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Review of Methodology for Estimating Taxes on Production in the Calculation of Household Final Income

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Living Conditions Section

AUSTRALIAN BUREAU OF STATISTICS

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INQUIRIES

The ABS welcomes comments on the research presented in this paper.
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CONTENTS

REVIEW OF METHODOLOGY FOR ESTIMATING TAXES ON PRODUCTION IN THE CALCULATION OF HOUSEHOLD FINAL INCOME

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ABSTRACT

Recent estimates of the effects of government benefits and taxes on the distribution of income among private households in Australia (also called the Fiscal Incidence Study or FIS) accounted for only 42% of the total taxes on production as measured in the Australian National Accounts. With the aim of significantly improving the coverage of these taxes allocated in the FIS, this paper investigated the use of a more complete input–output (IO) approach in the estimation of the incidence of taxes on production to Australian households. The result of the new approach was a significant improvement in the coverage of the total taxes on production allocated to households. The approach accounted for most of the taxes on production that were not captured in the previous FIS production tax methodology. The results also demonstrated its viability and applicability to the IO data available at the ABS. The approach will be used in the estimation of the taxes on production for the 2003–04 FIS.

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1. INTRODUCTION

The Australian Bureau of Statistics (ABS) for a few survey cycles has undertaken a fiscal incidence study (FIS) in association with the Household Expenditure Survey (HES). The FIS accounts for the distributional impact of taxation and government expenditure on household income. It provides estimates of the effect of government benefits and taxes, both direct and indirect, on the distribution of income among private households in Australia. In short, the FIS attempts to answer the questions, "Who pays the taxes?" and "Who gets the benefits that governments provide?" The benefits and taxes included in the FIS are only restricted to those that are relatable to particular types of households and household's expenditures reported in HES. The ABS produced its first FIS (1984) in 1987, followed by the 1988–89, 1993–94 and 1998–99 studies. The results of these studies are published in *Government Benefits, Taxes and Household Income* (ABS cat. no. 6537.0).

Recent estimates by the ABS of the effects of taxes on production on the distribution of income among Australian private households in the FIS (ABS, 2001) accounted for only 42% of the total taxes on production as measured in the Australian National Accounts. In the past, taxes on production that have been allocated in the FIS were limited to those taxes that could be directly attributed to households through their final consumption expenditure. Taxes levied on intermediate inputs at any stage prior to them flowing into the industries supplying the final goods and services, and the taxes on the commodities going to gross fixed capital formation (GFCF) could be assumed to be ultimately passed on to households in most cases, but were not captured in the FIS. Hence, the ABS method for estimating the household incidence of taxes on production in the FIS was regarded as relatively partial.

With the aim of significantly improving the coverage of taxes on production allocated in the FIS, this paper lays out the use of input–output (IO) analysis for the estimation of the incidence of these taxes to households. This approach accounts for three new elements in the allocation of taxes on production in the FIS, namely: the reallocation of production taxes incurred at any stage of the production process; the reallocation of production taxes levied during the creation of fixed capital utilised in the production of goods and services purchased by households; and, the reallocation of production taxes levied on the margin industries. The plausibility of the method is tested using the 1998–99 IO Tables and 1998–99 HES.

The result of the application revealed that there is a significant improvement in the coverage of the total taxes on production allocated to households using the new approach. The results have demonstrated its viability and applicability to the IO data. Hence, this approach will be used in the estimation of the incidence of taxes on production for the 2003–04 FIS.

The paper is structured as follows. Section 2 briefly describes the concepts and related frameworks concerning the ABS FIS, and outlines some FIS related studies conducted in Australia and in other statistical agencies. The ABS approach from the 1984 to the 1998–99 FIS in the estimation of effective tax rates as well as how they are allocated to households are discussed in the next section. Section 4 describes the new methodology for calculating the incidence of taxes on production. A comparative analysis between the previous and new methodologies is numerically illustrated in Section 5, whilst Section 6 concludes the paper.

2. CONCEPTS AND RELATED STUDIES

Before examining the previous and new approaches, it is necessary to give a brief introduction to the ABS FIS followed by some definitions of the concepts of taxes on production, subsidies and incidence of taxes on production. This section also includes an overview of the IO Table framework that was the basis for the new approach. A brief review of some tax incidence studies conducted in Australia and other statistical organisations closes the section.

2.1 The ABS fiscal incidence study

The FIS is a study of the effects of government benefits and taxes on the distribution of income among private households in Australia. Benefits and taxes included in the study are only restricted to those that are relatable to particular types of households and household expenditure.

The FIS produces estimates of the final household income following the ABS household income concepts. That is, estimates of household disposable income are extended by adding estimates of the value of indirect benefits household receive from free or subsidised government services otherwise known as the social transfers in kind (STIK), and deducting estimates of the value of taxes on production assumed to be ultimately paid by the households. Household disposable income is estimated from the regular ABS surveys of household income including HES while the two required components to estimate final household income are modelled using HES unit record data, aggregate government financial statistics and input–output tables. The basic unit of analysis in the study is the household.

To fully understand the income concepts used in the FIS, a diagram with brief explanation is presented in Appendix A.

2.2 Taxes on production and subsidies

As this paper focuses on estimating the second component in the derivation of the final household income, it is important to have a basic understanding of the concepts of taxes on production and subsidies.

2.2.1 Taxes on production

Indirect taxes as traditionally understood are taxes that can be passed on, in whole or in part, to other institutional units by increasing the prices of the goods and services sold. Following the 1993 System of National Accounts (SNA93) the term indirect taxes is no longer used in the Australian System of National Accounts and it is now termed taxes on production and imports (for this paper we are using the term *taxes on*

production). Taxes on production consist of taxes on products and other taxes on production.

Taxes on products are taxes payable on goods and services when they are produced, delivered, sold, transferred or otherwise disposed of by their producers. They include the following:

- Goods and services taxes (GST, same as value added tax (VAT) in the 1993 SNA);
- Taxes and duties on imports (excluding GST);
- Export taxes; and
- Other taxes on products (excluding GST).

Other taxes on production consist of all taxes except taxes on products that enterprises incur as a result of engaging in production. These taxes do not include any taxes on profits or other income received by the enterprise. They are taxes payable on the land, fixed assets or labour employed in the production process or on certain activities or transactions. Other taxes on production include the following:

- Taxes on payroll or workforce;
- Recurrent taxes on land, buildings or other structures;
- Business and professional licences;
- Taxes on the use of fixed assets or other activities;
- Stamp taxes;
- Taxes on pollution; and,
- Taxes on international transactions.

The 1998–99 FIS uses the above definition while the previous FIS studies follow the 1968 System of National Accounts (SNA68) framework where taxes on production still included regulatory fees such as interest charged on overdue taxes, fines and other penalties. Following the SNA93, fees and licences are classified as sales of goods and services (i.e. user's charges) while fines are treated as other revenue. In 1997–98, the amount of these regulatory fees is about $3.1 billion, around 5% of the reported total taxes on production. Examples of these regulatory fees are drivers' licenses, broadcasting listeners' licenses and television viewers' licenses. For more information on the changes in the classification of the regulatory fees see ABS (1998).

2.2.2 Subsidies

Subsidies as defined in the 1993 SNA are unrequited payments that government units, including non-resident government units, make to resident producers or importers on the basis of the levels of their production activities or the quantities or values of goods

or services that they produce, sell or import. Subsidies are equivalent to negative taxes on production in so far as their impact on the operating surplus is in the opposite direction to that of taxes on production.

Subsidies are not payable to final consumers, and current transfers that government make directly to households as consumers are treated as social benefits. Subsidies also do not include grants that governments make to enterprises in order to finance their capital formation. Just like the taxes on production, subsidies consist of subsidies on products and other subsidies on production.

In the FIS, government subsidies are usually netted out from the taxes on production.

2.3 Incidence of taxes on production to households

When the taxes on production that a household pays through its purchases of goods and services are expressed as a percentage of the household's income, the resulting value describes the household's incidence of taxes on production. Incidence of taxes on production (or tax burden) to a household is the impact of all taxes on production on the economic welfare of a household. The analysis assumes that removal of the taxes on production would lower the costs of the household by the amount of the taxes.

The underlying assumption is that industries will pass the burden of the taxes on production they pay to the purchasing industries and/or final consumers through higher prices. Also, the burden of the tax will be passed from one industry to another until the total burden of the tax is passed on to final demand, one of which is the household. Take for example, a wine manufacturer who pays tax amounting to $100 for its production inputs. This amount is considered as an additional cost in producing wines. If half of the wine products are purchased by supermarkets, and the remaining half by restaurants, the $100 tax burden is split into an increased cost of $50 for each industry. The increased input cost for both industries is assumed to be passed on to households through higher prices of wines assuming the households purchase wines from the supermarket and also consume wines from the restaurant. So the tax on inputs to the wine industry is passed forward indirectly as an increased price to the final consumers, in this case, to the households.

2.4 The Input–Output tables

The estimation of the incidence of taxes on production to households in FIS is based on the extensive use of input–output tables from within the Australian System of National Accounts (ASNA). The input–output tables present a comprehensive picture of the supply and use of goods and services (also referred to as *products*) in the economy and the incomes generated from production. It records the flows of products from one industry to another and to final demand for consumption. Some

products are consumed in the production process and never end up as final demand. An illustration of the basic structure of the Australian input–output table is shown in Appendix B.

The IO Tables are compiled using four basic tables (or matrices) as building blocks, namely the supply table, use table, imports table, and the margins tables. The supply table gives information about the resources of goods and services while the use table contains information on the uses of goods and services, and also on cost structures of the industries. The imports table shows the use of imported products by industries and final demand categories. The margins tables contain taxes on production less subsidies on products and trade and transport margins by products. Trade and transport margins tables come from a group of margin industries. Further details on the four basic tables can also be found in ABS (2004a).

The above basic tables as well as the industry-by-industry input–output table are essentially the matrices of flows that are commonly used in input–output analysis. The industry-by-industry table is derived by reorganising the use table. The use table is not symmetric, that is, the number of products in the row is not equal to the number of industries in the column. For analytical purposes, it is converted to arrive at a symmetric input–output table that is either industry-by-industry or product-by-product. Readers interested in how to convert the use and supply table into a symmetric IO table may refer to the United Nations (1999).

It can be noted that the inter-industry flows in the industry-by-industry table do not include taxes on production. The taxes on production are contained as a separate row in the primary inputs quadrant below the industry-by-industry input–output table. With the aid of these tables, any impact analysis, like the impact of taxes on production to household, can be examined for the Australian economy. Readers interested in a more detailed description of the input–output framework as well as the treatment of taxes on production and subsidies in Australian IO tables should refer to ABS (2000b, Chapter 9).

The ABS published the IO Tables in the *Australian National Accounts, Input–Output Tables, 1998–99* (ABS cat. no. 5209.0.55.001). This publication contains the supply–use (SU) tables including detailed explanatory notes on the data sources, content and construction of the symmetric input–output tables. The current 1998–99 IO Tables have been compiled in terms of 106 industry groups.

2.5 Other fiscal incidence studies

Earlier work on the incidence of taxes on production to Australian households was undertaken by Warren (1989). The National Centre for Social and Economic Modelling (NATSEM) have also made significant contributions to analysing tax burdens in the 1990s in Australia. In 1997, Lambert and Warren (1999) developed a

microsimulation model called STINMOD–STATAX that enables both fiscal and detailed distributional analyses of the impact of cash transfer systems in Australia. A particular strength of this simulation model is the analysis of the system of taxes on production. Harding and Warren (1999) examine the distribution of direct, indirect and company taxes, by income and expenditure quintiles, by life cycle stage, by family type, and by whether households contain smokers or drinkers. Their study reveals that overall the Australian taxation system is progressive.

The latest microsimulation study by NATSEM is that of Lloyd, Harding and Warren (2005). This study examines the distribution of household income, and of selected taxes and benefits in Australia, for households at different stages of the life cycle in 2001–02. The other two Australian studies on the incidence of taxes on production modelling are that of Chisholm (1993) and Scutella (1997). The input–output approach outlined in this paper is based on these studies and is further discussed in Section 4.

Several studies on tax burden have also been published in Canada. These are by Grady (1990), Gillespie (1991), Ruggeri, Van Wart and Howard (1994), and Vermaeten, Gillespie and Vermaeten (1994). Most of these studies used the Social Policy Simulation Database and Model (SPDP/M) developed by the Analysis and Development Branch (ADB) of Statistics Canada (StatCan). SPDP/M is a microcomputer-based product designed to assist clients interested in analysing the financial interactions of governments and individuals in Canada. This microdata simulation instrument also makes it possible for researchers to conduct tax incidence studies for Canada. Vermaeten, Gillespie and Vermaeten (1994) made use of the SPSD/M to measure the tax incidence for low, middle and high income families in Canada in 1988.

The UK Office of National Statistics (ONS) through their National Accounts publications often reports how much of the taxes on production are borne by four types of expenditure – consumers' expenditure; general government final consumption, gross domestic capital formation and exports. Their latest fiscal incidence publication is for 2002–03 making use of their Expenditure and Food Survey. The current ABS FIS methodology is somewhat similar to that of the ONS. Dilnot, Kay, and Keen (1990) also study the UK's tax incidence and incorporate company taxes in the allocation to final demand.

In 1990, Statistics New Zealand also made a one-shot 1987–88 study that examined the overall impact of government expenditure and revenue collection on the income of households in New Zealand. Their study includes the passing-on of company taxes to households. Another statistical agency that conducts incidence studies is Statistics Netherlands.

3. THE ABS APPROACH FROM 1984 TO 1998–99

3.1 The previous approach

In the previous FIS, taxes on production associated with different types of products were assigned to individual households on the basis of their expenditure on various goods and services. It was assumed that taxes on production levied on, and paid by businesses were fully passed on to households in the prices they paid for goods and services. Total taxes on production paid by a household were obtained by aggregating the taxes paid on each of their purchases.

The basic assumption of full passing forward of taxes on production, in reality may not be the case particularly for other taxes on production such as payroll taxes which perhaps are more likely to be shifted back on to employees rather than passing them forward in higher prices. But due to the unavailability of more disaggregated input–output data for net taxes on production, the previous approach as well as the new approach were confined to this assumption. It can be noted that the FIS uses net taxes on production. Net taxes mean subsidies on production are accounted for and treated as negative taxes. In addition, the recent study of Harding, Lloyd and Warren (2005) fully shifted payroll taxes to households.

In allocating these taxes, the amount of taxes on production paid by HES households was calculated as follows:

- Using the ABS IO tables, a final tax rate and an intermediate tax rate were calculated for each of the 106 IO commodity classifications;
- The 609 HES commodity codes were mapped to the 106 IO commodity classifications (this was done by mapping (concording) the IO commodities using the input–output product classification (IOPC), and the HES expenditures using the household expenditure classification (HEC)). The full documentation of how the mapping procedure was undertaken is given in Appendix A ("Mapping HEC commodity codes to Input–Output product codes") of ABS(2001b). That documentation also includes information on some IOPC codes that are given special treatment.); and,
- Household expenditure on the 609 HES commodity codes was multiplied by the relevant tax rates, and the final and intermediate taxes summed to obtain the total amount of taxes on production paid by the household.

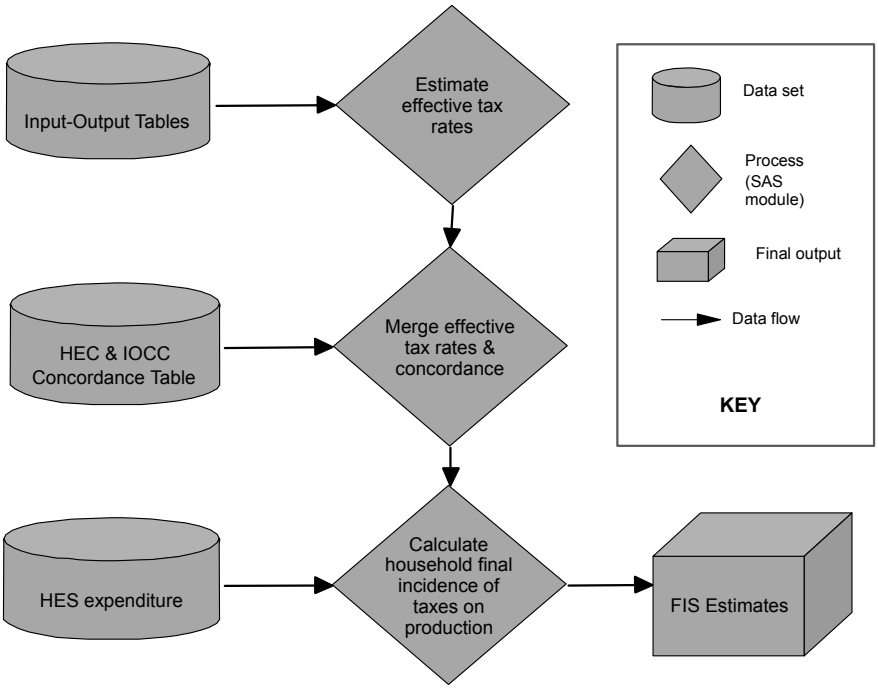
As with the current methodology, it was also assumed that the tax rates current during the reference period of the IO tables were applied at the time of production of the commodities reported in HES. This may not be the case if there were long lead times for the production processes or if the IO tables used for the analysis had a different reference base to the HES. It should be noted that for most of the FIS production tax

incidence estimation, the latest available input–output table always lags by two years from the HES reference year.

Details of the previous approach can be found in ABS (2001a) and ABS (2001b), the former containing methodological comparisons over time.

The flows of various processes involved in the previous approach are shown in figure 3.1 below.

3.1 Allocation of taxes on production to households



3.2 Limitation of the approach

The methodology used up until 1998–99 for estimating the incidence of taxes on production to households can be regarded as relatively partial. It captured the taxes on production levied directly on final goods and services purchased by households and the taxes on production levied on industries carrying out the final stage of production before the goods and services are supplied to households. However, it did not capture the:

- taxes on production levied on industries producing goods and services used as inputs to the production of commodities supplied to households;
- taxes on production levied during the creation of the fixed capital utilised in the production of goods and services purchased by households; and
- taxes on production levied on the so-called margin industries that are engaged in the transport and distribution of goods that are purchased by households.

4. NEW METHODOLOGY FOR CALCULATING THE INCIDENCE OF TAXES ON PRODUCTION

This section outlines the input–output approach in the calculation of the incidence of taxes on production in the ABS FIS. The approach is based on earlier work by Chisholm (1993) and Scutella (1997). While the works of Chisholm and Scutella are geared toward the calculation of effective tax rates for Australian taxes on production on all final demand categories, for the ABS FIS interest, the methodology is focused only on the household final consumption category. In addition, tax incidences are only calculated for the two components of taxes on production discussed in Section 2.2.1 (i.e. taxes on products, and other taxes on production). The section also shows the redistribution technique developed by the authors. Finally, the section ends with the incidence of taxes on production allocation procedure in FIS.

4.1 Calculating the effective tax rates

This subsection describes the new method in the calculation of effective tax rates on the household final demand for FIS. The basic assumption in this approach is that the taxes are fully passed on to non-exempt purchasers of products. Taxes paid on direct sales of products are passed on in higher prices to purchasing industries and consumers, and taxes paid on inputs further back in the production chain are also assumed to be passed on to final purchaser.

The input–output data used in the procedure comes from the publication *Australian National Accounts, Input–Output Tables, 1998–99* (ABS cat. no. 5209.0.55.001). They are further supplemented with unpublished taxes on production information using the same input–output industry classification.

4.1.1 The long-run model

The method adopts the long-run model in calculating the effective tax rates. This was also adopted in the works of Chisholm and Scutella. The long-run model treats the gross fixed capital expenditure of private and public enterprises as components in the inter-industry flows and not as final demand components. This implies that taxes on production falling both initially and subsequently on private and public enterprise gross fixed capital expenditures are assumed to be passed forward into higher prices on goods and services bought by final consumers for consumption. Hence, an adjustment should first be made to the original input–output table before the effective tax rates estimation proceeds.

The adjustment is made through the use of the symmetric industry-by-industry table. For this task, take the sum of public and private enterprise GFCF column from the final demand quadrant and move it to the intra-industry flow matrix making it one additional industry (column) in the table. Consequently, to account for capital inputs

to industries (i.e. as additional row in the table), add the consumption of fixed capital (COFC) by industry from the Australian National Accounts. Therefore, if the study has n industries in the original input–output tables then it would now have $n+1$ industries following the long-run model. The structure of the IO table following the long-run model is shown in Appendix C.

There are a number of assumptions that need to be considered when adopting the long-run model. These are:

- The taxes on production allocated to GFCF in the current period also applied for all the periods over which the current capital stock was built up;
- The level of GFCF in the current period is typical of all periods over which the capital stock has been built up;
- The incidence of production taxes on GFCF is the same for all industries; and,
- The consumption of fixed capital (COFC) data from Table 58 in ABS (2004b) are only available at broad industry levels. The COFC data for each of the broad industries is split into sub-industries using the sub-industry output from the IO table. For the usage of capital, it is assumed that all sub-industries in each broad industry have a common production function.

4.1.2 The eight steps procedure

The input–output approach involves eight major steps in the calculation of the final incidence of taxes on production. They are:

- Estimating the statutory incidence;
- Constructing an exemption matrix;
- Constructing the first-round non-exempt output coefficient matrix;
- Computing the first-round incidence of taxes on production on industry inputs;
- Estimating the final incidence of taxes on production on industry inputs;
- Estimating the first-round incidence of taxes on production on household final demand;
- Estimating the final incidence of taxes on production on household final demand; and,
- Estimating the effective tax rates.

These will now be considered in turn.

Step 1: Setting-up the statutory incidence vectors

The amount of tax paid by industries to the government (the tax collecting authority) is called the statutory incidence. Let us define the statutory incidence of taxes on production on industry *i* as

$$SI_i = \sum_{j=1}^{t} T_{ij} \quad , \; i = 1, 2, \ldots, n \tag{1}$$

where T_{ij} refers to a particular subtype of production tax for industry *i*. Note that there are *t* subtypes of taxes on production and *n* input–output industries. Using the above results, we could construct a statutory incidence vector *SI* given by

$$SI = \left[SI_1 \quad SI_2 \cdots SI_n \right]' . \tag{2}$$

For the FIS, two statutory incidence vectors are constructed following the breakdown (into components) of the taxes on production in Section 2.2.1. The first one, denoted by SI^P, is the statutory incidence vector for net taxes on products where the subtypes include that of value added tax, import duty, export tax and other taxes. The second statutory incidence vector SI^O, is for the net other taxes on production where the subtypes are payroll taxes, property taxes and the like.

Ideally, the setting-up of a statutory incidence vector should be at a more disaggregated level of tax data, but due to the unavailability of more disaggregated input–output data for net taxes on production, the approach is confined to these two aggregate levels.

Step 2: Constructing the exemption matrix

Not all industries pay tax for their production inputs. Some industries are exempted from tax on particular items and others are not. To account for this, an exemption matrix (*E*) is constructed using the industry-by-industry flow table. Depending on the taxes under investigation, an exemption matrix should be set up corresponding to the statutory incidence vector (*SI*) constructed in equation (2).

For the FIS, the construction of the exemption matrix is only applicable for the net other taxes of production, as the ABS does not generate detailed margin analysis tables for these taxes. The matrix is needed in the calculation of the first incidence of net other taxes on production to the purchasing industry and final demand in the next steps.

Starting with the full industry-by-industry flow matrix, flows between exempt industries are set to zero. For example, if government administration is exempt from a certain production tax component then the column on the input–output flow table

corresponding to the government administration industry is set to zero. Partial exemption is also possible in each industry in setting up the E matrix. This is the case when a particular sub-industry out of the range of sub-industries covered by a particular industry classification in the IO tables is exempted from the tax. The flow between the industries is scaled down by the proportion of the value added by the exempt sub-industry to the value added by the whole industry. That proportion can be calculated from the more detailed estimates of the gross value added in the Australian System of National Accounts (ASNA).

The exemption matrix E, for n industries is given by

$$E = \begin{bmatrix} E_{11} & E_{12} & \cdots & E_{1n} \\ E_{21} & E_{22} & \cdots & E_{2n} \\ \vdots & \vdots & & \vdots \\ E_{n1} & E_{n2} & \cdots & E_{nn} \end{bmatrix} \tag{3}$$

In addition to the exemption matrix the non-exempt final demand vector is also constructed. Flows from an industry to final demand categories exempt from the particular tax component are also set to zero. And, for each industry i, the sum of the non-exempt final demand categories, FDX_i, are obtained by

$$FDX_i = \sum_{j=1}^{d} FD_j \tag{4}$$

where d is the number of final demand categories. The non-exempt final demand vector, FDX, is given by

$$FDX = \begin{bmatrix} FDX_1 \\ FDX_2 \\ \vdots \\ FDX_n \end{bmatrix} \tag{5}$$

Summing across the rows of the exemption matrix in equation (3) and adding in the corresponding non-exempt final demand element in equation (5) gives the total non-exempt supply for each industry i as

$$TSX_i = \sum_{j=1}^{n} E_{ij} + FDX_i \quad \text{for } i = 1,2,3,\ldots n \tag{6}$$

It is important to note that for the FIS, it is only necessary for an exemption matrix to be constructed for net other taxes on production as the ABS already generates a detailed margin analysis table for the net taxes on products. The construction of the exemption matrix made use of the assumptions published by Scutella (1997) for net other taxes on production.

Step 3: Constructing the first-round non-exempt output coefficients matrix

The first-round non-exempt output coefficients matrix, *OX*, is derived by simply dividing each element of each row in the *E* matrix by the total non-exempt supply *TSX* for that row or supplying industry. This step will result in an $n \times n$ matrix of percentages for the non-exempt intermediate flows. That is, each element in *OX* is an industry's intermediate non-exempt supply of a product to a purchasing industry as a percentage of the total non-exempt supply of that product. Note that fixed capital consumption is also included in the calculation following the long-run model. Algebraically, it is given by

$$OX = \begin{bmatrix} \frac{E_{11}}{TSX_1} & \frac{E_{12}}{TSX_1} & \cdots & \frac{E_{1n}}{TSX_1} \\ \frac{E_{21}}{TSX_2} & \frac{E_{22}}{TSX_2} & \cdots & \frac{E_{2n}}{TSX_2} \\ \vdots & \vdots & & \vdots \\ \frac{E_{n1}}{TSX_n} & \frac{E_{n2}}{TSX_n} & \cdots & \frac{E_{nn}}{TSX_n} \end{bmatrix} \tag{7}$$

Again, the matrix *OX* will only be used for the derivation of the first-round incidence of net other taxes on production in the next step.

Step 4: Estimating the first-round incidence of taxes on production on industry inputs

The direct passing forward of increases in costs due to taxes of various industries to purchasing industries represents the first-round incidence on industry inputs. The first-round incidences for net taxes on products, denoted by vector TI^P , can be obtained directly from the margin analysis table (i.e. Table 33, ABS (2004a)) generated by ABS. This vector is just the transpose of the column vector corresponding to the total industry uses in the IO Table 33.

For the net other taxes on production, the vector of first-round incidences on industry inputs is calculated by multiplying the transpose of the statutory incidence vector, SI^O, with the first-round non-exempt output coefficient's matrix, *OX*. This is given by the formula

$$TI^O = SI^O \times OX = \begin{bmatrix} TI_1 & TI_2 & \cdots & TI_n \end{bmatrix} \tag{8}$$

where TI_i is the first-round incidence on industry inputs for industry i.

This can be expressed as

$$TI_i = \sum_{j=1}^{n} SI_j \times \frac{E_{ji}}{TSX_j} \quad \text{for } i = 1,2,3,\ldots,n \tag{9}$$

where Si_j is the statutory incidence of other taxes on production for industry j.

Step 5: Estimating the final incidence of taxes on production on industry inputs

In this step, the final incidence of taxes on production on households are calculated. This includes the first-round incidence on industry inputs and the tax on industry inputs that flows through to household final consumption. To help find the final incidence, it is necessary to first obtain the subsequent rounds output coefficients.

Step 5(a): Calculating the subsequent rounds output coefficient matrix

Estimating the tax on industry inputs that flows through to household final demand requires generating a matrix of output coefficients from the original intra-industry flow matrix which does not allow for exemptions. The reason is that those industries that are exempt from, say, taxes on products, only get the benefit of exemption for taxes on their direct inputs in production and not for tax paid by non-exempt industries on their inputs which is passed forward in higher prices to the exempt industry. By dividing each row element in the original intra-industry input–output table by the corresponding total supply (*TS*) for that row, we obtain the matrix *O*. The matrix is given by

$$O = \begin{bmatrix} O_{11} & O_{12} & \cdots & O_{1n} \\ O_{21} & O_{22} & \cdots & O_{2n} \\ \vdots & \vdots & & \vdots \\ O_{n1} & O_{n2} & \cdots & O_{nn} \end{bmatrix} = \begin{bmatrix} A_{11}/TS_1 & A_{12}/TS_1 & \cdots & A_{1n}/TS_1 \\ A_{21}/TS_2 & A_{22}/TS_2 & \cdots & A_{2n}/TS_2 \\ \vdots & \vdots & & \vdots \\ A_{n1}/TS_n & A_{n2}/TS_n & \cdots & A_{nn}/TS_n \end{bmatrix} \tag{10}$$

where A_{ij} is the intra-industry flow from industry i to industry j and TS_i is the total supply for industry j.

Step 5(b): Calculating the taxes on production on business inputs that flow through to household final demand

The next step is to estimate how much of the taxes on industry inputs eventually flow through to household final demand by allowing them to flow through the *O* matrix again and again. Because final goods or services may use inputs that have been through several stages of production, it is not possible to shift all of the taxes on

business inputs through to final demand in just one round. It is done one round at a time.

Industries pay tax on their industry inputs in round one. In the next round, a portion of their supply is passed on as industry inputs to purchasing industries, while some will end up to final demand. The process continues through subsequent rounds until the amount of tax remaining on industry inputs becomes insignificant, and all significant tax has been forwarded to some part of the final demand component. For the purpose of this study, we will limit the calculation to taxes on industry inputs forwarded to household final demand only.

In each round, the portion of tax passed on to household final demand in each industry, H_i, is given by dividing each element of the household final consumption expenditure (*HFCE*) vector in the industry-by-industry input–output table by the corresponding element in the total supply vector. For all the industries, it is given by the vector H, where

$$H = \begin{bmatrix} H_1 \\ H_2 \\ \vdots \\ H_n \end{bmatrix} = \begin{bmatrix} HFCE_1/TS_1 \\ HFCE_2/TS_2 \\ \vdots \\ HFCE_n/TS_n \end{bmatrix} \tag{11}$$

In the above case, no exemptions are made from any of the vectors as tax on inputs is borne by all industries and final demand components. When the amount of input tax remaining from a previous round is multiplied element by element by H, it gives the amount of tax forwarded to the household final demand in the current round. The amount of tax remaining on industry inputs is $TI \times I$ in round 2 (where I is an $n \times n$ identity matrix), $TI \times O$ in round 3, $TI \times O^2$ in round 4, and $TI \times O^{n-2}$ in round n. After $n+2$ rounds, the amount of tax forwarded on to the household final demand is given by the series

$$\left[\left(TI \times I\right)' \# H\right] + \left[\left(TI \times O\right)' \# H\right] + \left[\left(TI \times O^2\right)' \# H\right] + \ldots + \left[\left(TI \times O^n\right)' \# H\right] \tag{12}$$

Equation (12) simplifies to

$$\left[TI \times \left(I + O + O^2 + \ldots + O^n\right)\right] \# H \tag{13}$$

The amount of tax passed on to the household final demand will diminish with each successive round. When n gets very large, the sum of this series gives an estimate of the subsequent rounds incidence on household final demand. As the coefficients of the matrix of output coefficients in equation (10) are less than one, the limit as n tends towards infinity of the above series is given by

$$TB = \left[TI \times \left(I - O \right)^{-1} \right]' \# H \tag{14}$$

where *TB* is the estimate of the final incidence of taxes on production on industry inputs through to household final demand and *TI* is the first-round incidence on industry inputs vector. Note that # refers to element by element multiplication in matrices.

For the FIS, the final incidence of taxes above will be computed separately for net taxes on products and net other taxes on production. This is done by substituting TI^P and TI^O for the *TI* in equation 14.

Step 6: Estimating the first-round incidence of taxes on production on household final demand

When industries sell their products directly to households, the incidence of the taxes on production and imports is passed forward to household final demand in the first round. We call this passing forward of taxes as the first-round incidence on household final demand. The first-round incidence on household final demand is obtained by multiplying the statutory incidence of taxes on production by the non-exempt household final consumption expenditure as a percentage of total non-exempt final supply for each industry. This is given by the vector

$$TA = SI \# HX \tag{15}$$

where *SI* is the statutory incidence vector in equation (2), and *HX* is an $n \times 1$ vector containing the non-exempt household final consumption expenditure as a percentage of total non-exempt final supply for each industry *i*, that is,

$$HX = \begin{bmatrix} FD_{11}/TX_1 \\ FD_{21}/TX_2 \\ \vdots \\ FD_{n1}/TX_n \end{bmatrix} \tag{16}$$

The elements in the above equation are easily derived from step 2 results.

For the FIS, the first-round incidence of taxes on household final demand will also be computed separately for net taxes on products and net other taxes on production. This is through the substitution of SI^P and SI^O for the *SI* term in equation 15.

Step 7: Estimating the total final incidence of taxes on production on household final demand

The total final incidence of taxes on production, *TC*, is just the sum of the final incidence vector of industry inputs tax through to household final demand in equation (14) and the first-round incidence on household final demand vector in equation (15).

$$TC = TA + TB \tag{17}$$

It is important to note that in the FIS, the total final incidence of taxes on production will be the sum of the vector of the total final incidence for net taxes on products and the vector of total final incidence for net other taxes on production.

Step 8: Calculating the effective tax rates

An effective tax rate for each industry is then calculated by dividing the industry total final incidence elements in equation (17) by the corresponding industry level *HFCE*. The tax rates should be adjusted to purchasers' price since they will be mapped to HES expenditures in FIS. To do this, the *HFCE* that will be used in the computation is valued at purchasers' price.

Following the allocation process in the previous methodology discussed in Section 3.1, the obtained effective tax rates for each of the industry commodities are then applied to their corresponding average weekly household expenditures reported in the HES to come up with the value of taxes on production paid by individual households. The same concordance table as used in the earlier modelling approach is adopted in the mapping of tax rates to household expenditures.

4.2 Redistributing the final incidence of taxes on production on margin industries

Chisholm's (1993) technique allows for the passing on of taxes on inputs to final demand. However, Scutella (1997) criticised Chisholm's method because it fails to allocate taxes on margin industries, or inputs to margin industries, to the final sales of commodities that use those margins. Though Chisholm's method pushes taxes on inputs to margins through to the basic values of the final sales of margins, his method does not allocate the tax-boosted basic value of margin industries at the final demand level to those commodities that use margin services to get goods to final purchasers.

Scutella (1997) takes account of margin services to more fully account for the final incidence of taxes on production to final consumers. In her study, prior to calculating any incidence, the supply of margin services must first be redistributed to the commodities that use them, and inputs to margin services must also be redistributed

to the industries which rely on margin services. This increases the value of their produced goods and services. In the process, the sum of primary factors, final demand and total supply should not change with the redistribution. Moreover, the statutory incidence falling on the margin service should also be redistributed. The adjustment in the intra-industry transaction matrix is quite complicated as there are many flows to take account of, and margin services use more than one input. Interested readers can refer to Scutella (1997) for the complete details of the redistribution process and some illustrations. The redistribution process entails complex matrix manipulations and various tax exemption assumptions, and is not viable to apply in the FIS estimation.

4.2.1 Redistributing the margin services final incidence of taxes on production

The FIS methodology involves calculating the incidence of taxes on production for each input–output commodity group/industry and then applying those rates to the appropriate HES commodities. However, HES respondents report the values that they paid for goods and services, that is, the HES data are valued at "purchasers' prices", not "basic values". Therefore, the distribution margins separately identified within the input–output tables are an integral part of the values of goods and services purchased as reported in the HES. However, there are no separate HES commodities that match the input–output margin industries. Hence, the previous FIS methodology is somewhat deficient in allocating the margin services final incidence of taxes on production to Australian households.

To remedy this issue, an additional step to the procedure in Section 4.1 is proposed before calculating the effective tax rates. This is through the use of the detailed margin tables from the IO (ABS cat. no. 5209.0.55.001, Tables 23 to 32).

The detailed input–output margin analysis tables (Tables 23 to 32, ABS cat. no. 5209.0.55.001) for all the margin industries are used to redistribute the taxes on production attributed to the margin activities. The ten margin industries that are identified in the Australian IO tables are:

Wholesale trade (IOCC 4501);

Retail trade (IOCC 5101);

Restaurants, hotels and clubs (IOCC 5701 Accommodation, cafes & restaurant);

Road transport (IOCC 6101);

Rail transport (IOCC 6201 Rail, pipeline, other transport);

Pipeline transport (IOCC 6201 Rail, pipeline, other transport);

Water transport (IOCC 6301);

Air transport (IOCC 6401 Air and space transport);

Port handling (IOCC 6601: Services to transport; storage); and

Marine insurance (IOCC 7401: Insurance).

For each margin industry,

- Calculate the proportion of the margin services, *PM*, used by the household for each industry *i*. The *PM* vector is obtained by dividing each element of the household final consumption expenditure column in the detailed margin table by the corresponding column total. Note that *PM* is an $n \times 1$ vector of proportions.
- Allocate the portion of the *j*th margin industry's total final incidence, TC_j, in equation (17) attributable to margin services supplied by the traditional margin industry to the household users. This is given by the formula

$$TCM^j = \left[TC_j \times p_j \right] \# PM^j \quad , \; j = 1,2,3,\ldots m \tag{18}$$

where

TCM^j is an $n \times 1$ vector of tax adjustments provided by margin industry *j*;

TC_j is the scalar value of the total final incidence calculated for margin industry *j*;

p_j is a scalar proportion of *j* margin industry's outputs that are solely margin services obtained from IO Table 21;

PM^j is the margin services usage of other industries in providing final products to households; and,

m is the number of input–output margin industries.

A simple example to illustrates how the redistribution process work is provided here. We take road transport as the *j*th margin industry. Suppose the estimated total final incidence of taxes on production on household final demand, calculated using equation 17, for this margin industry amounted to $500 thousand dollars. The data from the IO Table 21 reveals that 47% of the road transport's outputs are solely for transport services. From the IO Table 26, an industry say the furniture manufacturing uses 26.7% of road transport services in delivering their final products to households. Following equation 18, the furniture manufacturing industry will get an additional $62.7 thousand dollars of final incidence of taxes on production coming from the usage of road transport services in providing their final products to households. The same procedure holds for all the non-margin industries that uses road transport services.

4.2.2 Adjusting the estimate of the total final incidence of taxes on production

The total final incidence of taxes on production for each non-margin industry is adjusted by adding the *TCM* obtained for all the *m* margin industries. That is,

$$TC^{adj}_{non-margin(i)} = TC_{non-margin(i)} + \sum_{j=1}^{m} TCM^{j}_{non-margin(i)} \qquad (19)$$

The total final incidence of taxes on production for each *j*th margin industry is also adjusted by

$$TC^{adj}_{margin(j)} = TC_{margin(j)} \times (1 - p_j) \qquad (20)$$

The above adjusted values of the total final incidence are used in the final calculation of the effective tax rates in step 8 of Section 4.1.

5. COMPARATIVE RESULTS

The impact of the new approach on the distribution of household taxes on production is measured and compared with the previous FIS production tax estimate. Both the previous and the new methodology use IO table data to identify the taxes on production to be allocated to households.

The previous methodology only captured those taxes levied directly on final goods and services purchased by households and the taxes on production levied on industries carrying out the final stage of production before the goods and services are supplied to households. Within the IO table data these accounted for 51% of all taxes on production. In practice, the final estimates from the previous methodology accounted for 42% of all taxes on production. The 9% difference reflects the difference between the HES estimates of household expenditure and the IO estimates of household expenditure. It is known that the HES has some under-reporting of expenditure, especially on alcohol, tobacco and gambling.

The new methodology captures all production taxes that have been paid at any stage during the production of the goods that are supplied to households. Within the IO table data these accounted for 76% of all taxes on production. The remaining 24% are implicitly allocated to the rest of the final demand components, namely, government final consumption expenditure, general government gross fixed capital formation, changes in inventory, and exports. Once the impact of the lower HES estimates of household expenditure are taken into account, the final estimates from the new methodology account for 65% of all taxes on production.

With the new methodology capturing 100% of taxes on production that should potentially be allocated to the household final demand, the result also reveals that only 67% of the household production tax incidences are being passed on to household by the previous methodology. What was remarkable is that the new method has actually allocated 86% of the potential household tax incidences.

The aggregate value of the taxes on production in the FIS analysis is therefore about 50% greater under the new methodology. Of this amount, 55% is attributable to taxes applicable to earlier stages of production, 36% is attributable to taxes levied during the creation of the gross fixed capital used during production, and 9% is attributable to the taxes levied on the margin services.

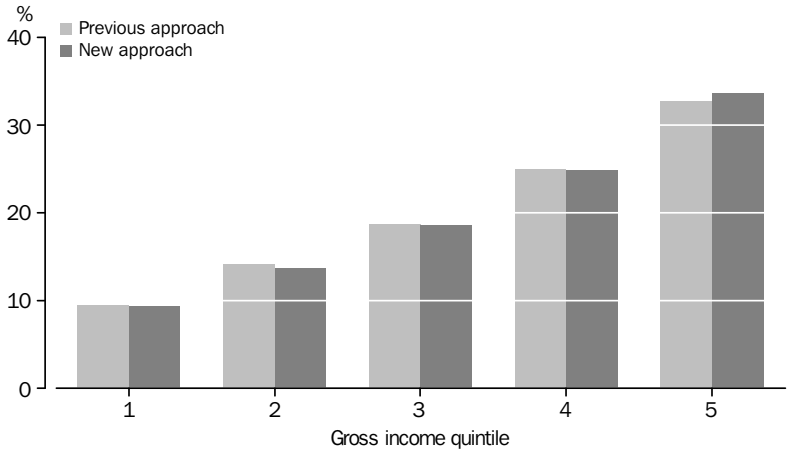
Table 5.1 summarises the household incidence estimates using the previous and new approaches.

5.1 Estimates of households taxes on production: previous vs. new methodology

	Taxes on production ($m)	*Proportion of taxes on production estimate over Net total taxes on production (row A)*	*Proportion of taxes on production estimate over Potential estimate (row B new method)*
A. Net total taxes on production (published in ASNA)	$69,842	100.0%	n.a.
B. Taxes on production potentially allocated			
New Method	$52,886	75.7%	100.0%
Previous Method	$35,595	51.0%	67.3%
C. Taxes on production actually allocated using HES			
New Method	$45,624	65.3%	86.3%
Previous Method	$29,410	42.1%	55.6%
D. Difference between the potential and actual taxes on production allocated			
New Method	$7,262	10.4%	13.7%
Previous Method	$6,185	8.9%	11.7%

Looking at the impact of the new methodology on the distribution of the incidence of taxes on production between income quintiles for 1998–99, figure 5.2 exhibits very little difference between the previous approach and the new approach. However, as the actual amounts are 50% greater using the new methodology, it can be expected that the overall estimate of Australian household final income will be correspondingly adjusted.

5.2 Distribution of taxes on production, by gross income quintile, 1998–99



6. CONCLUDING REMARKS

This paper investigates the use of a more complete input–output approach in the estimation of the incidence of taxes on production to Australian households. The result of the new approach was a significant improvement in the coverage of the total taxes on production allocated to the households. The results also demonstrated the viability and applicability of the new approach to the input–output data available at the ABS. Most of the taxes on production that were not captured in the previous FIS taxes on production methodology are accounted for in the new approach.

This approach will be used in the estimation of the incidence of taxes on production for the 2003–04 FIS. The introduction of the GST has resulted in a much larger proportion of taxes on production being levied at the point at which goods and services are provided to final consumers. Therefore, any analysis over time of the incidence of taxes on production needs to take account of the taxes wherever they are levied during the production process. So, the FIS results will be reestimated for 1998–99 using the new methodology in this paper to enable better comparison with the 2003–04 FIS.

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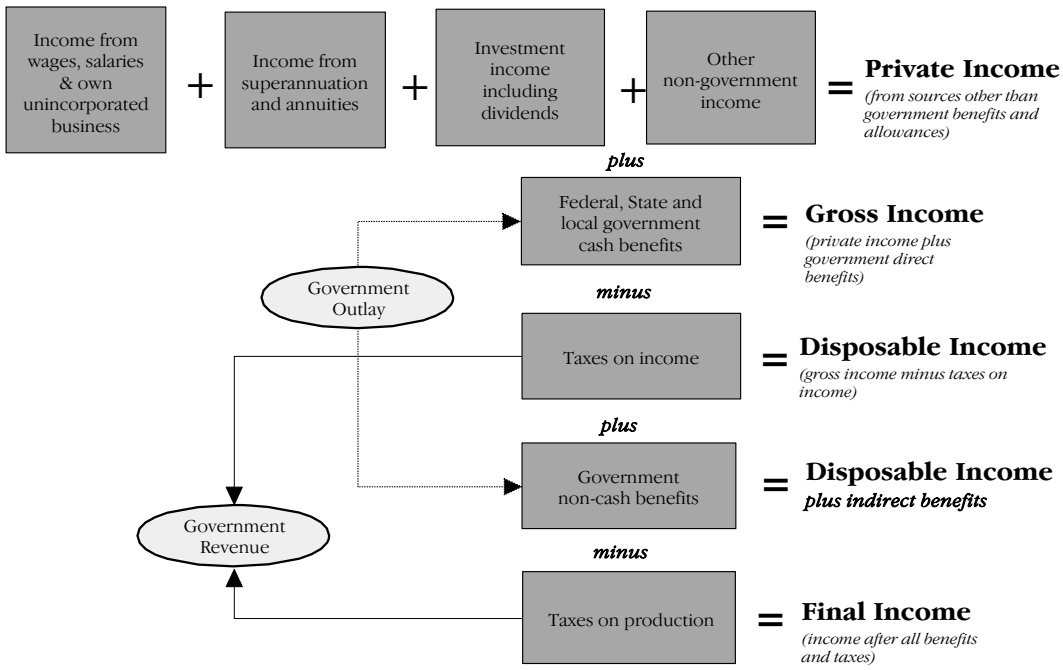
APPENDIXES

A. INCOME CONCEPTS [1]

The diagram below shows the set of income concepts used to describe the effects of different types of government benefits and taxes in the FIS. The starting point is the private income which is the total current income of all members of a household from sources other than government benefits and allowances. Government direct benefits, such as pensions and unemployment allowances paid to individuals, are added to private income to give gross income. Personal income taxes are deducted from gross income to give disposable income. The value of government indirect benefits for education, health, housing and social security and welfare (otherwise known as social transfers in kind) is added to disposable income to give disposable income plus indirect benefits. Finally, taxes on production are deducted from disposable income plus indirect benefits to give final income.

A.1 Income concepts and components



1 Sourced from ABS (2001a, p.11).

B. BASIC STRUCTURE OF THE INPUT–OUTPUT TABLE [2]

The diagram illustrates an industry-by-industry input–output table, which is the type of table published by the ABS and used in the estimation of household taxes on production in the FIS.

B.1 Industry-by-industry matrix

	To / From	Row prefix	Intermediate uses: Agriculture, etc	Intermediate uses: Mining	Intermediate uses: Manufacturing, etc	Intermediate uses: Construction	Intermediate uses: Services	Intermediate uses (sub-total)	Final uses: Household final consumption expenditure	Final uses: Government final consumption expenditure	Final uses: Gross fixed capital formation - private	Final uses: Gross fixed capital formation - public enterprises	Final uses: Gross fixed capital formation - general government	Final uses: Changes in inventories	Final uses: Exports of goods and services	Final Uses (sub-total)	Total Supply (grand total)
	Column prefix		0101-0400	1100-1500	2101-3701	4101-4102	4501-9610		Q1	Q2	Q3	Q4	Q5	Q6	Q7		
Intermediate uses	Agriculture, etc	0101-0400															
	Mining	1100-1500			QUADRANT 1						QUADRANT 2						
	Manufacturing	2101-3701			INTERMEDIATE USE						FINAL USE						
	Construction	4101-4102															
	Services	4501-9610															
	Intermediate uses (sub-total)																
Primary inputs	Compensation of employees	P1															
	Gross operating surplus and mixed income	P2															
	Taxes on products (net)	P3			QUADRANT 3						QUADRANT 4						
	Other taxes on production (net)	P4			PRIMARY INPUTS TO PRODUCTION						PRIMARY INPUTS TO FINAL USE						
	Imports (complementary)	P5															
	Imports (competing)	P6															
	Australian production																

Notes: The shaded areas correspond to aggregates shown in the Gross Domestic Product Account.

corresponds to aggregates shown as the components of gross domestic product, income approach

corresponds to aggregates shown as the components of gross domestic product, expenditure approach

2 Sourced from ABS (2000b, p. 99).

C. THE LONG-RUN MODEL

The diagram illustrates a modified industry-by-industry input–output table assuming a long-run model. This is the input–output framework used in the estimation of household taxes on production in the FIS following the new approach.

C.1 Adjusted industry-by-industry matrix

To / From		Row prefix	Intermediate uses: Agriculture, etc	Mining	Manufacturing, etc	Construction	Services	Gross fixed capital formation - private & public enterprises	Intermediate uses (sub-total)	Final uses: Household final consumption expenditure	Government final consumption expenditure	Gross fixed capital formation - general government	Changes in inventories	Exports of goods and services	Final Uses (sub-total)	Total Supply (grand total)
	Column prefix		0101-0400	1100-1500	2101-3701	4101-4102	4501-9610	Q3+Q4		Q1	Q2	Q5	Q6	Q7		
Intermediate uses	Agriculture, etc	0101-0400														
	Mining	1100-1500			QUADRANT 1						QUADRANT 2					
	Manufacturing	2101-3701			INTERMEDIATE USE						FINAL USE					
	Construction	4101-4102														
	Services	4501-9610														
	Consumption of fixed capital	Part of P2														
	Intermediate uses (sub-total)															
	Compensation of employees	P1														
	Gross operating surplus and mixed income less CFC	P2*														
Primary inputs	Taxes on products (net)	P3			QUADRANT 3						QUADRANT 4					
	Other taxes on production (net)	P4			PRIMARY INPUTS TO PRODUCTION						PRIMARY INPUTS TO FINAL USE					
	Imports (complementary)	P5														
	Imports (competing)	P6														
	Australian production															

Note: Shaded portion are the adjustments made to the industry-by-industry matrix in Appendix B.

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