source of inconsistency is reduced by the specification of the general background scenario. Remaining inconsistencies may be detected during the third stage of the project, when the forecasts are checked with further industry consultation.

3.7 Links Between the Matrices

The various matrices are inter-related and any forecast changes must be consistent for the industry over each of the three matrices. For example, the adoption of new sophisticated capital equipment will have implications not only for the capital matrix but also for the labour matrix where there is likely to be both a drop in the total number of persons required and also a tendency for a higher proportion of technicians to be employed. Further, the direct requirements matrix may also change due to altered composition and/or volume of the inputs.

3.8 The Numeraire of the Coefficients for 1990/91

Input output matrices are defined in terms of physical units of inputs and outputs. That is, the coefficient changes over time refer to input volume to output volume, all coefficients therefore are expressed in terms of base year values (i.e. at constant 1971/72 prices). In particular the technological coefficients forecast for 1990/91 are expressed in terms of these base year prices.

3.9 Some Problems Encountered

During the detailed updating many difficulties arose. Some of these which were recurring problems are described below.

Data Deficiencies -

As already mentioned there is insufficient supporting data to make reliable industry compositional breakdowns or analysis of trends. Even when a breakdown to four digit ASIC level was available, it was often an inappropriate way of separating the types of product produced by the industry. For example the building industry breakdown tends to be by trade activity; bricklaying, plumbing etc, rather than the type of construction; residential buildings, non-residential building, roadwork etc, which would be more appropriate. In other cases the data is confidential or as in the case of some service industries there is simply no information available at all, apart from that indicated in the input-output table itself.

Definitions of Industries -

In some cases it was difficult to explain to consultants exactly how to allocate different products to the various input-output industries. For example, given simple industry descriptions such as 25.04 Furniture, Mattresses and Brooms, 31.02 Sheet Metal Products, 34.03 Plastic and related products; a problem arises when allocating furniture, especially when more than one of the materials wood, metal and plastics is involved. Does sheet metal furniture belong to 25.04 or 31.02? And what happens when there is a combination of wood and metal or plastic laminates involved?

For the industries which they were updating, detailed descriptions of certain ASIC categories were provided, however it was impractical to clarify the definitions of all the supplying industries in this way. Correct allocation therefore depended very much on the interviewer.

ABS Compilation of the IO Table -

According to persons interviewed some features of the 1968/69 input output table were hard to reconcile with their own knowledge of the industry. This was particularly so in the transport industries. For example the IO table does not appear to reflect the considerable government subsidies required by the Railway industry.

The grouping of technologically dissimilar sub-industries within the one IO category (e.g. the amalgamation of crude petroleum and coal mining) creates problems when attempting to identify the technological changes specific to each component industry, or even the effect of changing industry composition.

Another aspect of the table presenting difficulties, and which will no doubt cause difficulties in modelling certain aspects of the economy, is the way in which inputs are allocated. The principal problem here are items lumped into the business expenses industry. It is intended that this industry represent certain business costs which are small and are not easily allocated to other industries. On inspection of the table, however, we find that virtually no industries have direct inputs from the communications industry or the banking industry. It seems that all such costs, are included under business expenses in spite of the existence of these industries in the table itself. In practice however the inputs from banking and communications are anything but small. The problem is accentuated by the fact that several of these industries (e.g. the communications industry) will be extremely important in 1990/91. Further, in the absence of existing input coefficients for communication it is very difficult to make forecasts as to the appropriate coefficient in 1990/91 although most experts have identified it as an area of increase.

3.10 Less Detailed Updates⁶

Although only twelve input-output industries have been selected for detailed study, changes in the technological coefficients of other industries should not be ignored. There are quite a range of relatively simple modifications that can be made to historical coefficients in order to capture the essential features of the 1990/91 coefficients.

Changes to the Labour Coefficients -

From the earlier comments on the instability of labour coefficients, clearly the changing labour requirements must be assessed for all input-output industries. On the basis of the detailed updates carried out for selected industries and an examination of occupation by industry data from 1961, 1966 and 1971 population census (13), it seems that changes in occupational composition of labour requirements are generally relatively minor compared with the overall changes in labour productivity. The broad occupational categories considered here reinforce this feature. This suggests that a reasonable update of the labour matrix can be obtained by using the likely change in total labour productivity between 1971/72 and 1990/91 to update the 1971/72 coefficients while maintaining constant proportions between the different occupational categories.

As an initial step in forecasting the likely labour productivity change, an attempt has been made to estimate productivity growth rates for Australian industries. To overcome some of the data deficiencies and provide a firmer foundation for making forecasts, labour productivity growth rates are also considered for different industry groupings, over several time periods, and for a number of countries. Further details of the data available and the estimates made, are given in appendix 2.1. In the absence of other information for an industry such trend determined rates of growth will be used to assess the productivity

growth rate to 1990/91. At the end of the third stage of the project however, it will be possible to modify such forecasts in the light of additional information e.g. expert advice, likely structural change, known technological developments, other industry studies and so on.

Ad Hoc Adjustments to Coefficients -

Ad hoc adjustments to one or more sets of coefficients relating to an industry depends largely on what information comes to light while obtaining information on other aspects of the project. For instance in the first phase of the project comments were sought on developments within all input-output industries from persons familiar with the industries concerned⁷.

Probably the most useful sources of information for ad hoc adjustments are from industry studies or forecasts carried out by other organisations or individuals.

Specific industry information may lead to changes in one or more coefficients (e.g. a substitution of energy inputs to an industry from fuel oil to electricity). Alternatively all factor inputs of the one type may change by the same proportion to give merely a change in the factor intensity, that is, the capital to output or labour to output ratio. For example, the output of the railway industry can be varied considerably without any change in many of the factor inputs. Thus an increased throughput could lead to a substantial drop in factor to output ratios, without any changes in the proportional breakdown of each factor.

Information regarding industry composition is also important. In the detailed studies, changed industry composition was found to be responsible for quite significant coefficient changes. In other industries, it may be a cause of coefficient change, even when the technological coefficients

for the component industries are quite stable. The changes able to be made to coefficients in such cases would depend on the amount of information at hand regarding each of the sub-industries.

Such ad hoc adjustments have not been pursued at this stage.

Pervasive Developments -

A significant type of development, which affects all industries in a similar way, is the existence of high growth industries whose products are used increasingly as intermediate inputs. Such growth is usually a result of technical developments which increase the availability of such products and at the same time reduce their price. The consequence is that such goods tend to substitute for others not only in final demand but also as intermediate inputs. Two examples of such growth industries are communications (55.01) and Plastic and related products (34.03).

These types of development primarily effect the direct requirements matrix. There are probably some less important effects on the other matrices as well but these are much more difficult to quantify. For example the communications services provided may reduce the need for some types of labour (e.g. drivers) and increase others (e.g. technicians), however the extent of substitution is uncertain and would vary from one industry to another.

While such pervasive developments may not have an obvious significant effect on the behaviour of individual industries, however since the effects are common to all industries the accumulated effect may be quite significant. Certainly adjustments to capture such changes will be necessary if the outputs of industries such as Communications are

to be forecast in a sensible fashion.

The effect of such industries on the coefficients of other industries may be approximated in a number of ways. One method is described in the appendix A2.2 with details for the Communications and the Plastic and Related Products industry.

4. SUMMARIES AND CONCLUSIONS

4.1 Summary

A technique for providing forecasts of technological coefficients has been outlined. The approach updates existing coefficient estimates to a future year using information derived from a number of sources. The more crucial inputs are based on the subjective judgement of persons having a good knowledge of the industry concerned.

In updating it was not necessary to examine all industries in the same detail. The amount of effort devoted to looking at particular industries was adjusted according to the likely economy wide significance of any changes to 1990/91. In this way it is hoped that some balance has been achieved whereby model outputs are not unduly biased by failing to consider the possibility of important changes in some industries.

Generally, the behaviour forecast for the coefficients is similar to that observed by Carter in her study of changes in US technology. Changes to the direct intermediate input coefficients were slight, even when substantial changes of a technical nature are expected to occur (e.g. Plastic products). The capital coefficients are less stable, however the greater throughput enabled by the purchase of more expensive equipment tends to limit increases in the capital to output ratios. In fact, for

many industries the increases in output are sufficient to cause a net reduction in the capital coefficients. In contrast to the relative stability of the direct and capital input coefficients, the labour coefficients undergo quite large changes. This is due to a combination of technical and industry structural changes which all usually serve to decrease labour requirements for an industry.

As most industries include a range of activities, each of which can be associated with a distinct set of coefficients, any changes in the composition of these activities can be expected to change the "average" coefficients for the industry. The surprising feature however, was the number of times this proved to be the dominant cause of coefficient change. When such compositional changes are expected, pure technological change is often of secondary importance. Technological innovations, while they often affect the labour coefficients (labour saving equipment), rarely affect the direct requirements coefficients.

4.2 Conclusions

The likely magnitude of forecast error could not be determined. Naturally, the accuracy of the forecasts are contingent upon a wide range of assumptions, and any number of unforeseen events may lead to different outcomes. The use of the technology forecasts, within the strict accounting framework of a model which allows the economic consequences of the forecasts to be assessed, may also serve to indicate certain shortcomings or inconsistencies. Even at this stage, however, those coefficients subject to the greatest uncertainties are fairly easily identified. The sensitivity of the labour requirements coefficients to a wide range of technical and non-technical factors combined with the high rate of change means that forecasts of these coefficients will be subject to greater errors than those for either direct inputs or capital.

Perhaps the most important conclusion to be drawn from the study is the significance of industry composition. When two or more industries, each having different inherent technological coefficients, are aggregated together for the purpose of economic modelling (e.g. as in input-output tables), then any changes in the relative outputs of the component industries may lead to substantial changes in the coefficients. This point has implications for any updating of coefficients, and indicates a relatively simple update technique especially applicable to the direct requirements matrix. The method would require the compilation of rectangular input-output flow tables containing, say the usual number of "supplying" industries. However the "using" industries should be considered in the greatest possible detail (e.g. 4 digit ASIC or finer). Direct coefficients for each "using" industry can be derived for that year. Coefficients for more highly aggregated industries in other years can then be calculated from these direct requirement coefficients using the outputs (or forecasts of outputs) of each sub-industry to obtain "weighted average" coefficients.

Such a procedure would capture many of the changes in direct requirement coefficients over time and greatly extend the useful life of input-output tables. Further, such a process can be used in conjunction with other update procedures (e.g. RAS, judgemental) to provide, presumably, even better results.

One of the greatest difficulties encountered in this project was the lack of data, in particular the absence of sets of coefficients for different years on a comparable basis. Therefore the expected release in 1979 of the ABS input-output table updated to 1974/75 and 1976 population census data will provide considerable additional input to the

forecasts. Each will fill a number of present information gaps. Perhaps more importantly however, they will provide some check on the forecasts and conclusions made so far.

APPENDIX

- A1. Detailed Updates of Selected Industries.
 - A1.1 Preliminary coefficient forecasts
 - Direct Requirement Coefficients, Table 1.
 - Labour Requirements Coefficients, Table 2.
 - Capital Requirements Coefficients, Table 3.
 - A1.2 Outline of Major developments within each Industry
 - Iron Ore Mining (11.01)
 - Non Ferrous Metallic Minerals Mining (11.02)
 - Coal and Crude Petroleum (12.00)
 - Petroleum and Coal Products (27.08)
 - Non Ferrous Basic Metal Products (29.02)
 - Motor Vehicles and Parts (32.01)
 - Plastic and Related Products (34.03)
 - Residential Building (41.01)
 - Non-Residential Building and Construction (41.02)
 - Motor Vehicle Repairs (48.02)
 - Road Transport (51.01)
 - Communication (55.01)
- A2. Less Detailed Updates
 - A2.1 Changes in labour productivity
 - A2.2 Adjustment of Coefficients for pervasive developments.

TABLE 1 : DIRECT REQUIREMENTS (\$) FOR \$100 OF OUTPUT (1971/72 PRICES),
YEARS 1968/69 AND 1990/91

SUPPLYING INDUSTRY	USING INDUSTRY		11.02		12.00		27.08		29.02	
	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91
1 01.01 SHEEP										
2 01.02 CEREAL GRAINS										
3 01.03 MEAT CATTLE										
4 01.04 MEAT PIGS										
5 01.05 POULTRY										
6 01.06 OTHER FARMING										
7 02.00 SERVICES IN AGRICULTURE										
8 03.00 FORESTRY AND LOGGING			1.178	0.589	3.997	1.434	0.008	0.008	0.002	0.002
9 04.00 FISHING, TRAPPING, HUNTING										
10 11.01 IRON			0.001		0.001	0.001	0.001		33.758	33.758
11 11.02 OTHER METALLIC MINERALS							50.336	47.213	0.532	0.532
12 12.00 COAL & CRUDE PETROLEUM		0.389	0.031	0.015					0.105	0.105
13 14.00 NON-FERROUS METALS	0.007	0.007	0.572	0.289	0.042	0.042	0.384	0.360	0.055	0.055
14 16.00 SERVICES TO MINING	0.312	0.437	2.283	1.814	2.243	3.023				
15 21.01 MEAT PRODUCTS					0.001	0.001				
16 21.02 MILK PRODUCTS							0.012	0.011		
17 21.03 BAKED & READY-TO-EAT PRODUCTS	0.003	0.003	0.002	0.002			0.001			
18 21.04 BAKING INGREDIENTS & FEEDS							0.001			
19 21.05 FLOUR & CEREAL PRODUCTS			0.001				0.001		0.043	0.043
20 21.06 BREADS, CAKES & MISCELLS										
21 21.07 CONFECTIONERY PRODUCTS					0.002	0.002	0.001		0.001	0.001
22 21.08 FOOD PRODUCTS N.E.C.	0.001	0.001	0.001	0.001			0.001			
23 21.09 SOFT DRINKS, CORDIALS, ETC.										
24 21.10 BEER & MALT										
25 21.11 ALCOHOLIC BEVERAGES N.E.C.										
26 22.01 TOBACCO PRODUCTS										
27 23.01 PREPARED FEEDS							0.037	0.035	0.003	0.003
28 23.02 MAN-MADE FIBRES, YARNS ETC.					0.002	0.002	0.117	0.110	0.004	0.004
29 23.03 CHEMICALS, PLASTICS, RUBBERS ETC.							0.003	0.003		
30 23.04 WOOD & WOOD-RELATED PRODUCTS									0.001	0.001
31 23.05 TEXTILE FINISHING							0.069	0.065	0.001	0.001
32 23.06 TEXTILE FIBRE SPINNING							0.002	0.002	0.231	0.231
33 23.07 TEXTILE PRODUCTS N.E.C.										
34 24.01 KILLING MILLS									0.001	0.001
35 24.02 CLOTHING	0.016	0.016	0.024	0.020			0.001			
36 24.03 FOOTWEAR	0.001	0.001			0.479	0.196			0.095	0.095
37 25.01 SAWMILL PRODUCTS			0.112	0.056	0.001	0.001	0.025	0.023	0.001	0.001
38 25.02 PLYWOOD, VENEERS & BOARDS			0.001	0.001	0.010	0.009	0.008	0.008	0.005	0.005
39 25.03 JOINERY & WOOD PRODUCTS	0.001	0.001								
40 25.04 FURNITURE, UTENSILS, BROOMS							0.214	0.201	0.125	0.125
41 26.01 PULP, PAPER & PAPERBOARD					0.002	0.002	0.032	0.030	0.003	0.003
42 26.02 FIBREBOARD, FIBRE CONTAINERS			0.011	0.005	0.001	0.001	0.002	0.002	0.001	0.001
43 26.03 PAPER PRODUCTS N.E.C.			0.005	0.002					0.001	0.001
44 26.04 NEWSPRINTS & BOOKS					0.001	0.001	0.010	0.009	0.019	0.019
45 26.05 CHEMICALS, INK & DYE PRINTING			0.002	0.001					0.024	0.024
46 27.01 CHEMICALS, FERTILIZERS					0.005	0.005	1.062	0.996	1.972	1.972
47 27.02 INDUSTRIAL CHEMICALS N.E.C.	0.004	0.004	0.005	0.005	0.005	0.005	0.010	0.009	0.101	0.101
48 27.03 FIBRES, YARNS, THREADS, CORDINGS	0.002	0.002	0.001	0.001	0.005	0.005			0.002	0.002
49 27.04 PHARMACEUTICALS & CHEMICALS	0.035	0.035	0.024	0.030	0.005	0.005	0.006	0.006	0.024	0.024
50 27.05 SOAP & OTHER PREPARATIONS	0.009	0.009	0.016	0.012	0.014	0.013	0.006	0.006	0.005	0.005
51 27.06 COSMETIC, TOILET PREPARATIONS					1.054	1.189	3.801	3.565	0.357	0.357
52 27.07 CHEMICAL PRODUCTS N.E.C.	1.770	2.006	2.016	4.043	0.444	0.432			0.524	0.524
53 27.08 PETROLEUM & COAL PRODUCTS	1.730	1.743	1.093	1.414	0.002	0.002	0.004	0.004	0.001	0.001
54 28.01 GLASS & GLASS PRODUCTS			0.013	0.006					0.881	0.881
55 28.02 CLAY PRODUCTS					0.387	0.356				
56 28.03 CEMENT			0.003	0.001	0.259	0.277	0.001			
57 28.04 READY-MIXED CONCRETE			0.393	0.191	1.093	1.308				
58 28.05 CONCRETE PRODUCTS			0.035	0.033	0.042	0.039	0.007	0.007	0.058	0.058
59 29.06 NON-METALLIC MINERAL PRODS	0.011	0.011	0.055	0.033	1.274	1.172	0.014	0.013	1.679	1.579
60 29.01 BASIC IRON & STEEL	0.391	0.762	0.843	0.519	0.031	0.029	0.266	0.249	0.381	0.381
61 29.02 OTHER BASIC IRON PRODUCTS	0.064	0.096	0.003	0.005	0.558	0.552	0.053	0.049	0.031	0.031
62 31.01 STRUCTURAL METAL PRODUCTS	0.008	0.008	0.003	0.005	0.677	0.659	0.029	0.027	0.636	0.636
63 31.02 SHEET METAL PRODUCTS	0.049	0.049	0.160	0.129	0.658	0.614	0.029	0.025	0.052	0.052
64 31.03 METAL PRODUCTS N.E.C.	0.098	0.098	0.167	0.162	0.602	0.554	0.027	0.025	0.176	0.176
65 32.01 MOTOR VEHICLES & PARTS	0.156	0.078	0.001		0.051	0.047	0.434	0.407	0.001	0.001
66 32.02 SHIP & BOAT BUILDING			0.088	0.084	0.226	0.208	0.001			
67 32.03 LOCOMOTIVES, RAILING STOCK	0.082	0.082	0.001	0.001						
68 32.04 AIRCRAFT BUILDING	0.002	0.002	0.029	0.017	0.038	0.035				
69 33.01 SCIENTIFIC EQUIPMENT ETC.	0.006	0.006	0.001	0.001			0.001			
70 33.02 ELECTRONIC EQUIPMENT	0.002	0.002	0.009	0.046	0.015	0.014	0.060	0.056	0.007	0.007
71 33.03 INDUSTRIAL APPLIANCES N.E.C.	0.085	0.085	0.332	0.506	0.925	0.852	0.069	0.056	0.335	0.335
72 33.04 PHYSICAL INSTRUMENTS	0.025	0.025	0.048	0.037	0.022	0.020				
73 33.05 AGRICULTURAL MACHINERY	0.239	0.239	2.250	1.244	0.275	0.253			0.073	0.073
74 33.06 CONSTRUCTION, ETC. EQUIPMENT	0.745	0.834	0.171	0.458	1.096	1.008	0.319	0.299	0.397	0.397
75 33.07 OTHER MACHINERY EQUIPMENT					0.043	0.039	0.005	0.005	0.007	0.007
76 34.01 LEATHER PRODUCTS	0.963	1.156	0.784	1.050	0.041	0.037	0.160	0.150	0.103	0.103
77 34.02 PLASTIC & RUBBER PRODUCTS	0.013	0.013	0.101	0.057						
78 34.03 SIGNS, BILLING EQUIPMENT ETC.					0.002	0.002	0.006	0.006	0.003	0.003
79 34.05 OTHER MANUFACTURING					4.043	1.450	1.172	1.099	3.197	2.558
80 36.01 ELECTRICITY	1.219	1.457	3.201	2.616	0.002	0.002	0.090	0.084	0.148	0.148
81 36.02 GAS	0.001	0.001	0.002	0.001	0.167	0.172	0.222	0.208	0.029	0.029
82 37.01 WATER, SEWERAGE & DRAINAGE	0.050	0.050	0.735	0.392						
83 41.01 RESIDENTIAL BUILDINGS			0.375	0.581	1.388	1.277	0.535	0.502	0.375	0.375
84 41.02 BUILDING, ETC. CONSTRUCTION	0.788	0.788	3.023	2.422	2.423	2.229	1.301	1.258	2.758	2.758
86 45.01 WHOLESALE TRADE	1.822	1.822	0.073	0.045	0.025	0.023	0.063	0.059	0.070	0.070
87 44.01 RETAIL TRADE	0.016	0.016	0.178	0.163	0.063	0.058	0.014	0.013	0.035	0.035
88 44.02 MOTOR VEHICLE REPAIRS	0.055	0.055	0.178	0.163	0.823	0.757	0.032	0.030	0.035	0.035
89 44.03 OTHER REPAIRS	0.261	0.425	0.178	0.278	1.407	0.505	0.994	0.932	1.447	1.447
90 51.01 ROAD TRANSPORT	0.208	0.122	1.242	0.722	1.000	0.357	0.259	0.243	3.003	3.003
91 52.01 RAIL TRANSPORT	0.094	0.235	0.797	0.445	0.054	0.049	3.441	3.327	1.535	1.535
92 53.01 WATER TRANSPORT	0.067	0.067	0.131	0.099	0.130	0.119	0.008	0.008	0.028	0.028
93 54.01 AIR TRANSPORT	0.131	0.131	0.157	0.144						
94 55.01 COMMUNICATION										
95 61.01 BANKING										
96 61.02 FINANCY & LIFE INSURANCE					0.001	0.001	0.118	0.111	0.055	0.055
97 61.03 OTHER INSURANCE			0.005	0.022	0.428	0.394	0.187	0.175	0.426	0.426
98 61.04 INVESTMENT, REAL ESTATE ETC.	0.052	0.052		0.026						
99 61.05 OTHER BUSINESS SERVICES										
100 61.06 OWNERSHIP OF BUILDINGS					0.003	0.003				
101 71.01 PUBLIC ADMINISTRATION										
102 72.01 DEFENCE										
103 81.01 HEALTH										
104 82.01 EDUCATION, REPAIRS, ETC.					0.047	0.043				
105 91.01 RECREATION SERVICES										
106 91.01 RECREATION SERVICES			0.040	0.020			0.001			
107 92.01 RESTAURANTS, HOTELS, CLUBS										
108 93.01 PERSONAL SERVICES										
109 99.10 BUSINESS SERVICES	0.691	1.036	3.751	2.858	1.073	0.785	2.842	2.666	3.009	3.009
110 TOTAL INTERMEDIATE USAGE	12.951	15.345	28.807	24.931	29.217	21.398	67.293	64.980	38.586	37.947

(Continuation)

TABLE 1 : DIRECT REQUIREMENTS (\$) FOR \$100 OF OUTPUT (1971/72 PRICES), YEARS 1968/69 AND 1990/91

SUPPLYING INDUSTRY	USING INDUSTRY		32.01		34.03		41.01		41.02		48.02	
	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91	1968/69	1990/91
1 01.01 SHEEP	-	-	-	-	-	-	-	-	-	-	-	-
2 01.02 CROSSLA CHAINS	-	-	-	-	-	-	-	-	-	-	-	-
3 01.03 MEAT CATTLE	-	-	-	-	-	-	-	-	-	-	-	-
4 01.04 MILK CATTLE & PIGS	-	-	-	-	-	-	-	-	-	-	-	-
5 01.05 POULTRY	-	-	-	-	-	-	-	-	-	-	-	-
6 01.06 OTHER FARMING	-	-	-	-	-	-	-	-	-	-	-	-
7 02.00 SERVICES TO AGRICULTURE	-	-	-	-	0.003	0.003	0.001	0.001	0.004	0.004	-	-
8 03.00 FORESTRY AND LOGGING	-	-	-	-	-	-	-	-	-	-	-	-
9 04.00 FISHING, TRAPPING, HUNTING	-	-	-	-	-	-	-	-	-	-	-	-
10 11.01 LEAD	-	-	-	-	-	-	-	-	-	-	-	-
11 11.02 OTHER METALLIC MINERALS	-	-	-	-	0.005	0.005	-	-	0.002	0.002	-	-
12 12.00 COAL & CRUDE PETROLEUM	0.013	0.010	-	-	0.011	0.011	-	-	0.068	0.068	-	-
13 14.00 NON-FERROUS METALS	0.005	0.010	-	-	0.099	0.099	0.401	0.401	1.382	1.382	-	-
14 16.00 SERVICES TO MINING	-	-	-	-	-	-	-	-	-	-	-	-
15 21.01 MEAT PRODUCTS	-	-	-	-	-	-	-	-	-	-	0.001	0.001
16 21.02 MILK PRODUCTS	0.001	0.001	-	-	0.268	0.268	-	-	-	-	-	-
17 21.03 FRUIT & VEGETABLE PRODUCTS	0.003	0.003	-	-	-	-	0.001	0.001	0.027	0.027	-	-
18 21.04 MARGARINE, MILK & FATS	-	-	-	-	0.227	0.227	-	-	-	-	-	-
19 21.05 FLOUR & CEREAL PRODUCTS	-	-	-	-	0.013	0.013	-	-	-	-	-	-
20 21.06 BREAD, CAKES & BISCUITS	-	-	-	-	-	-	-	-	-	-	-	-
21 21.07 CONFECTIONERY PRODUCTS	-	-	-	-	-	-	-	-	-	-	-	-
22 21.08 FISH PRODUCTS N.E.C.	0.001	0.001	-	-	0.005	0.005	0.009	0.009	0.001	0.001	-	-
23 21.09 SOFT DRINKS, BEVERAGES ETC.	-	-	-	-	-	-	-	-	-	-	-	-
24 21.10 BEER & WINE	-	-	-	-	-	-	-	-	-	-	-	-
25 21.11 ALCOHOLIC BEVERAGES N.E.C.	-	-	-	-	0.001	0.001	-	-	-	-	-	-
26 22.01 TOBACCO PRODUCTS	-	-	-	-	-	-	-	-	-	-	-	-
27 23.01 FARMPOWER ENGINES	-	-	-	-	0.001	0.001	-	-	-	-	-	-
28 23.02 HAND-MADE FIBRES, YARNS ETC.	0.053	0.050	-	-	0.377	0.377	0.005	0.005	0.005	0.005	-	-
29 23.03 COTTON, SILK, FLAX YARNS ETC.	0.006	0.006	-	-	0.586	0.586	-	-	0.001	0.001	-	-
30 23.04 WOOL & WASTED YARNS ETC.	0.003	0.003	-	-	0.034	0.034	-	-	-	-	-	-
31 23.05 TEXTILE FINISHING	0.002	0.002	-	-	0.689	0.689	-	-	-	-	-	-
32 23.06 TEXTILE FLOOR COVERING	0.570	0.440	-	-	0.689	0.689	0.001	0.001	-	-	-	-
33 23.07 TEXTILE PRODUCTS N.E.C.	0.065	0.040	-	-	0.658	0.658	0.013	0.013	0.008	0.008	0.001	0.001
34 24.01 KNITTING MILLS	-	-	-	-	-	-	-	-	-	-	-	-
35 24.02 CLOTHING	0.010	0.010	-	-	0.005	0.005	-	-	0.003	0.003	-	-
36 24.03 FOOTWEAR	0.015	0.015	-	-	0.001	0.001	0.005	0.005	0.008	0.008	-	-
37 25.01 SAWMILL PRODUCTS	0.291	0.230	-	-	0.025	0.025	9.755	6.791	1.866	0.933	-	-
38 25.02 PLYWOOD, VENEERS & BOARDS	0.036	0.030	-	-	0.112	0.112	0.333	0.333	0.320	0.320	-	-
39 25.03 JOINERY & WOOD PRODUCTS	0.074	0.074	-	-	0.027	0.027	5.120	5.120	1.747	1.747	0.055	0.058
40 25.04 FURNITURE, PATENT CASES, ROOMS	0.017	0.010	-	-	0.027	0.027	0.004	0.160	0.064	0.064	-	-
41 26.01 PAPER, PAPER & PAPERMADE	-	-	-	-	1.220	1.220	-	-	-	-	-	-
42 26.02 CORRUGATED PAPER CONTAINERS	0.115	0.090	-	-	0.294	0.294	0.024	0.024	0.015	0.015	-	-
43 26.03 PAPER PRODUCTS N.E.C.	0.004	0.004	-	-	0.153	0.153	-	-	-	-	-	-
44 26.04 NEWSPAPERS & BOOKS	-	-	-	-	0.020	0.020	-	-	-	-	-	-
45 26.05 COMMERCIAL & JOB PRINTING	0.002	0.002	-	-	0.353	0.353	-	-	-	-	-	-
46 27.01 CHEMICAL FERTILIZERS	0.001	0.001	-	-	0.057	0.057	-	-	-	-	-	-
47 27.02 INDUSTRIAL CHEMICALS REC.	0.065	0.050	-	-	21.856	24.856	0.002	0.002	0.019	0.019	-	-
48 27.03 PAINTS, VARNISHES, LACQUERS	1.180	0.930	-	-	0.708	0.708	1.322	1.322	1.058	1.058	-	-
49 27.04 PHARMACEUTICAL & CHEMICALS	-	-	-	-	0.005	0.005	-	-	-	-	-	-
50 27.05 SOAP & OTHER DETERGENTS	-	-	-	-	0.033	0.033	-	-	0.003	0.003	-	-
51 27.06 COSMETIC, TOILET PREPARATIONS	0.008	0.008	-	-	0.008	0.008	-	-	0.002	0.002	-	-
52 27.07 CHEMICAL PRODUCTS N.E.C.	0.031	0.031	-	-	0.690	0.690	0.072	0.072	0.124	0.124	0.016	0.017
53 27.08 FIBREGLASS & COROL PRODUCTS	0.403	0.290	-	-	0.623	0.623	0.589	0.589	1.520	1.520	2.264	2.527
54 28.01 GLASS CRASS PRODUCTS	0.587	0.430	-	-	0.300	0.300	0.536	0.919	0.353	0.530	-	-
55 28.02 CLAY PRODUCTS	-	-	-	-	0.012	0.012	8.026	8.026	1.112	1.112	-	-
56 28.03 CEMENT	-	-	-	-	-	-	0.431	0.431	0.527	0.501	-	-
57 28.04 READY-MIXED CONCRETE	-	-	-	-	-	-	1.943	1.983	2.527	2.423	-	-
58 28.05 CONCRETE PRODUCTS	-	-	-	-	-	-	3.000	3.320	0.975	0.975	-	-
59 28.06 NON-FERROUS METAL PRODS	0.001	0.001	-	-	0.186	0.186	3.108	3.467	0.975	0.975	0.054	0.057
60 29.01 BASIC IRON & STEEL	7.033	4.840	-	-	0.346	0.346	1.443	1.443	2.628	2.628	0.001	0.001
61 29.02 OTHER BASIC METAL PRODUCTS	2.208	1.560	-	-	1.240	1.240	1.095	1.005	1.335	1.335	0.021	0.022
62 31.01 STRUCTURAL METAL PRODUCTS	0.324	0.030	-	-	0.081	0.081	0.656	0.984	6.763	7.439	0.061	0.064
63 31.02 SHEET METAL PRODUCTS	0.170	0.010	-	-	0.133	0.133	1.433	2.224	0.735	0.808	0.099	0.104
64 31.03 METAL PRODUCTS N.E.C.	3.161	2.050	-	-	0.663	0.668	2.531	3.796	4.285	4.713	27.134	28.455
65 32.01 MOTOR VEHICLES & PARTS	-	-	-	-	0.065	0.065	0.050	0.050	0.137	0.137	-	-
66 32.02 SHIP & BOAT BUILDING	0.134	0.090	-	-	0.185	0.185	0.001	0.001	0.015	0.015	-	-
67 32.03 AIRCRAFT, HELICOPTERS, SLIDING STOCK	0.183	0.183	-	-	0.003	0.003	0.017	0.017	0.069	0.069	0.018	0.019
68 33.01 AIRCRAFT BUILDING	0.039	0.039	-	-	-	-	0.001	0.001	0.010	0.010	0.036	0.038
69 33.02 SCIENTIFIC EQUIPMENT ETC.	0.005	1.000	-	-	0.029	0.029	0.005	0.005	0.003	0.003	0.001	0.001
70 33.03 ELECTRIC EQUIPMENT	0.031	1.000	-	-	0.005	0.005	0.098	0.098	0.186	0.186	0.005	0.005
71 33.04 HOUSEHOLD APPLIANCES REC.	0.030	0.020	-	-	0.011	0.020	3.455	4.512	0.964	0.964	0.031	0.033
72 33.05 ELECTRICAL MACHINERY REC.	0.841	1.350	-	-	0.106	0.106	1.626	1.927	3.864	3.864	0.053	0.051
73 33.06 AGRICULTURAL MACHINERY	0.279	0.279	-	-	0.001	0.001	0.032	0.032	0.037	0.037	0.210	0.221
74 33.07 CONSTRUCTION ETC. EQUIPMENT	0.240	0.240	-	-	-	-	0.003	0.003	0.169	0.169	0.176	0.155
75 33.08 OTHER MACHINERY, EQUIPMENT	1.605	0.250	-	-	0.248	0.248	0.155	0.155	2.168	2.168	-	-
76 34.01 LEATHER PRODUCTS	0.004	0.004	-	-	0.137	0.137	0.008	0.008	0.024	0.024	-	-
77 34.02 RUBBER PRODUCTS	2.994	2.250	-	-	-	-	0.477	0.954	0.821	1.642	0.022	0.023
78 34.03 PLASTIC & RELATED PRODUCTS	0.699	0.540	-	-	0.013	0.013	0.001	0.001	0.001	0.001	-	-
79 34.04 SIGNS, FILING EQUIPMENT ETC.	-	-	-	-	0.070	0.070	0.017	0.017	0.020	0.020	0.001	0.001
80 34.05 OTHER MANUFACTURING	0.992	0.740	-	-	1.548	1.548	0.080	0.080	0.394	0.394	0.019	0.020
81 36.01 ELECTRICITY	0.129	0.090	-	-	0.055	0.055	0.036	0.036	0.041	0.041	0.001	0.001
82 36.02 GAS	0.033	0.030	-	-	0.015	0.015	0.032	0.032	0.141	0.141	-	-
83 37.01 WATER, SEWERAGE & DRAINAGE	-	-	-	-	-	-	-	-	-	-	-	-
84 41.01 RESIDENTIAL BUILDINGS	-	-	-	-	-	-	-	-	-	-	-	-
85 41.02 BUILDING REC., CONSTRUCTION	0.348	0.260	-	-	0.739	0.739	-	-	-	-	3.935	4.132
86 45.01 WHOLESALE TRADE	2.085	1.440	-	-	5.865	5.865	9.608	10.500	6.462	7.000	0.140	0.147
87 44.01 RETAIL TRADE	0.067	0.070	-	-	0.137	0.137	0.044	0.044	0.140	0.140	-	-
88 48.02 MOTOR VEHICLE REPAIRS	0.039	0.030	-	-	0.059	0.059	0.336	0.336	0.338	0.338	-	-
89 48.03 OTHER REPAIRS	0.065	0.050	-	-	0.094	0.094	-	-	0.215	0.215	-	-
90 51.01 ROAD TRANSPORT	0.857	0.630	-	-	0.779	0.789	2.396	4.792	1.926	1.926	0.346	0.363
91 52.01 AIR TRANSPORT	0.353	0.280	-	-	0.124	0.124	0.552	1.104	0.589	0.589	0.171	0.180
92 53.01 WATER TRANSPORT	0.341	0.250	-	-	0.210	0.210	0.248	0.496	0.435	0.435	0.125	0.131
93 54.01 AIR TRANSPORT	0.025	0.020	-	-	0.002	0.002	0.052	0.104	0.052	0.052	-	-
94 55.01 COMMUNICATION	-	-	-	-	-	-	-	-	-	-	-	-
95 61.01 BANKING	-	-	-	-	-	-	-	-	-	-	-	-
96 61.02 FINANCE & LIFE INSURANCE	-	-	-	-	-	-	-	-	-	-	-	-
97 61.03 OTHER INSURANCE	-	-	-	-	-	-	-	-	-	-	-	-
98 61.04 INVESTMENT, REAL ESTATE ETC.	0.012	0.010	-	-	0.007	0.007	0.005	0.008	0.015	0.015	0.002	0.002
99 61.05 OTHER BUSINESS SERVICES	0.745	0.550	-	-	1.957	1.957	0.003	0.003	0.001	0.001	1.177	1.236
100 61.06 MEMBERSHIP OF CLUBS	-	-	-	-	-	-	0.241	0.241	0.233	0.238	-	-
101 71.01 PUBLIC ADMINISTRATION	-	-	-	-	-	-	-	-	-	-	-	-
102 72.01 DEFENCE	-	-	-	-	-	-	-	-	-	-	-	-
103 73.01 HEALTH	-	-	-	-	-	-	-	-	-	-	-	-
104 74.01 EDUCATION, LIBRARIES, ETC.	-	-	-	-	-	-	-	-	-	-	-	-
105 83.01 RECREATION SERVICES	-	-	-	-	-	-	-	-	0.002	0.002	-	-
106 91.01 ENTERTAINMENT	-	-	-	-	-	-	-	-	0.008	0.008	-	-
107 92.01 RESTAURANTS, HOTELS, CLUBS	0.003	0.003	-	-	-	-	0.002	0.002	-	-	-	-
108 93.01 PERSONAL SERVICES	-	-	-	-	-	-	0.001	0.001	-	-	-	-

(Continuation)

TABLE 1 : DIRECT REQUIREMENTS (\$) FOR \$100 OF OUTPUT (1971/72 PRICES),
YEARS 1968/69 AND 1990/91.

SUPPLYING INDUSTRY	USING INDUSTRY		55.01	
	1968/69	1990/91	1968/69	1990/91
1 01.01 SHEEP	-	-	-	-
2 01.02 CEREAL GRAINS	-	-	-	-
3 01.03 MEAT CATTLE	-	-	-	-
4 01.01 MILK CATTLE & PIGS	-	-	-	-
5 01.05 Poultry	-	-	-	-
6 01.06 OTHER FARMING	-	-	-	-
7 02.00 SERVICES TO AGRICULTURE	-	-	-	-
8 03.00 FORESTRY AND LOGGING	0.001	0.001	0.050	0.028
9 04.00 FISHING, TRAPPING, HUNTING	-	-	-	-
10 11.01 IRON	-	-	-	-
11 11.02 OTHER METALLIC MINERALS	0.023	0.020	-	-
12 12.00 COAL & BRUIK PEAKHEUM	0.018	0.010	-	-
13 14.00 NON-FERROUS M.E.C.	0.023	0.010	-	-
14 16.00 SERVICES TO MINING	-	-	-	-
15 21.01 MEAT PRODUCTS	-	-	-	-
16 21.02 MILK PRODUCTS	-	-	-	-
17 21.01 FURRIE & VEGITABLE PRODUCTS	-	-	0.001	-
18 21.04 MARGARINE, OILS & FATS	-	-	-	-
19 21.05 FLOUR & CEREAL PRODUCTS	-	-	-	-
20 21.06 BREAD, CAKES & BISCUITS	-	-	-	-
21 21.07 CONFECTIONERY PRODUCTS	-	-	-	-
22 21.08 FOOD PRODUCTS N.E.C.	-	-	0.001	-
23 21.09 SOFT DRINKS, BEVERAGES ETC.	-	-	-	-
24 21.10 BEER & MALT	0.008	0.008	-	-
25 21.11 ALCOHOLIC BEVERAGES N.E.C.	-	-	-	-
26 22.01 TOBACCO PRODUCTS	-	-	-	-
27 23.01 WOODEN PRODUCTS	-	-	-	-
28 23.02 MAN-MADE FIBRES, YARNS ETC.	-	-	-	-
29 23.03 CHEMICALS, PLASTIC YARNS ETC.	0.008	0.008	-	-
30 23.04 WOOL & WOVEN YARNS ETC.	-	-	-	-
31 23.05 TEXTILE FINISHING	0.008	0.008	0.001	-
32 23.06 TEXTILE FLOOR COVERING	0.014	0.014	-	-
33 23.07 TEXTILE PRODUCTS N.E.C.	0.398	0.045	0.005	0.003
34 24.01 WHITING MILLS	-	-	-	-
35 24.02 CLOTHING	0.017	0.017	0.002	0.001
36 24.03 FURWEAR	-	-	-	-
37 25.01 SAWMILL PRODUCTS	-	-	-	-
38 25.02 PLYWOOD, VENEERS & BOARDS	-	-	-	-
39 25.03 JOINERY & WOOD PRODUCTS	-	-	0.004	0.002
40 25.04 FURNITURE, MATRESSES, BEDDINGS	0.005	0.005	0.005	0.003
41 26.01 PULP, PAPER & PAPERBOARD	0.020	0.020	-	-
42 26.02 CORRUGATED, PAPER CONTAINERS	0.003	0.003	0.112	0.062
43 26.03 PAPER PRODUCTS N.E.C.	-	-	0.004	0.002
44 26.04 NEWS PAPERS & BOOKS	-	-	-	-
45 26.05 COMMERCIAL & JOB PRINTING	0.001	0.001	0.002	0.553
46 27.01 CHEMICAL FERTILIZERS	0.001	0.001	-	-
47 27.02 INDUSTRIAL CHEMICALS REC.	0.037	0.040	0.003	0.002
48 27.03 PAINTS, VARNISHES, LACQUERS	-	-	-	-
49 27.04 PHARMACEUTICAL & CHEMICALS	-	-	-	-
50 27.05 SOAP & OTHER DETERGENTS	-	-	-	-
51 27.06 COSMETIC, TOILET PREPARATIONS	-	-	-	-
52 27.07 CHEMICAL PRODUCTS REC.	0.002	0.002	-	-
53 27.08 MEMBRANE & CHEM. PRODUCTS	5.919	4.700	0.094	0.052
54 28.01 GLASS & GLASS PRODUCTS	-	-	0.001	-
55 28.02 CLAY PRODUCTS	-	-	0.014	0.008
56 29.03 CEMENT	-	-	-	-
57 29.04 READY-MIXED CONCRETE	0.001	0.001	-	-
58 29.05 CERAMIC PRODUCTS	-	-	0.317	0.055
59 29.06 NON-METALLIC MINERAL PRDUS	-	-	0.003	0.002
60 29.01 BASIC IRON & STEEL	0.013	0.013	0.018	0.010
61 29.02 OTHER BASIC METAL PRODUCTS	-	-	0.009	0.005
62 31.01 STRUCTURAL METAL PRODUCTS	0.001	0.001	0.059	0.033
63 31.02 SHEET METAL PRODUCTS	0.014	0.014	1.577	0.872
64 31.03 METAL PRODUCTS REC.	0.035	0.035	0.222	0.127
65 32.01 MOTOR VEHICLES & PARTS	5.084	6.640	0.032	0.018
66 32.02 SHIP & BOAT BUILDING	-	-	0.002	0.001
67 32.03 LOCOMOTIVES, ROLLING STOCK	0.004	0.004	0.003	0.002
68 32.04 AIRCRAFT BUILDING	0.001	0.001	-	-
69 33.01 SCIENTIFIC EQUIPMENT ETC.	-	-	0.084	0.086
70 33.02 ELECTRONIC EQUIPMENT	-	-	12.111	5.553
71 33.03 PHOTOGRAPHIC APPLIANCES REC.	0.001	0.001	0.058	0.032
72 33.04 ELECTRICAL MACHINERY REC.	0.008	0.008	5.123	6.126
73 33.05 AGRICULTURAL MACHINERY	0.012	0.012	0.032	0.018
74 33.06 CONSTRUCTION, ETC., EQUIPMENT	0.029	0.029	0.001	-
75 33.07 OTHER MACHINERY EQUIPMENT	0.038	0.038	0.036	0.020
76 34.01 LEATHER PRODUCTS	0.001	0.001	0.001	-
77 34.02 RUBBER PRODUCTS	3.300	2.450	0.010	0.006
78 34.03 PLASTIC & RELATED PRODUCTS	0.033	0.030	0.909	0.502
79 34.04 SIGNS, MARKING EQUIPMENT ETC.	-	-	-	-
80 34.05 OTHER MANUFACTURING	0.002	0.002	0.010	0.005
81 36.01 ELECTRICITY	0.240	0.240	0.834	0.461
82 36.02 GAS	0.062	0.060	0.001	-
83 37.01 WATER, SEWERAGE & DRAINAGE	0.004	0.010	0.058	0.032
84 41.01 RESIDENTIAL BUILDINGS	-	-	-	-
85 41.02 BUILDING REC., CONSTRUCTION	0.315	0.320	0.814	0.750
86 46.01 WHOLESALE TRADE	4.628	4.600	3.466	1.473
87 49.01 RETAIL TRADE	0.388	0.430	0.098	0.027
88 49.02 MOTOR VEHICLE REPAIRS	3.441	2.800	0.734	0.418
89 44.01 OTHER REPAIRS	-	-	-	-
90 51.01 ROAD TRANSPORT	-	-	0.263	0.145
91 52.01 RAIL TRANSPORT	0.157	1.120	0.616	0.340
92 53.01 WATER TRANSPORT	1.173	1.160	0.044	0.024
93 54.01 AIR TRANSPORT	0.160	0.160	3.033	1.674
94 55.01 COMMUNICATION	-	-	-	-
95 61.01 BANKING	-	-	-	-
96 61.02 FINANCE & LIFE INSURANCE	-	-	-	-
97 61.03 OTHER INSURANCE	0.004	0.010	0.102	0.001
98 61.04 INVESTMENT, REAL ESTATE ETC.	-	-	0.242	0.145
99 61.05 OTHER BUSINESS SERVICES	-	-	-	-
100 61.06 OWNERSHIP OF BUILDINGS	-	-	-	-
101 71.01 PUBLIC ADMINISTRATION	-	-	-	-
102 72.01 RESEARCH	-	-	-	-
103 81.01 HEALTH	-	-	-	-
104 82.01 EDUCATION, LIBRARIES, ETC.	-	-	-	-
105 83.01 RECREATION SERVICES	-	-	-	-
106 91.01 ENTERTAINMENT	-	-	-	-
107 92.01 RESTAURANTS, HOTELS, CLUBS	0.005	0.010	-	-
108 93.01 PERSONAL SERVICES	-	-	-	-
109 99.10 BUSINESS SERVICES	4.952	5.056	2.071	1.145
110 11 TOTAL INTERMEDIATE USAGE	30.613	30.243	33.293	26.497

TABLE 2 : LABOUR REQUIREMENTS (PERSONS) PER \$1 MILLION OF ANNUAL OUTPUT (1971/72 PRICES), YEARS 1971/72 AND 1990/91

OCCUPATIONAL GROUP	11.01		11.02		12.00		27.08	
	1971/72	1990/91	1971/72	1990/91	1971/72	1990/91	1971/72	1990/91
USING INDUSTRY								
PROFESSIONAL WHITE COLLAR	0.21	0.20	1.67	0.75	0.28	0.12	0.38	0.31
SKILLED WHITE COLLAR	0.68	0.80	4.21	2.21	1.56	0.70	0.95	0.67
SEMI AND UNSKILLED WHITE COLLAR	1.10	0.75	4.64	1.51	1.53	0.70	1.02	0.65
SKILLED BLUE COLLAR, METAL AND ELECT'L	2.09	2.10	6.98	3.14	7.42	3.29	1.29	0.98
SKILLED BLUE COLLAR, BUILDING	0.10	0.10	0.86	0.39	0.48	0.22	0.09	0.05
SKILLED BLUE COLLAR, OTHER	0.03	0.02	0.14	0.04	0.01	0.01	0.02	0.01
SEMI AND UNSKILLED BLUE COLLAR	8.38	5.88	28.92	10.95	21.26	9.52	4.55	2.81
RURAL WORKERS	0.06	0.05	0.33	0.14	0.09	0.04	0.01	0.01
ARMED SERVICES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL LABOUR	12.8	10.0	47.8	19.2	32.7	14.6	8.2	5.5

OCCUPATIONAL GROUP	29.02		32.01		24.03		41.01	
	1971/72	1990/91	1971/72	1990/91	1971/72	1990/91	1971/72	1990/91
USING INDUSTRY								
PROFESSIONAL WHITE COLLAR	0.55	0.46	0.42	0.47	0.82	0.69	0.26	0.31
SKILLED WHITE COLLAR	2.18	2.27	3.61	3.55	8.04	4.59	5.34	4.03
SEMI AND UNSKILLED WHITE COLLAR	4.59	1.36	5.35	5.23	11.27	5.55	3.35	2.42
SKILLED BLUE COLLAR, METAL AND ELECT'L	2.69	3.40	16.49	13.50	5.56	5.48	6.87	4.90
SKILLED BLUE COLLAR, BUILDING	0.38	0.20	1.55	1.26	0.36	0.41	16.29	10.01
SKILLED BLUE COLLAR, OTHER	0.02	0.01	0.047	0.00	0.34	0.12	0.00	0.00
SEMI AND UNSKILLED BLUE COLLAR	10.75	3.98	19.45	14.48	41.91	20.17	13.64	9.30
RURAL WORKERS	0.04	0.02	0.047	0.00	0.00	0.00	0.04	0.03
ARMED SERVICES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL LABOUR	21.2	11.70	47.0	38.5	68.7	37.0	47.8	31.0

OCCUPATIONAL GROUP	41.02		48.02		51.01		55.01	
	1971/72	1990/91	1971/72	1990/91	1971/72	1990/91	1971/72	1990/91
USING INDUSTRY								
PROFESSIONAL WHITE COLLAR	0.63	0.41	0.0	0.0	0.15	0.13	1.16	0.51
SKILLED WHITE COLLAR	6.07	3.79	12.8	9.0	6.06	5.2	3.41	1.25
SEMI AND UNSKILLED WHITE COLLAR	5.04	2.90	12.8	8.7	8.91	9.7	27.75	8.57
SKILLED BLUE COLLAR, METAL AND ELECT'L	13.32	8.32	50.1	30.8	3.50	4.6	26.40	5.92
SKILLED BLUE COLLAR, BUILDING	24.90	14.51	6.5	4.4	0.22	0.2	0.36	0.12
SKILLED BLUE COLLAR, OTHER	0.07	0.04	0.0	0.0	0.07	0.1	0.00	0.00
SEMI AND UNSKILLED BLUE COLLAR	28.21	17.64	12.3	10.1	53.95	44.17	29.36	12.31
RURAL WORKERS	0.55	0.34	0.0	0.0	0.15	0.13	0.10	0.03
ARMED SERVICES	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.00
TOTAL LABOUR	78.8	47.9	94.6	63.0	73.0	64.2	89.8	31.1

TABLE 3 CONTINUED

USING INDUSTRY		41.01	41.02	48.02	51.01	55.01
SUPPLYING INDUSTRY	RESIDENTIAL BUILDINGS	BUILDINGS N.E.C. CONSTRUCTIONS	MOTOR VEHICLES REPAIRS	ROAD TRANSPORT	COMMUNICATION	
	1971/72 1990/91	1971/72 1990/91	1971/72 1990/91	1971/72 1990/91	1971/72 1990/91	
11.01/11.02/12.0 Mine Development						
23.04 Furniture mattresses and brooms	*	0.001 0.001				0.012 0.004
26.05 Concrete products		0.001 0.001				0.130 0.040
31.01 Structural metal products	*	0.001 0.001				
31.02 Sheet metal products	*	0.001 0.001				0.012 0.004
31.03 Metal products	*	0.001 0.001				
32.01 Motor vehicles		0.004 0.005				0.042 0.015
32.02 Ship and boat buildings				0.313 0.293		
32.03 Locomotives, rolling stock				0.005 0.005		
33.01 Scientific Equipment	*	*				0.001 0.003
33.02 Electronic Equipment	*	0.002 0.002				1.074 0.345
33.03 Household appliances	*	*				
33.04 Electrical machinery		0.001 0.001				1.598 0.606
33.06 Construction equipment		0.005 0.007				0.035 0.012
33.07 Other machinery		0.010 0.013				0.015 0.005
34.02 Rubber Products		0.052 0.052				0.099 0.036
41.02 Buildings n.e.c. Constructions			0.033 0.036			0.436 0.155
TOTAL	0.073 0.078	0.160 0.194		0.419 0.420		3.459 1.231

A1.2 Outline of Major Developments within Selected Industries.

Iron Ore Mining (IO Industry 11.01, ASIC 1104)

The outlook for the Iron Ore industry is one of considerable growth with increased foreign demand from the USA, China and Europe, Korea and Taiwan. By 1990/91 it is expected that domestic production will be at more than double 1971/72 levels. Several of the ore deposits currently being mined will be exhausted but several other new deposits will be exploited. An important limiting factor on domestic production will be competition for exports from Brazil.

The fact that much of the iron ore mining development is relatively recent and that the scale of these developments have been rather large means that the scope for technological change is not as great as in some other countries. The size of individual machines, trucks etc will increase. However efficiencies obtained in this way will tend to be offset by increases in the waste to ore ratios. The mining of lower grade deposits will also require an increase in the level of beneficiation.

The relative importance of intermediate material and service inputs overall will not alter markedly, however there will be some compositional changes. Inputs from Services to Mining (16.00), Chemical Products nec (27.07), Coal (12.00), Electrical and other machinery (33.04, 33.07), Rubber Products (34.02), Electricity (36.01), Other Repairs (48.03), Railway (52.01) will all increase. The relative inputs of other industries will adjust downwards accordingly. Basically these changes reflect the move towards slightly increased automation, or at least larger capacity machines, combined with a decline in the grade of ore being mined.

In the labour matrix, the number of skilled workers (particularly technicians) and tradesmen will increase relative to the semi and unskilled groups, in keeping with the move towards further automation. The overall level of labour productivity increase will however be slight.

The capital stock requirements, particularly the mine development and rolling stock components, depend on the location and nature of mines in operation. Electronic equipment (33.02) will increase reflecting the greater provision of automatic equipment. Electrical machinery (33.04) will increase (replacing diesel). Buildings will undergo a relative decline.

Other Metallic Minerals (IO Industry (11.02, ASIC 110 excluding 1104)

This industry combines mining activities associated with a range of metallic ores, many of which, even individually contribute significantly to GDP. The industry will continue to be very significant in 1990/91. The outlook for many of these metals is one of considerable growth and it is expected that the total output of the industry to 1990/91 will increase at an average rate of about 7% p.a.

The sub-industries are quite different in terms of mining technology, growth rates, pricing structure and end-use markets. The changes expected to occur in the industry are not very marked in terms of new technology. The most significant changes relate to its composition, particularly the growth in output of the mining activities associated with bauxite, copper, lead, zinc and most importantly uranium. It is these compositional changes which will have the most significant impact on the values of the technological coefficients.

The outputs for each of the mining activities in 1971/72

TABLE 4: COMPOSITION OF OTHER METALLIC MINERALS MINING 11.02

ASIC	DESCRIPTION	1968/69	1971/72	1974/75	1990/91
1101	<u>BAUXITE</u>				
	- Quantity ('000 tonnes)	6,317	13,697	22,205	55,500
	- Value (\$m 1971-72 prices)	31.6	68.5 (12.1%)	111.0	277.5 (19.7%)
1102	<u>COPPER (Ores & Concentrates)</u>				
	- Quantity ('000 tonnes)	547.6	697.2	911.9	1384.1
	- Value (\$m 1971-72 prices)	95.5	121.6 (21.5%)	159.0	241.4 (17.2%)
1103	<u>GOLD</u>				
	- Quantity - (tonnes)	24.6	20.8	12.9	21.4
	- Value (\$m 1971-72 prices)	25.3	21.4 (3.8%)	13.3	22.0 (1.6%)
1105	<u>MINERAL SANDS</u>				
	- Quantity ('000 tonnes)	1344.3	1468.9	1639.1	1520.0
	- Value (\$m 1971-72 prices)	57.9	63.3 (11.2%)	70.6	65.5 (4.7%)
1106	<u>NICKEL (By Content)</u>				
	- Quantity ('000 tonnes)	29.8	35.5	60.8	34.4
	- Value	79.5	94.7 (16.8%)	162.2	91.8 (6.5%)
1107	<u>SILVER-LEAD-ZINC</u>				
	- Quantity ('000 tonnes)	1518.8	1541.1	1587.4	2551.7
	- Value (\$m 1971-72 prices)	132.6	134.5 (23.8%)	138.5	222.7 (15.8%)
1108	<u>TIN (Concentrate)</u>				
	- Quantity (tonnes)	12.0	19.7	19.6	20.7
	- Value (\$m 1971-72 prices)	18.5	30.4 (5.4%)	30.2	31.9 (2.3%)
1109	<u>METALLIC MINERALS NEC</u>				
	- Uranium (Yellow Cake)	-	-	-	27.5
	- Quantity ('000 tonnes)	-	-	-	424.4 (30.2%)
	- Value (\$m 1971-72 prices)	-	-	-	-
	- Other	-	-	-	-
	- Value (\$m 1971-72 prices)	30.0	30.0 (5.3%)	-	30.0 (2.1%)
	Total Value (\$m 1971-72 prices)	470.9	564.4	-	1407.2

Source: ABS Mineral Production, 1973-74 and 1975-76, Ref. No. 10.51. Price estimates and forecasts from BMR.

TABLE 5 : FORECASTS OF AGGREGATE COEFFICIENTS TO 1990/91 (1971/72 prices)

Factor/Industry	Bauxite	Copper	Gold	Mineral Sands	Nickel	Silver- Lead- Zinc	Tin	Uranium	Other	Total (weighted average)
Output (% of total by value)										
1971/72	12.1	21.5	3.8	11.2	16.8	23.8	5.4	0.0	5.3	100.0
1990/91	19.7	17.2	1.6	4.7	6.5	15.8	2.3	30.2	2.1	100.0
Intermediate Inputs as a percentage of industry output										
1971/72	17.3	31.8	23.0	40.7	28.7	28.7	30.8	-	27.8	27.5
1990/91	17.3	31.8	23.0	40.7	28.7	28.7	30.8	34.4	27.8	29.2
Number of persons employed per \$m of output										
1971/72	19.8	56.1		43.1	23.7	58.5	68.0	-		47.8
1990/91	15.0	28.0		40.0	12.0	30.0	34.0	5.8		19.2
Total Value (\$m) of Capital Stock for \$1m p.a. output										
1971/72	1.7	2.35		6.0	1.75	2.35	4.0	-		2.7
1990/91	1.35	2.35		6.0	1.75	2.35	4.0	2.3		2.2

and projections to 1990/91 are summarised in table 4. The proportions in 1990/91 based on 1971/72 prices are used to impute the overall industry coefficients for that year. Table 5 shows the aggregated factor to output ratios for the component activities and the resultant aggregated coefficients estimated for 1990/91.

The direct requirements coefficients have been altered to reflect the higher proportion of above ground uranium and bauxite mining.

The capital requirements have been similarly altered. Since uranium mining is in many respects similar to Iron ore mining, the coefficients for iron ore mining have been used as a guide in assessing the effect of the development of uranium mining on the overall coefficients.

The major compositional changes in labour requirements tend to be similar for all mining activities, that is, relative increases in the numbers of technicians, engineers and skilled blue collar workers and a corresponding reduction in the semi and unskilled groups. The expected improvements in labour productivity varies from one activity to another. Generally slower rates of increase are observed for those activities which have been established more recently and are consequently already using quite modern technology.

Coal and Crude Petroleum (IO Industry 12.00, ASIC 120, 130)

This industry has undergone substantial changes since 1968/69 to the present time and further change is likely. The major commodities produced are black coal (steaming and coking), brown coal and crude petroleum (including natural gas). Although these each share the "energy/fuel" label, methods of production are quite different as are the markets to which their outputs are distributed.

Since 1968/69 there has been a significant increase in the production of both crude petroleum and natural gas. It is expected that oil production will be maintained at about current levels ($23 \times 10^6 \text{ m}^3$ p.a.), until 1980 but, barring unanticipated discoveries, production will taper off significantly by 1990/91. Production will decrease in spite of import parity pricing being achieved by 1990/91. Gas production will increase, with continued production from Bass Strait and Cooper Basin, as well as the likely exploitation of North West Shelf reserves by 1990/91. Part of the North West Shelf reserves will be used to supply domestic needs in WA, however a national pipeline to supply the rest of Australia is unlikely. About half the total production will go instead to supply quite considerable exports of liquid natural gas (LNG).

Coal production too, has undergone considerable expansion since 1968/69, however, in contrast to crude petroleum, continued growth is almost assured. Recent expansion has taken place both in Europe and Japan, usually at the expense of the higher priced American coals. Exports thus far have been mainly coking coal, however with the increasing world price of crude oil, the exports prospects for black steaming coal are also very significant. Brown coal production will increase, continuing in its present role as the principal fuel for electricity generation in Victoria.

Table 6 shows the breakdown of industry output estimated for various years from 1968/69 to 1990/91 in quantity terms as well as constant and current prices. The forecast values used are those thought likely, given our present knowledge. In the table, price levels for 1990/91 are real price estimates using 1974/75 values as the base

TABLE 6 : BREAKDOWN OF PRODUCTION IN THE PETROLEUM & COAL MINING
INDUSTRY

COMMODITY	YEAR			
	1968/69	1971/72	1974/75	1990/91
Black Coal				
- Quantity (m tonnes)	43.3	53.5	70.1	150.0
- Value (\$m 1971/72 prices)	267.4	330.4	432.8	925.0
- Value (\$m current prices)	198.7	330.5	874.9	3744.0
- Av. Price (\$ per tonne)	4.59	6.18	12.48	24.96
Brown Coal (& briquettes)				
- Quantity (m tonnes)	20.6	21.3	25.5	62.0
- Value (\$m 1971/72 prices)	31.9	33.0	39.6	96.1
- Value (\$m current prices)	29.3	33.0	51.9	126.5
- Av. Price (\$ per tonne)	1.42	1.55	2.04	2.04
Crude Petroleum (incl. LPG)				
- Quantity (10 ⁶ m ³)	2.2	19.0	23.1	8.0
- Value (\$m 1971/72 prices)	28.4	241.1	293.1	101.5
- Value (\$m current prices)	39.7	241.1	302.6	607.8
- Av. Price (\$ per m ³)	17.73	12.69	13.10	75.98
Natural Gas				
- Quantity (10 ⁹ m ³)	0.1	2.6	4.6	18.8
- Value (\$m 1971/72 prices)	0.46	20.5	36.3	148.5
- Value (\$m current prices)	0.52	20.5	43.5	533.0
- Av. Price (\$ per 10 ³ m ³)	8.90	7.90	9.45	28.35

- the real price of black coal is assumed to double
- the price of brown coal is assumed unchanged in real terms
- the crude oil price increases from the 1974/75 price by a factor of 5.8. This takes account of a move to import parity followed by a real increase in the world price of crude from 1974/75 to 1990/91 of 2% p.a.
- the average price of natural gas (average of domestic and export well head prices) is assumed to treble in real terms, reflecting the higher proportion of higher priced NW Shelf gas.

Although there will be a number of technological changes taking place within each sub-industry, probably a more important cause of change for the coefficients of the overall industry is its rapidly changing composition.

In coal mining the causes of change are associated with different methods of extraction. In 1968/69, 79% of black coal was mined by underground methods, by 1974/75 this figure had declined to 53%. It is expected that this figure will reduce even further. In underground mining there will be other changes such as the adoption of long wall mining techniques, particularly in NSW mines. These factors will lead to changes in the coefficients of each of the matrices.

Direct input requirements for coal mining will be reduced overall and this will be accompanied by compositional changes in these inputs. Labour productivity will be greatly increased through the swing to open cut methods and the adoption of new techniques. Capital requirements may also increase.

Crude petroleum and gas requires on average, much greater capital expenditure for a given level of output than coal; and this requirement will increase with the development of the North West Shelf which involves additional technological problems. Intermediate input requirements and labour requirements are minimal in oil and gas production and no significant changes are expected. Coal mining therefore is the major influence causing changes in the direct intermediate requirements and labour matrices.

Petroleum and Coal Products (IO industry 27.08, ASIC 273,274)

This is a highly capitalised industry having very low labour requirements. The principal activity is petroleum refining ASIC 273 (95% in 1968/69), the balance being the manufacture of bitumen or asphalt paving materials and other petroleum and coal products.

The underlying factor causing change in this industry is the rapid and continuing rise in the world price of crude oil since 1971/72. As crude oil represents the major input to the industry the cost of inputs will rise substantially. However in constant price terms changes to the direct intermediate requirements matrix from this source will be minimal.

Fuel oil competes with natural gas, coal and nuclear energy. With the anticipated increase in crude oil imports, and with the existing oil refining installations, there is likely to be a growing surplus of fuel oil (or black refining products). In contrast, white oil products are used for transport, for which there are no effective substitutes. Consequently there will be a growing disparity between the prices of black and white oil products. This will encourage moves to reduce the proportion of fuel oil produced by the installation of additional cracking equipment in the medium term.

One new activity which should logically be included within this industry would be the conversion of coal to oil and other petrochemical feedstocks. Such a development once established is potentially of major importance to the industry and would be a major determinant of the technological coefficients. By 1990/91 however, it is thought unlikely that such an activity will be highly significant. The lead time and size of investment for such ventures are large. There is likely to be a ten year period of pilot and demonstration plants before a full scale plant (of say, 50,000 barrels per day capacity) comes into operation. The demand for crude in 1990/91 is, however, likely to be of the order of 800,000 barrels per day. The forecasts made here assume that only 10% of crude oil will be supplied from this source.

Petroleum refining will be still the major activity in 1990/91. Labour productivity is expected to increase with the development of additional refining capacity, partly due to the improved technology of the newer plant and partly the productivity gains that would be achieved from the expansion of some existing refineries where much of the infrastructure already exists. Capital requirements coefficients are expected to increase slightly reflecting the additional investment in cracking equipment and the higher capital costs associated with the coal to oil process.

Non-Ferrous Basic Metal Products (IO industry 29.02, ASIC 292,293)

This industry includes a number of different types of operations associated with non-ferrous metals, including primary and secondary recovery, rolling, drawing, extruding and castings. The industry has undergone a fairly significant compositional change since 1968/69 with a large increase in the share held by alumina and aluminium production. Although there are a number of technological developments which may alter the processes involved in the refining of some metals these are not expected to

TABLE 7 : Estimated ASIC Composition of IO Industry 29.02
 (1971/72 Prices)
 PERCENT

ASIC	DESCRIPTION	1968/69	1971/72	1974/75	1990/91
2921	Smelting & Refining of Copper	16.2	12.7	10.7	9.0
2922	Smelting & Refining of Silver, Lead & Zinc	20.5	17.6	17.4	20.0
2923/24	Alumina/Smelting of Aluminium	15.2	21.4	27.5	29.0
2925/26	Smelting & Refining of Nickel & Non-ferrous metals nec	3.4	5.9	10.3	8.0
2927	Rolling, Drawing and Extruding of Aluminium	13.2	12.7	10.6	11.0
2928	Rolling, Drawing and Extruding of non-ferrous metals	21.1	17.8	14.7	14.0
2929	Non-ferrous metal castings	2.4	2.4	1.9	1.0
2931	Secondary Recovery & Alloying of Non-Ferrous Metals	7.8	9.5	6.9	8.0
	Total	100.0	100.0	100.0	100.0
	Total Output (\$1971/72 million)	1163.3	1074.1	1410.4	

cause any large changes to the coefficients. The rolling, drawing and extruding sub-industries are not expected to undergo any significant technological changes.

There will be a gradual trend towards further automation in all activities thus reducing labour requirements. The major changes to the coefficients will be brought about however through the changing industry composition. The changing composition of the industry is indicated in table 7 with forecasts of the composition expected in 1990/91. These compositional forecasts are used to impute changes in industry coefficients brought about by the compositional change together with the minor changes of a technical nature.

For the purposes of the forecasts it is assumed that the processing of uranium will not be undertaken within Australia by 1990/91.

Motor Vehicles and Parts (IO industry 321, 3225)

The nature of the motor vehicle industry in 1990/91 will depend very much on government policy towards the industry. It seems very likely that there will be some reduction in protection for the industry combined with some rationalisation of the industry. In these forecasts we assume however, that a fairly high level of protection will be maintained. Should government policy be substantially different towards the industry in 1990/91, then these forecasts would need to be adjusted accordingly.

The trend towards smaller vehicles will continue. The increasing cost of buying and running current types of passenger cars will ensure a trend towards cheap specialised vehicles with limited lives.

The major changes expected in the intermediate input requirements is the substitution of steel by materials such as plastics, fibreglass and lightweight alloys. This substitution is not all one way, steel is improving in many ways such as better design and new fabrication techniques. Increased inputs are expected from the scientific and electronic equipment categories to provide increased electronic control of engine performance through the use of sensors, monitoring equipment, electronic ignitions, etc.

Due to the large number of manufacturers and assemblers of motor vehicles in Australia, and the likelihood of continued passenger vehicle market fragmentation in terms of models available, it is not likely that Australian industries will be able to benefit nearly as much from increased automation as many overseas countries have done. The proportion of semi-skilled and unskilled labour will decrease as limited automation is introduced. The major impact will be in the expansion of prefabrication techniques. It will be cheaper for subassemblies to be assembled off line, and then inserted into the production line.

Capital stock coefficients are expected to increase reflecting not only the trend towards limited automation but also the increasing diversity in the types of vehicles that will be produced in 1990/91.

Plastic and Related Products (IO industry 34.03, ASIC 343)

This industry has recently experienced a rapid rate of growth (10.4% between 1968/69 and 1974/75). Rapid growth is expected to continue to 1990/91 although at a somewhat slower rate (7-10%). In spite of the escalation of crude oil prices, products have maintained their price advantage

over substitute products. This advantage is expected to be maintained. Significant technological innovations in processing, formulation and resultant properties (via fibre reinforced plastics, laminates and composites which substitute for metals, wood, cardboard etc., in many uses) will help to maintain this high growth.

Direct intermediate input requirements are not expected to alter markedly. On the other hand the occupational composition of the workforce is projected to change as well as the overall labour to output ratio. The major compositional changes are relative increases in the numbers of scientists, engineers, technicians, skilled metal and electrical tradesmen and a relative decrease in the number of employers and management staff, production workers and labourers.

Although the overall capital to output ratio is not expected to alter markedly some changes in the composition of the capital stock will take place. The proportions of scientific equipment, electronic equipment, electrical machinery and other machinery are expected to increase slightly, relative to the other categories of capital equipment. These changes basically reflect the moves towards more automated equipment.

Residential Building (IO industry 41.01, ASIC 411 (part), 42 (part))

A major factor affecting the technical coefficients for this industry will be a continuing trend towards off-site fabrication of building or parts of buildings.

The direct intermediate requirements coefficients are affected by two major influences. The first is the degree of fabrication of products supplied by other industries, with consequent increases in coefficients representing

such inputs. (IO Industries in this category include 25.03, 28.05, 31.01, 31.02, 31.03, 34.04, 45.01). The second factor is the substitution of materials. The extent and direction of substitution depends ultimately on relative pricing and the relative merits of different materials. The present forecasts have been made on the basis of present knowledge regarding these factors. For example glass fibre reinforced concrete products are likely to replace steel and asbestos reinforced concrete. This will not only reduce steel input requirements but less concrete is used as well. Metals, plastics and concrete products will tend to substitute for wood. Other changes expected include more widespread use of insulation, the use of more sophisticated hand tools and increased input from household appliances.

The labour requirements per unit of output are expected to decrease in line with long term trends in labour productivity, largely through the use of fabricated components. This will be true for each occupational category except professional white collar; semi and unskilled worker requirements will be increased relative to some other groups through their employment in pre-fabrication factories.

In the capital matrix the major factors causing change are the moves towards pre-fabrication factories and the use of more sophisticated capital equipment items.

Non-Residential Building and Construction (IO industry 411 (part), 412, 42 (part))

Changes expected in Non-Residential building are similar in nature to those forecast for the Residential Building industry 41.01. The Construction activities, however, are quite diverse in nature and it is difficult to make detailed projections regarding them all. Examples of

construction activities include road work, water storage and supply, sewerage and drainage, electricity, oil and gas production and distribution facilities, marine work and so on. The forecasts therefore are necessarily fairly broad in character.

Qualitatively similar changes are expected to the direct intermediate requirement and capital coefficients as for 41.01. The labour requirements are considered in the light of labour productivity trends and the likely Non-Residential Building vs Construction split. For the purpose of the forecasts a 35%/65% split is assumed for 1990/91.

Motor Vehicle Repairs (IO industry 48.02, ASIC redefinitions from wholesale trade classification)

The two major activities are (a) motor vehicle body and chassis repairs and (b) mechanical and electrical repairs. Quite major improvements are anticipated in the efficiency of most repair operations.

There are likely to be more assembly line type operations for mechanical repairs (e.g. reconditioned engines). Modular replacement of parts (both new and reconditioned) will reduce time and labour costs. There will be increased use of plastic and fibre glass body repair, including replacement panels.

Assembly line operations, which include the repairing and reconditioning of modular parts, are considered as part of this industry. The changes will have a number of effects. Overall labour requirements will be reduced, there will be a reduction in skilled metal trades workers who will be replaced by semi-skilled workmen. Less skilled persons will be required not only for use with diagnostic equipment, but also because of modular replacement

and for the assembly line operations. There will be a change in the types of capital equipment with more scientific and electronic apparatus, but less metal working equipment. The increase in assembly line type operations means some additional capital stock resembling the proportions of factories will be required. This may tend to increase the plant and machinery components. However it is thought that modular replacement will mean much faster turnaround with repairs and far better utilization of equipment (especially buildings) so that the capital stock requirements per unit of output is reduced overall.

Road Transport (IO industry 51.01, ASIC 51)

The road transport industry covers two types of transport, passenger, and freight. By far the largest component of the industry in value terms is the freighting activity which in 1968/69 amounted to 77% of total industry output.

In passenger transport there could be the development of a wide range of taxi-like services. Bus and tram services will probably grow only slowly in line with city populations.

Freight transport characteristically has a large number of operators, is very competitive and operates on very low margins. In recent years there has been a trend towards using trains for long haulage and trucks being used for shorter haulage. Train freight rate increases combined with the greater convenience of trucks means that this trend is not expected to continue. Overall growth is expected to be comparable with increases in the general level of economic activity.

There will be considerable improvements in terminal facilities, material handling equipment and increased usage of computer systems. The operating efficiency of

trucks such as improved tyres and larger truck capacities. The cost of repairs will be reduced through modular replacement. The number of persons employed in the industry per unit of output should decline as more modern terminal facilities commence operations.

Communication (IO industry 55.01, ASIC 56)

This industry consists principally of the activities of two government agencies, Telecom and Australia Post. The balance of the industry consists of Broadcasting and OTC operations.

Between now and 1990/91 Australia Post activities and the associated technological coefficients are expected to remain fairly static. By contrast the demand for Telecom services is expected to increase enormously (8.5% p.a. in terms) and by 1990/91 will contribute most of the industry's output (at least 75%). The utilisation of new technological developments will enable this growth of Telecom. The change reflects the increasing trend towards an information based society with large growth in such services as datel (digital data transmission), facsimile reproduction, automatic mobile telephones, cable television, televised conferences, and so on.

While intermediate inputs for the Postal Commission are expected to remain static, for Telecom, a much higher utilization of capital equipment with no additional requirements in terms of material requirements or operating staff will reduce overall input requirements of both intermediate goods and labour quite significantly. The composition of these inputs are expected to vary slightly as well.

Inputs from industries electronic equipment (33.02, wholesale trade (46.01) are expected to decline while the input from electrical machinery n.e.c. (33.04) will relatively increase. The major changes in labour composition reflect relative increases in the numbers of technical staff employed on new equipment installation and a relative reduction of operating staff because of automation.

The capital requirements coefficients for the overall industry are determined principally by Telecom whose activities are far more capital intensive than those of Australia post. The large increases in output from Telecom will be available via new or improved telecommunications equipment which will supplement and in some cases replace existing equipment. However, total capital stock will not be very much greater than present levels, so the overall capital to output requirements will be lower in 1990/91.

A2. LESS DETAILED UPDATES

A2.1 Changes in labour productivity^{8,9}

Indices (14) showing the movement of labour productivity in the major industry sectors between 1962/63 and 1974/75 are presented graphically in Figure 1. Unfortunately similar information is not available at the input-output industry level. The information that is available on a consistent basis varies with industry sector. From manufacturing industry statistics (15,16) it was only possible to estimate average rates of productivity growth at the input-output industry level for the period 1968/69 to 1974/75.

Using other data (17) average rates of productivity growth have been estimated for the years 1962/63 to 1972/73,

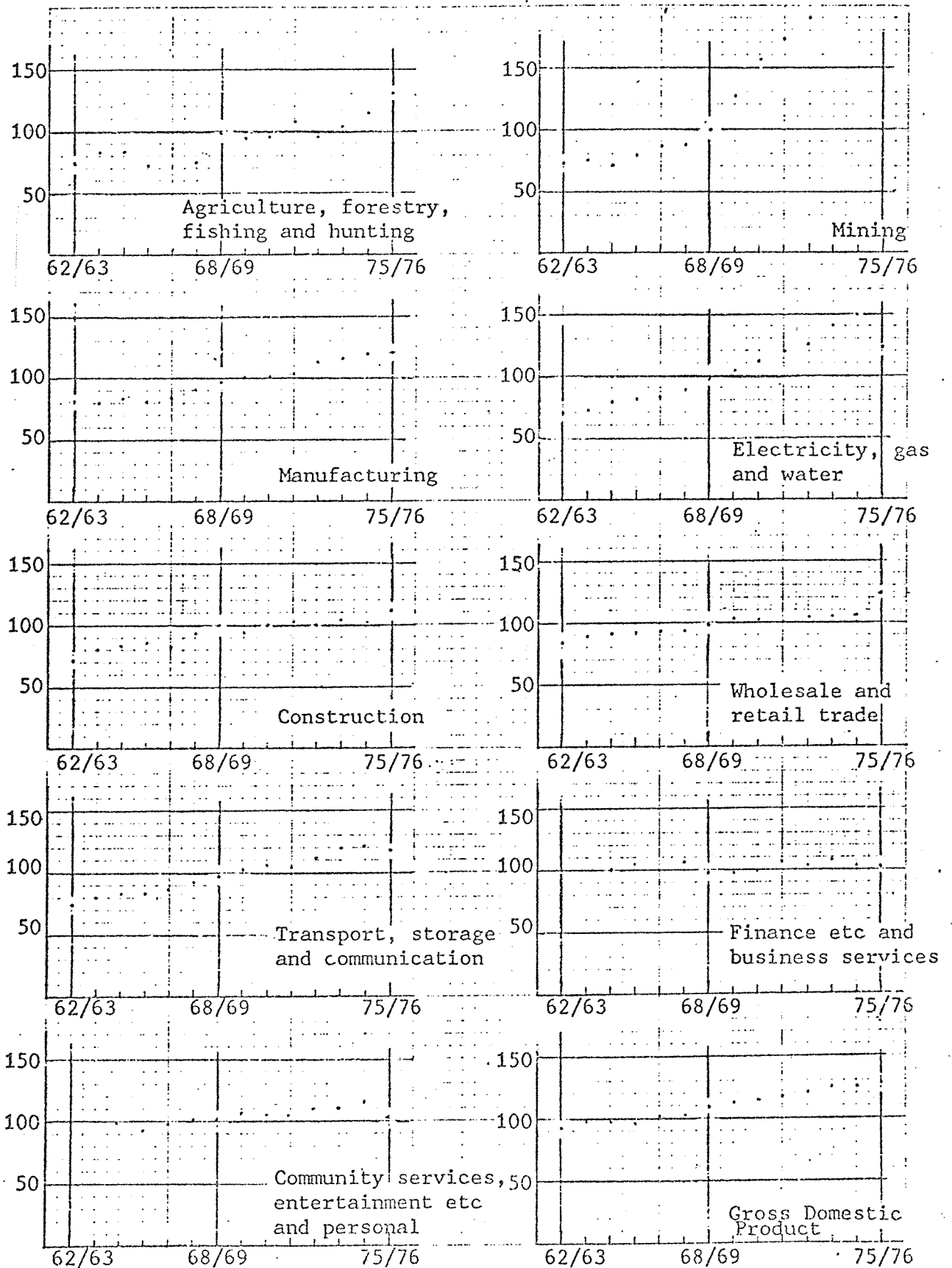


Figure 1 : Labour Productivity Indices 1962/63 to 1975/76
 (Base Year = 1968/69, Index = 100)

for a breakdown of 19 industry groups (9 of which are manufacturing). Roughly comparable statistics are also given for a number of other countries.

All of the estimates of productivity growth obtained as described above are shown in Table 8.

For non-manufacturing industries, figures are not available at the required input-output level of detail. For the manufacturing industries, the period considered is too short for reliable extrapolation. In addition to these problems there are several other questions that need to be considered. Some assessment must be made as to the causes for change between, say, 1968/69 and 1974/75, and whether such influences can be expected to continue to 1990/91.

Referring to Table 8, some avenues are open as a check on the shorter term estimates. Firstly Australian data for broad industry sectors is available for longer periods, as are the corresponding figures for other countries. These can be compared with Australian growth rates at the same level of detail, computed from 1968/69 to 1974/75, to indicate whether recent trends in each sector are representative of the sector's behaviour in the longer term or whether recent behaviour is transitory. The data for other countries offer a further guide, particularly where it is expected that Australia may be following overseas trends in a particular industry sector. Additional estimates have been made using US data available at the level of detail used in a 90 industry input-output classification (18). Where these industries are roughly identifiable with Australian input-output industries such figures are also included in Table 8.

TABLE 8

AN INTERNATIONAL COMPARISON OF LABOUR PRODUCTIVITY GROWTH RATES

INPUT/OUTPUT INDUSTRY	AUSTRALIA 68/74	AUSTRALIA 63/73	CANADA 63/73	U.S.A. 63/73	U.S.A. 55/73	U.S.A. 55/85	1990
1 01.01 SHEEP							
2 01.02 CEREAL GRAINS							
3 01.03 MEAT CATTLE							
4 01.04 MILK CATTLE & PIGS	-3.35	-2.42					
5 01.05 POULTRY							
6 01.06 OTHER FARMING			-3.2				
7 02.00 SERVICES TO AGRICULTURE				-3.7			
8 03.00 FORESTRY AND LOGGING	1.36						
9 04.00 FISHING, TRAFFING, HUNTING	-1.60						
10 11.01 IRON							
11 11.02 OTHER METALLIC MINERALS							
12 12.00 COAL & CRUDE PETROLEUM							
13 14.00 NON-METALLIC N.E.C.	3.5	-18.4	-1.6				
14 16.00 SERVICES TO MINING	-						
15 21.01 MEAT PRODUCTS							
16 21.02 MILK PRODUCTS	4.2						
17 21.03 FRUIT & VEGETABLE PRODUCTS	3.5						
18 21.04 MARGARINE, OILS & FATS	7.0						
19 21.05 FLOUR & CEREAL PRODUCTS	3.7						
20 21.06 BREAD, CAKES & BISCUITS	0.5						
21 21.07 CONFECTIONERY PRODUCTS	1.9						
22 21.08 FOOD PRODUCTS N.E.C.	2.6						
23 21.09 SOFT DRINKS, CORDIALS ETC.	8.0						
24 21.10 BEER & MALT	4.25						
25 21.11 ALCOHOLIC BEVERAGES N.E.C.	4.55	-5.0					
26 22.01 TOBACCO PRODUCTS	-2.1						
27 23.01 PREPARED FIBRES	6.0						
28 23.02 MAN-MADE FIBRES, YARNS ETC.							
29 23.03 COTTON, SILK, FLAX YARNS ETC.	3.5	-5.1					
30 23.04 WOOL & WORSTED YARNS ETC.	4.8						
31 23.05 TEXTILE FINISHING							
32 23.06 TEXTILE FLOOR COVERING	10.1						
33 23.07 TEXTILE PRODUCTS N.E.C.	4.4	-5.6					
34 24.01 KNITTING MILLS	3.6						
35 24.02 CLOTHING	5.3	-3.4					
36 24.03 FOOTWEAR	7.8						
37 25.01 SAWMILL PRODUCTS	3.5						
38 25.02 FLYWOOD, VENEERS & BOARDS	4.7	-3.2					
39 25.03 JOINERY & WOOD PRODUCTS	2.15						
40 25.04 FURNITURE, MATTRESSES, BROOMS	1.75						
41 26.01 PULP, PAPER & PAPERBOARD	5.0						
42 26.02 FIBREBOARD, PAPER CONTAINERS	4.9	-4.2					
43 26.03 PAPER PRODUCTS N.E.C.	3.2						
44 26.04 NEWSPAPERS & BOOKS	3.4						
45 26.05 COMMERCIAL & JOB PRINTING	4.3	-3.85					
46 27.01 CHEMICAL FERTILIZERS	3.6						
47 27.02 INDUSTRIAL CHEMICALS N.E.C.	5.7						
48 27.03 PAINTS, VARNISHES, LACQUERS	3.0						
49 27.04 PHARMACEUTICAL & CHEMICALS	7.6						
50 27.05 SOAP & OTHER DETERGENTS	4.2						
51 27.06 COSMETIC, TOILET PREPARATIONS	8.3						
52 27.07 CHEMICAL PRODUCTS N.E.C.	5.4						
53 27.08 PETROLEUM & COAL PRODUCTS	4.2						
54 28.01 GLASS, GLASS PRODUCTS	7.9						
55 28.02 CLAY PRODUCTS	4.1						
56 28.03 CEMENT	2.35						
57 28.04 READY-MIXED CONCRETE	0.0						
58 28.05 CONCRETE PRODUCTS	2.14	-2.13					
59 28.06 NON-METALLIC MINERAL PRODS	4.9						
60 29.01 BASIC IRON & STEEL	1.1						
61 29.02 OTHER BASIC METAL PRODUCTS	7.5	-4.0					
62 31.01 STRUCTURAL METAL PRODUCTS	2.1						
63 31.02 SHEET METAL PRODUCTS	2.55						
64 31.03 METAL PRODUCTS N.E.C.	1.0						
65 32.01 MOTOR VEHICLES & PARTS	1.5						
66 32.02 SHIP AND BOAT BUILDING	-0.15						
67 32.03 LOCOMOTIVES, ROLLING STOCK	2.0						
68 32.04 AIRCRAFT BUILDING	-2.08						
69 33.01 SCIENTIFIC EQUIPMENT ETC.	12.6	-2.68					
70 33.02 ELECTRONIC EQUIPMENT	6.2						
71 33.03 HOUSEHOLD APPLIANCES N.E.C.	3.5						
72 33.04 ELECTRICAL MACHINERY N.E.C.	0.8						
73 33.05 AGRICULTURAL MACHINERY	1.2	-2.0					
74 33.06 CONSTRUCTION ETC., EQUIPMENT	1.0						
75 33.07 OTHER MACHINERY, EQUIPMENT	3.0						
76 34.01 LEATHER PRODUCTS	4.7						
77 34.02 RUBBER PRODUCTS	2.9						
78 34.03 PLASTIC & RELATED PRODUCTS	6.3						
79 34.04 SIGNS, WRITING EQUIPMENT ETC.	7.95	-4.9					
80 34.05 OTHER MANUFACTURING	0.77	-3.6					
81 35.01 ELECTRICITY							
82 35.02 GAS							
83 37.01 WATER, SEWERAGE & DRAINAGE							
84 41.01 RESIDENTIAL BUILDINGS							
85 41.02 BUILDING N.E.C., CONSTRUCTION							
86 46.01 WHOLESALE TRADE							
87 48.01 RETAIL TRADE							
88 48.02 MOTOR VEHICLE REPAIRS							
89 48.03 OTHER REPAIRS							
90 51.01 ROAD TRANSPORT							
91 52.01 RAIL TRANSPORT							
92 53.01 WATER TRANSPORT							
93 54.01 AIR TRANSPORT							
94 55.01 COMMUNICATION							
95 61.01 BANKING							
96 61.02 FINANCE & LIFE INSURANCE							
97 61.03 OTHER INSURANCE							
98 61.04 INVESTMENT, REAL ESTATE ETC.							
99 61.05 OTHER BUSINESS SERVICES							
100 61.06 OWNERSHIP OF DWELLINGS							
101 71.01 PUBLIC ADMINISTRATION							
102 72.01 DEFENCE							
103 81.01 HEALTH							
104 82.01 EDUCATION, LIBRARIES, ETC.							
105 83.01 WELFARE SERVICES							
106 91.01 ENTERTAINMENT							
107 92.01 RESTAURANTS, HOTELS, CLUBS							
108 93.01 PERSONAL SERVICES							
109 99.10 BUSINESS EXPENSES							

TABLE 9 : PRODUCTIVITY GROWTH RATES AND
LABOUR REQUIREMENTS 1971/72, 1974/75 AND
1990/91

Industry	1968/69 - 1974/75 Av. Growth Rate (% p.a.)	Labour Requirements (persons per \$m output - 1971/72 prices)		
		1971/72	1974/75	1990/91
01.01 Sheep	3.3	119.		63.
01.02 Cereal Grains	3.3	41.		21.
01.03 Meat Cattle	3.3	28.		15.
01.04 Milk Cattle & Pigs	3.3	128.		68.
01.05 Poultry	3.3	50.		26.
01.06 Other Farming	3.3	94.		50.
02.00 Services to Agriculture	3.3	72.		38.
03.00 Forestry and Logging	1.3	77.		60.
04.00 Fishing, Trapping, Hunting	0.0	89.		89.
11.01 Iron	-	13.		10.
11.02 Other Metallic Minerals	-	48.		19.
12.00 Coal & Crude Petroleum	-	33.		14.
14.00 Non-Metallic n.e.c.	3.5	48.		25.
16.00 Services to Mining	2.5	50.		31.
21.01 Meat Products	3.3	33.	25.	17.
21.02 Milk Products	4.2	25.	21.	11.
21.03 Fruit & Vegetable Products	3.5	50.	39.	26.
21.04 Margarine, Oils & Fats	7.0	26.	20.	7.
21.05 Flour & Cereal Products	3.7	30.	30.	15.
21.06 Bread, Cakes & Biscuits	0.5	90.	74.	82.
21.07 Confectionery Products	1.9	63.	66.	44.
21.08 Food Products n.e.c.	2.6	26.	14.	16.
21.09 Soft Drinks Cordials etc.	8.0	52.	39.	12.
21.10 Beer & Malt	4.2	28.	27.	12.
21.11 Alcoholic Beverages n.e.c.	4.5	43.	31.	18.
22.01 Tobacco Products	0.0	24.	26.	24.
23.01 Prepared Fibres	6.0	25.	19.	8.
23.02 Man-Made Fibres, Yarns, etc.	6.0	62.	43.	20.
23.03 Cotton, Silk, Flax Yarns etc.	3.5	83.	88.	43.
23.04 Wool & Worsted Yarns etc.	4.8	101.	92.	41.
23.05 Textile Finishing	5.1	47.	-	18.
23.06 Textile Floor Covering	10.1	52.	38.	8.
23.07 Textile Products n.e.c.	4.4	69.	66.	30.
24.01 Knitting Mills	3.6	71.	67.	36.
24.02 Clothing	5.3	121.	97.	45.
24.03 Footwear	7.8	102.	79.	24.

TABLE 9 : PRODUCTIVITY GROWTH, RATES AND
(Cont.) LABOUR REQUIREMENTS 1971/72, 1974/75 AND
1990/91

Industry	1968/69 - 1974/75 Av. Growth Rate (% p.a.)			Labour Requirements (persons per \$m output - 1971/72 prices)		
	1971/72	1974/75	1990/91	1971/72	1974/75	1990/91
25.01 Sawmill Products	3.5			78.	69.	41.
25.02 Plywood, Vencers & Boards	4.7			74.	64.	31.
25.03 Joinery & Wood Products	2.1			80.	69.	53.
25.04 Furniture, Mattresses, Brooms	1.7			87.	79.	62.
26.01 Pulp, Paper & Paperboard	5.0			44.	39.	17.
26.02 Fibreboard, Paper Containers	4.9			54.	46.	21.
26.03 Paper Products n.e.c.	3.2			46.	37.	25.
26.04 Newspapers & Books	3.4			76.	61.	40.
26.05 Commercial & Job Printing	4.3			94.	80.	42.
27.01 Chemical Fertilizers	3.8			27.	28.	13.
27.02 Industrial Chemicals n.e.c.	5.7			35.	30.	12.
27.03 Paints, Varnishes, Lacquers	3.0			50.	45.	28.
27.04 Pharmaceutical & Chemicals	7.6			47.	36.	11.
27.05 Soap & Other Detergents	4.2			39.	35.	18.
27.06 Cosmetic, Toilet Preparations	8.3			52.	38.	11.
27.07 Chemical Products n.e.c.	5.4			68.	48.	25.
27.08 Petroleum & Coal Products	4.2			8.	7.	5.
28.01 Glass, Glass Products	7.9			69.	52.	16.
28.02 Clay Products	4.1			82.	75.	38.
28.03 Cement	2.3			36.	35.	23.
28.04 Ready-Mixed Concrete	0.0			15.	15.	15.
28.05 Concrete Products	2.1			61.	60.	41.
28.06 Non-Metallic Mineral Products	4.8			51.	44.	21.
29.01 Basic Iron & Steel	1.1			48.	42.	39.
29.02 Other Basic Metal Products	7.5			21.	17.	12.
31.01 Structural Metal Products	2.1			67.	61.	45.
31.02 Sheet Metal Products	2.5			68.	63.	42.
31.03 Metal Products n.e.c.	1.0			78.	72.	64.
32.01 Motor Vehicles & Parts	1.5			47.	46.	38.
32.02 Ship & Boat Building	0			96.	101.	96.
32.03 Locomotives, Rolling Stock	2.0			130.	121.	89.
32.04 Aircraft Building	0			97.	-	97.
33.01 Scientific Equipment etc.	12.6			88.	59.	9.
33.02 Electronic Equipment	6.2			87.	70.	27.
33.03 Household Appliances n.e.c.	3.5			64.	56.	33.
33.04 Electrical Machinery n.e.c.	0.8			68.	68.	59.
33.05 Agricultural Machinery	1.2			84.	75.	67.
33.06 Construction etc. Equipment	1.0			58.	57.	48.
33.07 Other Machinery, Equipment	3.0			71.	75.	40.

TABLE 9 : PRODUCTIVITY GROWTH RATES AND
(cont.) LABOUR REQUIREMENTS 1971/72, 1974/75 AND
1990/91

Industry	1968/69 - 1974/75 Av. Growth Rate (% p.a.)	Labour Requirements (persons per \$m output-- 1971/72 prices)		
		1971/72	1974/75	1990/91
34.01 Leather Products	4.7	80.	65.	33.
34.02 Rubber Products	2.9	60.	54.	35.
34.03 Plastic & Related Products	6.3	69.	50.	37.
34.04 Signs, Writing Equipment etc.	7.9	87.	60.	20.
34.05 Other Manufacturing	0.7	100.	97.	86.
36.01 Electricity	5.8	61.	21.	21.
36.02 Gas	5.9	64.	22.	22.
37.01 Water, Sewerage & Drainage	5.9	53.	18.	18.
41.01 Residential Buildings	2.9	62.	42.	42.
41.02 Building n.e.c. Construction	2.9	84.	46.	46.
46.01 Wholesale Trade	1.6	81.	60.	60.
48.01 Retail Trade	1.6	165.	122.	122.
48.02 Motor Vehicle Repairs	1.6	121.	63.	63.
48.03 Other Repairs	1.6	87.	64.	64.
51.01 Road Transport	2.5	72.	64.	64.
52.01 Rail Transport	2.0	106.	73.	73.
53.01 Water Transport	10.0	52.	52.	17.
54.01 Air Transport	6.3	50.	50.	35.
55.01 Communication	-	101.	46.	46.
61.01 Banking	3.9	95.	34.	34.
61.02 Finance & Life Insurance	3.9	71.	45.	45.
61.03 Other Insurance	3.9	94.	45.	45.
61.04 Investment, Real Estate etc.	3.9	55.	26.	26.
61.05 Other Business Services	3.9	98.	47.	47.
61.06 Ownership of Dwellings	3.9	-	-	-
71.01 Public Administration	-	156.	-	-
72.01 Defence	-	81.	-	-
81.01 Health	1.9	147.	102.	102.
82.01 Education, Libraries etc.	1.9	147.	102.	102.
83.01 Welfare Services	1.9	157.	110.	110.
91.01 Entertainment	1.9	66.	46.	46.
92.01 Restaurants, Hotels, Clubs	1.9	116.	81.	81.
93.01 Personal Services	1.9	220.	154.	154.

The need to be able to represent industry output in constant price terms is one of the major difficulties in estimating labour productivity trends. For some industries, the bulk of whose output is identifiable as a single commodity, this problem is eliminated. Good estimates of labour productivity growth can be made provided that employment data for the industry and production estimates for the commodity are readily available. Examples of such industries include Electricity (36.01) and Gas (36.02).

Labour requirements in 1990/91 have been estimated for each input-output industry using these growth rates as a guide. To offer an upper limit to the labour requirements, estimates of labour requirements in 1975/76 have also been made.¹⁰ Both sets of these estimates are shown in Table 9.

A2.2 ADJUSTMENT OF COEFFICIENTS FOR PERVASIVE DEVELOPMENTS

To adjust for the effect of high growth industries on the direct requirements coefficients of other industries the following approach has been adopted. For any industry it is assumed that the input coefficient corresponding to supply from the growth industry increases at a rate corresponding to the growth rate of this supplying industry relative to the economy as a whole. It is also assumed that all other coefficients decrease so that aggregate intermediate input requirements remain unchanged. Probably some inputs would be reduced more than others but as a first approximation it is assumed that the effect is uniform over all coefficients for the industry.

Consider a growth industry whose output in 1990/91 is a factor A times larger than it would have been had its growth merely kept pace with GDP. The effects on the

input coefficients of a user industry are approximated by

- (i) multiplying the coefficient, B, representing input from the growth industry by A to obtain

$$B^1 = A \times B$$

- (ii) restoring total intermediate inputs to its initial value (C), by dividing all input coefficients by D, where $D = (C + B^1 - B)/C$

Where the relevant coefficient for an industry has been considered as part of a detailed update then this industry is skipped in the described procedure.

Numerical examples of such adjustments are indicated below for two growth industries, plastics and related products (34.03) and communication (55.01)

(a) Plastics and Related Products

Between 1968/69 and 1974/75 real growth in this industry averaged 10.4% p.a., compared with an all industries growth rate of 4.8% p.a. A similar relative growth rate (5.6% p.a.) is expected to continue until 1990/91 (see detailed update of Plastics and Related Products). This implies a growth relative to the economy as a whole of 232%, and A in the above analysis would be 3.32.

(b) Communications

Based upon an assumed growth rate for the economy of 4.0% p.a., this industry was forecast to expand at an average rate of 6.7% p.a. or at a rate of 2.7% p.a. relative to the rest of the economy. This implies a relative growth over the period 1968/69 to

1990/91 of 78% (i.e. $A = 1.78$). The coefficients of the less detailed industries were modified according to this growth rate along the lines described above.

Adjustments for the communications industry however are complicated by the structure of the 1968/69 input-output table. In the table only a small quantity of the industry's output is shown as being supplied directly to other industries. Instead, it is usually shown as supplied via the dummy industry, Business Expenses (99.01). Since Communications represents a significant input to Business Expenses, it is desirable to make further adjustment of the input coefficients.

As Communications represented 15.4% of the Business Expenses industry in 1968/69, Communications growth was assumed to induce approximately 12% above normal growth in the latter (i.e. $A = 1.12$). The correction was incorporated by following the above procedure for the Business Expenses industry.

Footnotes

1. The SNAPSHOT model was formulated by Peter B. Dixon, John D. Harrower and Alan A. Powell, in, "SNAPSHOT, a Long Term Economy-Wide Model of Australia: Preliminary Outline", Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. SP-01, Industries Assistance Commission, Melbourne, February 1976 (mimeo), pp.26. Other detailed technical papers describing the mathematical and computational solution of the model and the specification of consumption behaviour have also been issued by IMPACT.

2. The IMPACT Project is described in its first progress report:
Alan A. Powell, The IMPACT Project: An Overview, March, 1977
First Progress Report of the IMPACT Project, Vol. 1 (Canberra. Australian Government Publishing Service 1977).

3. At this stage drafts of three BIE working papers have been prepared. These are:
 - (a) "Technological Update of Input-Output Industries to 1990/91" (9)
which outlines the methodology in greater detail.
 - (b) "Technology in 1990/91 - An analysis of Selected Industries" (10)
which gives detailed forecasts in relation to 12 input-output industries.
 - (c) "Less Detailed Technological Updates of Input-Output Industries to 1990/91" (11)
which considers only the more important changes in all industries.

4. Further details are provided in the draft working paper titled "Technology in 1990/91 - An Analysis of Selected Industries".
5. In fact the pricing of factor inputs (materials, wages, capital) are an output of the SNAPSHOT model itself. Therefore we are to some extent forced to prejudge the output of the model.
6. A more comprehensive examination of less detailed updates is given in the draft working paper titled "Less Detailed Technological Updates of Input-Output Industries to 1990/91".
7. The draft paper, "Less Detailed Technological Updates of Input-Output industries to 1990/91" contains a summary of such comments and provides qualitative descriptions of major developments thought likely to take place by 1990/91 for all input-output industries.
8. Labour productivity throughout the paper is defined as the quantity of output per person employed in an industry sector. It is emphasised that increases in labour productivity do not necessarily imply that individual employees actually produce more output.
9. The data on labour productivity growth rates given in this section actually relate to industry value added per person. However in the absence of other information this is considered a reasonable proxy for changes in industry output per person.
10. These are given only for manufacturing industries. Estimates for non-manufacturing industries are based on a range of sources not all covering the 1968/69 to 1974/75 period. Estimates from the

detailed forecasts are used for 1990/91 wherever available.

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