Australian Government
Productivity Commission

Measuring the Contributions of Productivity and Terms of Trade to Australia's Economic Welfare

Consultancy Report

W. Erwin Diewert
Denis Lawrence
Meyrick and Associates

The views expressed in this report are those of the authors and do not necessarily reflect those of the Productivity Commission.

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Publications Inquiries:
Media and Publications
Productivity Commission
Locked Bag 2 Collins Street East
Melbourne VIC 8003

Tel: (03) 9653 2244
Fax: (03) 9653 2303
Email: maps@pc.gov.au

General Inquiries:
Tel: (03) 9653 2100 or (02) 6240 3200

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Foreword

Prominent American economist, Paul Krugman, is often cited for his observation that 'Productivity isn't everything, but in the long run it is almost every thing.'

While Australia's 1990s productivity surge highlighted productivity growth as a major source of income growth, a favourable shift in the terms of trade in recent times has raised prosperity by giving Australian income more purchasing power.

So could Australia rely on favourable terms of trade movements, rather than productivity growth, for on-going prosperity improvements? The answer rests on establishing an operational concept of Krugman's 'everything' and on assessing the major contributions to it.

The Commission engaged Erwin Diewert and Denis Lawrence of Meyrick and Associates to undertake research that would:

- identify and implement improvements in practical welfare measurement beyond the conventional average income or GDP per capita measure; and
- gauge the welfare contributions of productivity and the terms of trade.

In this report, the authors net out non-welfare-enhancing investment and use consumer, rather than producer, price deflation in their welfare measure. They find the terms of trade to have lifted welfare over short periods, but confirm Krugman's maxim for Australia — that productivity growth has been the major long-term source of increased prosperity. They also find that technological advances and other efficiency improvements assume greater significance in their welfare measure.

The Commission is publishing the report as a contribution to understanding key issues bearing on Australia's economic future. Feedback on the study is welcomed.

Gary Banks
Chairman

March 2006

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About the Authors

Erwin Diewert

Prof Erwin Diewert is Professor of Economics at the University of British Columbia, Canada and an Associate of Meyrick and Associates. He is a Fellow of the Royal Society of Canada, of the Econometric Society and of the World Academy of Productivity Science. Erwin is an internationally renowned economic theorist, empirical economist and policy analyst. He has made seminal contributions to economic theory, especially in the economics of production and index numbers, and has received a number of distinguished prizes and awards for his contributions across a range of fields. He advises a number of national and international statistical agencies on development of statistics. Erwin has been motivated not only to advance theory and technique but also apply his vast expertise to important policy issues of the day.

Denis Lawrence

Dr Denis Lawrence is Director of Meyrick and Associates. He has over 20 years experience in productivity measurement and applied regulatory analysis including infrastructure pricing, benchmarking of firm and industry performance, and general equilibrium modelling. Denis holds a PhD in Economics from the University of British Columbia, Canada. His first degree was from the ANU. Before joining Meyrick, Denis was Director of Tasman Economics and held senior executive positions with the Bureau of Industry Economics and the Industry Commission.

Meyrick and Associates

Postal address: 6 Kurundi Place, Hawker ACT 2614, Australia
Telephone: +61 2 6278 3628
Facsimile: +61 2 6278 5358
Website: www.meyrick.com.au

Executive summary

Improvements in a country's terms of trade, as well as improvements in a country's productivity growth, raise domestic welfare. Whilst productivity growth raises domestic income, an increase in export prices relative to import prices allows a larger quantity of imports to be purchased for a given quantity of exports, thus raising the purchasing power of domestic income.

The recent resurgence in commodity prices has focussed attention on the potential impact of the terms of trade on Australia's welfare. The Productivity Commission has engaged Meyrick and Associates to undertake a quantitative study of the relative impact of productivity and terms of trade changes on Australia's welfare over recent decades.

We adapt the methodology of Diewert and Morrison (1986) that enabled index number estimates of the contribution of each type of welfare gain to be calculated and show how it can be used to measure the contribution of the following determinants of growth to an economy's real income:

- technical progress or improvements in Total Factor Productivity;
- growth in domestic output prices or the prices of internationally traded goods and services relative to the price of consumption (ie the terms of trade); and
- growth in primary inputs.

We undertake the analysis in both the gross product and net product frameworks. While the gross product framework has traditionally been used, it overstates the level of real income as it treats investment to cover depreciation as part of real output when only net investment increases sustainable final consumption possibilities. For welfare measurement purposes, Net Domestic Product (NDP) is, thus, a superior measure of output. We implement this by subtracting depreciation from gross investment and using consumption plus sales to the government sector plus *net investment* plus the trade balance as our output concept. Depreciation is treated as an intermediate input in this model of production.

The Diewert and Lawrence database of the Australian economy is used in this study. It covers the years 1959-60 to 2003-04 and differs from the ABS Multifactor Productivity database in a number of ways. It covers 16 of the 17 industrial sectors in the National Accounts whereas the ABS database only covers 12 sectors, its output measure is built up from final demand components rather than sectoral gross output, and it uses producer prices.

Figure A **Contributions of productivity, terms of trade, real output price change and input quantity factors to Australian real gross income levels, 1960–2004**

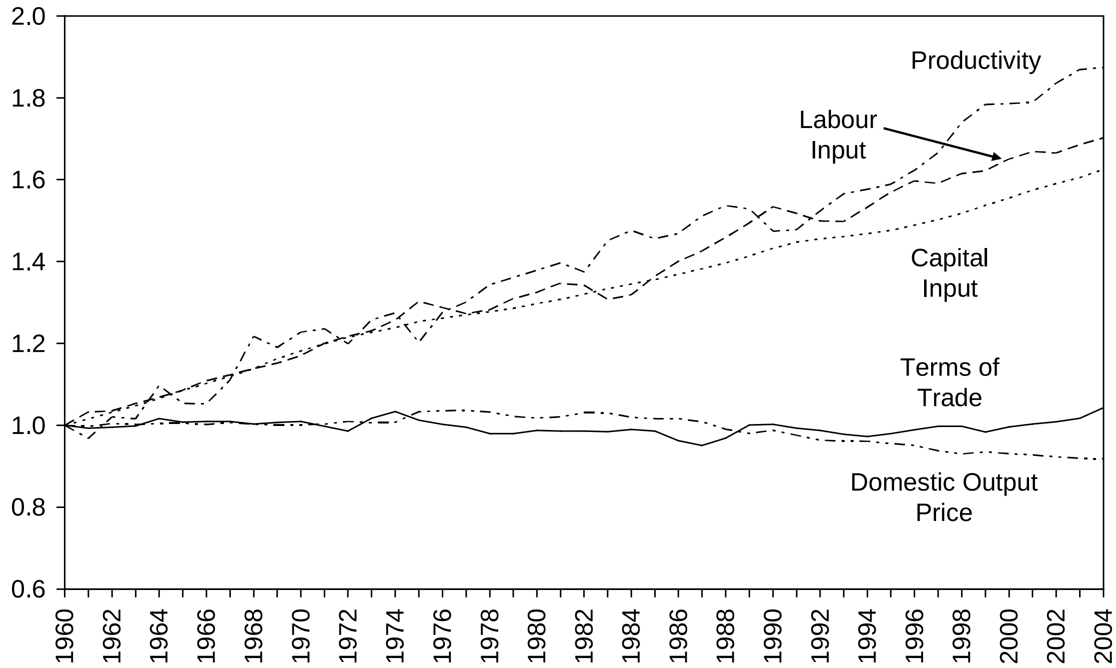
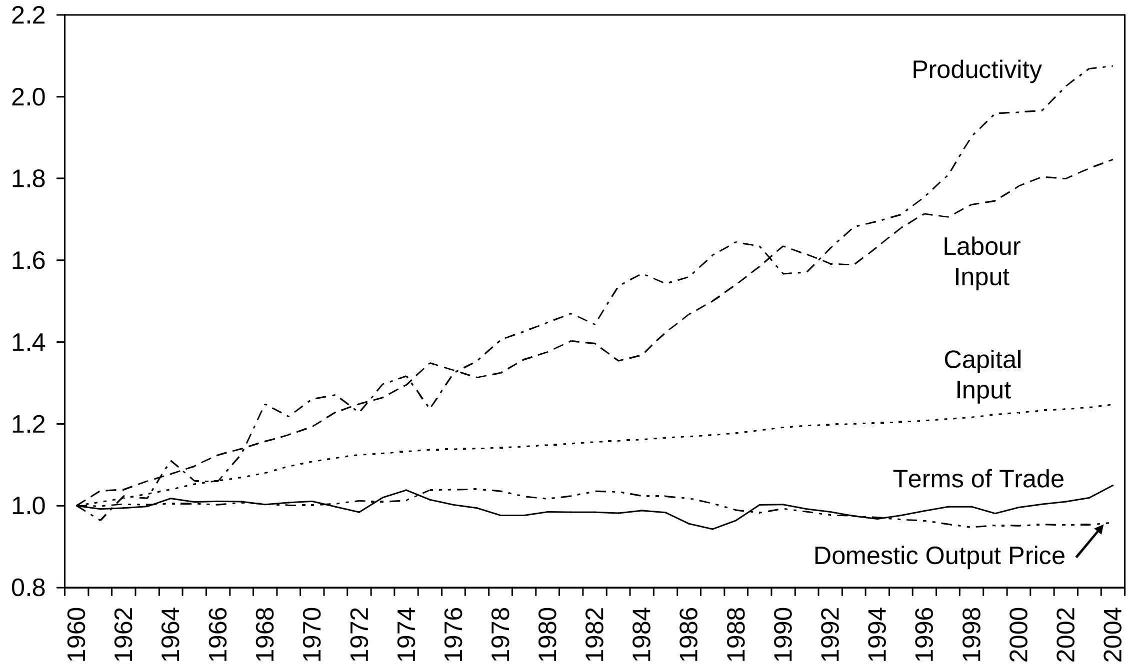
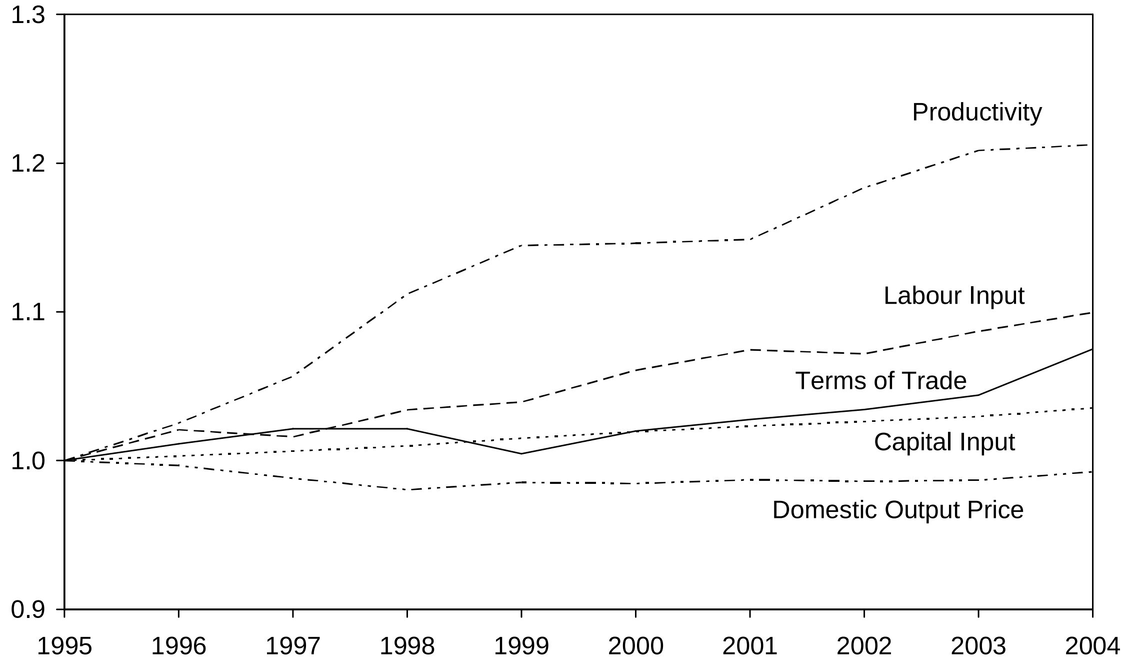


Figure B **Contributions of productivity, terms of trade, real output price change and input quantity factors to Australian real net income levels, 1960–2004**



The main conclusion emerging from this study is that, taken over long time periods of several decades, changes in the terms of trade have relatively little impact on Australian welfare. Welfare benefits from improvements in the terms of trade in one period tend to be offset by losses from subsequent deteriorations in the terms of trade. Over the last four and a half decades changes in the terms of trade have increased real income by less than 5 per cent in aggregate in both the gross and net product frameworks (see Figures A and B, respectively). Over the same period real income has increased by almost four fold. Productivity improvements were the largest single source of improvements in real income followed by labour force increases and capital stock increases.

Figure C **Contributors to real net income levels, 1995–2004**



There is evidence, however, that terms of trade changes can have a more important, albeit usually transitory, impact over shorter periods of time. In particular, improvements in the terms of trade over the decade up to 2003-04 led to an increase in real income of 7.5 per cent (see Figure C). The total increase in real income over the same period was 47 per cent with higher productivity growth accounting for almost half this increase. In this instance the contribution of terms of trade changes exceeded that of growth in the capital stock. The Diewert and Lawrence database has not yet been updated to include the 2004-05 financial year but preliminary evidence from ABS (2005) indicates that the (standard) terms of trade has made another substantial improvement in the latest year. After an improvement of 7.5 per cent in 2003-04 due to a substantial fall in import prices combined with a modest fall in export prices, the terms of trade increased by 10 per cent in 2004-05 as import prices remained largely unchanged but export prices rebounded with the growing demand for commodities. This could be expected to make a further significant contribution to real income growth.

The other major conclusion to emerge from this study is that it makes a big difference whether we use the market sector gross domestic product or net domestic product framework. The latter framework is the more relevant one for looking at the sources of real income growth generated by the market sector. When we move to a net domestic product framework from a gross domestic market sector framework, we find that the role of capital deepening as an explanatory factor for improving living standards is reduced and the role of technical progress (or TFP growth) and labour growth is increased.

1 Introduction

Improvements in a country's terms of trade, as well as improvements in a country's productivity growth, raise domestic welfare. Whilst productivity growth raises domestic income, an increase in export prices relative to import prices allows a larger quantity of imports to be purchased for a given quantity of exports, thus raising the purchasing power of domestic income. The Industry Commission (1995) examined the impact of terms of trade changes on Australia's 'purchasing power' over the period 1968–69 to 1993–94 and found they had a small negative impact. Terms of trade changes reduced purchasing power by 0.1 per cent per annum on average while productivity growth increased it by 1.5 per cent per annum over the same period.

The recent resurgence in commodity prices has again focussed attention on the potential impact of the terms of trade on Australia's welfare. The Productivity Commission has engaged Meyrick and Associates to undertake a quantitative study of the relative impact of productivity and terms of trade changes on Australia's welfare over recent decades.

Calculating the exact magnitude of each source of welfare gain is not straightforward. Diewert (1983), Diewert and Morrison (1986), Morrison and Diewert (1990) and Kohli (1990) (1991) (2003) (2004a) (2004b) developed a production theory methodology that enables one to obtain index number estimates of the contribution of each type of gain. In section 2, we adapt this methodology and show how it can be used to measure the determinants of growth in an economy's real income. We show how this theoretical approach can be implemented in sections 3-5 using techniques that are used in index number theory. Sections 3 and 4 assume that the market sector of the economy can be represented by a translog GDP function whereas section 5 pursues a first order approximation approach to implementing the theoretical indexes defined in section 2. Section 6 implements the translog approach using Australian data for the years 1960–2004 and Section 7 implements the average of first order approximation approach using the same data. It will be seen that the two approaches give virtually the same empirical results. The main determinants of growth in real income generated by the market sector of the economy are:

- technical progress or improvements in Total Factor Productivity;
- growth in domestic output prices or the prices of internationally traded goods and services relative to the price of consumption; and
- growth in primary inputs.

However, GDP is a measure of productive potential, not welfare. For welfare measurement purposes, it is generally conceded that Net Domestic Product (NDP) is a better measure of output, since investment that just meets depreciation means that society is not made any better off from the viewpoint of sustainable final consumption possibilities (see, for example, Weitzman 1976, 1997 and Oulton 2002). Hence, in the second part of the report, we propose to subtract depreciation from gross investment and use consumption plus sales to the government sector plus *net investment* plus the trade balance as our output concept. Thus, depreciation will be treated as an intermediate input in this model of production. Section 8 explains this real net product approach and adapts the translog model of sections 3 and 4 to this new model of market sector real income generation. The translog deflated net product approach is implemented using Australian data in section 8, while section 9 implements the average of the first order approximation results. Again, the empirical results for the growth in real net income exhibited in sections 8 and 9 are very similar.

Section 10 concludes by noting that the determinants of real net income growth in Australia are quite different from the corresponding determinants for real gross income in Australia: technical progress becomes much more important as a determinant and the role of capital deepening is diminished.

2 The production theory framework

In this section, we present the production theory framework that will be used in the remainder of the report. The main reference is Diewert and Morrison (1986)[1] but we also draw on the theory of the output price index, which was developed by Fisher and Shell (1972) and Archibald (1977). This theory is the producer theory counterpart to the theory of the cost of living index for a single consumer (or household) that was first developed by the Russian economist, A. A. Konüs (1924). These economic approaches to price indexes rely on the assumption of (competitive) *optimising behaviour* on the part of economic agents (consumers or producers). Thus, we consider only the market sector of the economy in what follows; ie that part of the economy that is motivated by profit maximising behaviour. In our empirical work, we define the market sector to be the entire production sector of the economy as defined in the System of National Accounts, less the general government sector and the owner occupied housing sector.[2]

[1] The theory also draws on Samuelson (1953), Diewert (1974, pp. 133–41; 1980; 1983, pp. 1077–100), Fox and Kohli (1998), Kohli (1978; 1990; 1991; 2003; 2004a; 2004b), Morrison and Diewert (1990), Samuelson (1953) and Sato (1976).

[2] For both of these sectors, output is equal to input and hence no productivity improvements can be generated by these two sectors according to SNA conventions. Due to the difficulties involved in

Initially, we assume that the market sector of the economy produces quantities of M (net)[3] outputs, $y \equiv [y_1,...,y_M]$, which are sold at the positive producer prices $P \equiv [P_1,...,P_M]$. We further assume that the market sector of the economy uses positive quantities of N primary inputs, $x \equiv [x_1,...,x_N]$ which are purchased at the positive primary input prices $W \equiv [W_1,...,W_N]$. In period t, we assume that there is a feasible set of output vectors y that can be produced by the market sector if the vector of primary inputs x is utilised by the market sector of the economy; denote this period t production possibilities set by S^t. We assume that S^t is a closed convex cone that exhibits a free disposal property.[4]

Given a vector of output prices P and a vector of available primary inputs x, we define *the period t market sector GDP function*, $g^t(P,x)$, as follows:[5]

$$(1)\ g^t(P,x) \equiv \max_y \{P \cdot y : (y,x) \text{ belongs to } S^t\} ; \qquad t = 0,1,2, ...$$

Thus market sector GDP depends on t (which represents the period t technology set S^t), on the vector of output prices P that the market sector faces and on x, the vector of primary inputs that is available to the market sector.

If P^t is the period t output price vector and x^t is the vector of inputs used by the market sector during period t and if the GDP function is differentiable with respect to the components of P at the point P^t,x^t, then the period t vector of market sector

splitting up the residential housing stock into the rental and owner occupied portions, we omit the entire residential housing stock and the consumption of residential housing services in our Australian data. However, we do include investment in residential housing, since that investment is part of the output of the market production sector.

3 If the mth commodity is an import (or other produced input) into the market sector of the economy, then the corresponding quantity y_m is indexed with a negative sign. We will follow Kohli (1978; 1991) and Woodland (1982) in assuming that imports flow through the domestic production sector and are ‘transformed’ (perhaps only by adding transportation, wholesaling and retailing margins) by the domestic production sector. The recent textbook by Feenstra (2004, p. 76) also uses this approach.

4 For a more detailed explanation for the meaning of these properties, see Diewert (1973; 1974, p. 134) or Woodland (1982) or Kohli (1978; 1991). The assumption that S^t is a cone means that the technology is subject to constant returns to scale. This is an important assumption since it implies that the value of outputs should equal the value of inputs in equilibrium. In our empirical work, we use an ex post rate of return in our user costs of capital, which forces the value of inputs to equal the value of outputs for each period. The function g^t is known as the *GDP function* or the *national product function* in the international trade literature (see Kohli (1978; 1991), Woodland (1982) and Feenstra (2004, p. 76). It was introduced into the economics literature by Samuelson (1953). Alternative terms for this function include: (i) the *gross profit function*; see Gorman (1968); (ii) the *restricted profit function*; see Lau (1976) and McFadden (1978); and (iii) the *variable profit function*; see Diewert (1973; 1974; 1993).

5 The function $g^t(P,x)$ will be linearly homogeneous and convex in the components of P and linearly homogeneous and concave in the components of x; see Diewert (1973) (1974; 136). Notation: $P \cdot y \equiv \sum_{m=1}^{M} P_m y_m$.

outputs y^t will be equal to the vector of first order partial derivatives of $g^t(P^t,x^t)$ with respect to the components of P; ie we will have the following equations for each period t:[6]

(2) $y^t = \nabla_P\, g^t(P^t,x^t)$; $\qquad t = 0,1,2, ...$

Thus the period t market sector supply vector y^t can be obtained by differentiating the period t market sector GDP function with respect to the components of the period t output price vector P^t.

If the GDP function is differentiable with respect to the components of x at the point P^t,x^t, then the period t vector of input prices W^t will be equal to the vector of first order partial derivatives of $g^t(P^t,x^t)$ with respect to the components of x; ie we will have the following equations for each period t:[7]

(3) $W^t = \nabla_x\, g^t(P^t,x^t)$; $\qquad t = 0,1,2, ...$

Thus, the period t market sector input prices W^t paid to primary inputs can be obtained by differentiating the period t market sector GDP function with respect to the components of the period t input quantity vector x^t.

The constant returns to scale assumption on the technology sets S^t implies that the value of outputs will equal the value of inputs in period t; ie we have the following relationships:

(4) $g^t(P^t,x^t) = P^t \cdot y^t = W^t \cdot x^t$; $\qquad t = 0,1,2, ...$

The above material will be useful in what follows but of course, our focus is not on GDP; instead our focus is on the income generated by the market sector or more precisely, on *the real income generated by the market sector*. However, since market sector GDP (the value of market sector production) is distributed to the factors of production used by the market sector, nominal market sector GDP will be equal to nominal market sector income; ie from (4), we have $g^t(P^t,x^t) = P^t \cdot y^t = W^t \cdot x^t$. As an approximate welfare measure that can be associated with market sector production,[8] we will choose to measure the *real income generated by the market*

6 These relationships are due to Hotelling (1932, p. 594). Note that $\nabla_P\, g^t(P^t,x^t) \equiv [\partial g^t(P^t,x^t)/\partial P_1, ..., \partial g^t(P^t,x^t)/\partial P_M]$.

7 These relationships are due to Samuelson (1953) and Diewert (1974, p. 140). Note that $\nabla x\, g^t(P^t,x^t) \equiv [\partial g^t(P^t,x^t)/\partial x_1, ..., \partial g^t(P^t,x^t)/\partial x_N]$.

8 Since some of the primary inputs used by the market sector can be owned by foreigners, our measure of *domestic* welfare generated by the market production sector is only an approximate one. Moreover, our suggested welfare measure is not sensitive to the distribution of the income that is generated by the market sector.

sector in period t, r^t, in terms of the number of consumption bundles that the nominal income could purchase in period t; ie define ρ^t as follows:

(5) $\rho^t \equiv W^t \cdot x^t / P_C{}^t$; $\qquad$ t = 0,1,2, ...

$= w^t \cdot x^t$

$= p^t \cdot y^t$

$= g^t(p^t,x^t)$

where $P_C{}^t > 0$ is the *period t consumption expenditures deflator* and the market sector period t *real output price* p^t and *real input price* w^t vectors are defined as the corresponding nominal price vectors deflated by the consumption expenditures price index; ie we have the following definitions:[9]

(6) $p^t \equiv P^t/P_C{}^t$; $w^t \equiv W^t/P_C{}^t$; $\qquad$ t = 0,1,2, ...

The first and last equality in (5) imply that period t real income, ρ^t, is equal to the period t GDP function, evaluated at the period t real output price vector p^t and the period t input vector x^t, $g^t(p^t,x^t)$. Thus *the growth in real income over time can be explained by three main factors: t (Technical Progress or Total Factor Productivity growth), growth in real output prices and the growth of primary inputs*. We will shortly give formal definitions for these three growth factors.

Using the linear homogeneity properties of the GDP functions $g^t(P,x)$ in P and x separately, we can show that the following counterparts to the relations (2) and (3) hold using the deflated prices p and w:[10]

(7) $y^t = \nabla_p\, g^t(p^t,x^t)$; $\qquad$ t = 0,1,2, ...

(8) $w^t = \nabla_x\, g^t(p^t,x^t)$; $\qquad$ t = 0,1,2, ...

[9] Our approach is similar to the approach advocated by Kohli (2004b, p. 92), except he essentially deflates nominal GDP by the domestic expenditures deflator rather than just the domestic (household) expenditures deflator; ie he deflates by the deflator for C+G+I, whereas we suggest deflating by the deflator for C. Another difference in his approach compared to the present approach is that we restrict our analysis to the market sector GDP, whereas Kohli deflates all of GDP (probably due to data limitations). Our treatment of the balance of trade surplus or deficit is also different.

[10] If producers in the market sector of the economy are solving the profit maximization problem that is associated with $g^t(P,x)$, which uses the original output prices P, then they will also solve the profit maximisation problem that uses the normalised output prices $p \equiv P/P_C$; ie they will also solve the problem defined by $g^t(p,x)$.

Now we are ready to define a family of *period t productivity growth factors or technical progress shift factors* $\tau(p,x,t)$:[11]

(9) $\tau(p,x,t) \equiv g^t(p,x)/g^{t-1}(p,x)$; $t = 1,2, \ldots$.

Thus $\tau(p,x,t)$ measures the proportional change in the real income produced by the market sector at the reference real output prices p and reference input quantities used by the market sector x where the numerator in (9) uses the period t technology and the denominator in (9) uses the period t–1 technology. Thus, each choice of reference vectors p and x will generate a possibly different measure of the shift in technology going from period t–1 to period t. Note that we are using the chain system to measure the shift in technology.

It is natural to choose special reference vectors for the measure of technical progress defined by (9): a *Laspeyres type measure* $\tau_L{}^t$ that chooses the period t–1 reference vectors p^{t-1} and x^{t-1} and a *Paasche type measure* $\tau_P{}^t$ that chooses the period t reference vectors p^t and x^t:

(10) $\tau_L{}^t \equiv \tau(p^{t-1},x^{t-1},t) = g^t(p^{t-1},x^{t-1})/g^{t-1}(p^{t-1},x^{t-1})$; $t = 1,2, \ldots$;

(11) $\tau_P{}^t \equiv \tau(p^t,x^t,t) = g^t(p^t,x^t)/g^{t-1}(p^t,x^t)$; $t = 1,2, \ldots$.

Since both measures of technical progress are equally valid, it is natural to average them to obtain an overall measure of technical change. If we want to treat the two measures in a symmetric manner and we want the measure to satisfy the time reversal property from index number theory[12] (so that the estimate going backwards is equal to the reciprocal of the estimate going forwards), then the geometric mean will be the best simple average to take.[13] Thus, we define the geometric mean of (10) and (11) as follows:[14]

(12) $\tau^t \equiv [\tau_L{}^t\, \tau_P{}^t]^{1/2}$; $t = 1,2, \ldots$.

At this point, it is not clear how we will obtain empirical estimates for the theoretical productivity growth indexes defined by (10)–(12). One obvious way would be to assume a functional form for the GDP function $g^t(p,x)$, collect data on output and input prices and quantities for the market sector for a number of years

[11] This measure of technical progress is due to Diewert and Morrison (1986, p. 662).

[12] See Fisher (1922, p. 64).

[13] See the discussion in Diewert (1997) on choosing the 'best' symmetric average of Laspeyres and Paasche indexes that will lead to the satisfaction of the time reversal test by the resulting average index.

[14] The theoretical productivity change indexes defined by (10)–(12) were first defined by Diewert and Morrison (1968, pp. 662–3). See Diewert (1993) for properties of symmetric means.

(and for the consumption expenditures deflator), add error terms to equations (7) and (8) and use econometric techniques to estimate the unknown parameters in the assumed functional form. However, econometric techniques are generally not completely straightforward: different econometricians will make different stochastic specifications and will choose different functional forms.[15] Moreover, as the number of outputs and inputs grows, it will be impossible to estimate a flexible functional form. Thus, we will suggest methods for implementing measures like (12) in this report that are based on exact index number techniques.

We turn now to the problem of defining theoretical indexes for the effects on real income due to changes in real output prices. Define a family of *period t real output price growth factors* $\alpha(p^{t-1},p^t,x,s)$:[16]

$$(13)\ \alpha(p^{t-1},p^t,x,s) \equiv g^s(p^t,x)/g^s(p^{t-1},x)\ ; \qquad s = 1,2, \ldots .$$

Thus $\alpha(p^{t-1},p^t,x,s)$ measures the proportional change in the real income produced by the market sector that is induced by the change in real output prices going from period t−1 to t, using the technology that is available during period s and using the reference input quantities x. Thus, each choice of the reference technology s and the reference input vector x will generate a possibly different measure of the effect on real income of a change in real output prices going from period t−1 to period t.

Again, it is natural to choose special reference vectors for the measures defined by (13): a *Laspeyres type measure* $\alpha_L{}^t$ that chooses the period t−1 reference technology and reference input vector x^{t-1} and a *Paasche type measure* $\alpha_P{}^t$ that chooses the period t reference technology and reference input vector x^t:

$$(14)\ \alpha_L{}^t \equiv \alpha(p^{t-1},p^t,x^{t-1},t-1) = g^{t-1}(p^t,x^{t-1})/g^{t-1}(p^{t-1},x^{t-1})\ ; \qquad t = 1,2, \ldots ;$$

$$(15)\ \alpha_P{}^t \equiv \alpha(p^{t-1},p^t,x^t,t) = g^t(p^t,x^t)/g^t(p^{t-1},x^t)\ ; \qquad t = 1,2, \ldots .$$

Since both measures of real output price change are equally valid, it is natural to average them to obtain an overall measure of the effects on real income of the change in real output prices:[17]

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15 'The estimation of GDP functions such as (19) can be controversial, however, since it raises issues such as estimation technique and stochastic specification. ... We therefore prefer to opt for a more straightforward index number approach.' (Kohli 2004a, p. 344).

16 This measure of real output price change was essentially defined by Fisher and Shell (1972, pp. 56–8), Samuelson and Swamy (1974, pp. 588–92), Archibald (1977, pp. 60–1), Diewert (1980, pp. 460–1); 1983, p. 1055) and Balk (1998, pp. 83–9). Readers who are familiar with the theory of the true cost of living index will note that the real output price index defined by (13) is analogous to the Konüs (1924) *true cost of living index* which is a ratio of cost functions, say $C(u,p^t)/C(u,p^{t-1})$ where u is a reference utility level: g^s replaces C and the reference utility level u is replaced by the vector of reference variables x.

(16) $\alpha^t \equiv [\alpha_L{}^t \, \alpha_P{}^t]^{1/2}$; t = 1,2, ...

Finally, we look at the problem of defining theoretical indexes for the effects on real income due to changes in input quantities. Define a family of *period t real input quantity growth factors* $\beta(x^{t-1},x^t,p,s)$:[18]

(17) $\beta(x^{t-1},x^t,p,s) \equiv g^s(p,x^t)/g^s(p,x^{t-1})$; s = 1,2, ...

Thus $\beta(x^{t-1},x^t,p,s)$ measures the proportional change in the real income produced by the market sector that is induced by the change in input quantities used by the market sector going from period t–1 to t, using the technology that is available during period s and using the reference real output prices p. Thus, each choice of the reference technology s and the reference real output price vector p will generate a possibly different measure of the effect on real income of a change in input quantities going from period t–1 to period t.

Again, it is natural to choose special reference vectors for the measures defined by (17): a *Laspeyres type measure* $\beta_L{}^t$ that chooses the period t–1 reference technology and reference real output price vector p^{t-1} and a *Paasche type measure* $\beta_P{}^t$ that chooses the period t reference technology and reference real output price vector p^t:

(18) $\beta_L{}^t \equiv \beta(x^{t-1},x^t,p^{t-1},t-1) = g^{t-1}(p^{t-1},x^t)/g^{t-1}(p^{t-1},x^{t-1})$; t = 1,2, ... ;

(19) $\beta_P{}^t \equiv \beta(x^{t-1},x^t,p^t,t) = g^t(p^t,x^t)/g^t(p^t,x^{t-1})$; t = 1,2, ...

Since both measures of real input growth are equally valid, it is natural to average them to obtain an overall measure of the effects of input growth on real income:[19]

(20) $\beta^t \equiv [\beta_L{}^t \, \beta_P{}^t]^{1/2}$; t = 1,2, ...

Recall that market sector real income for period t was defined by (5) as ρ^t equal to nominal period t factor payments $W^t \cdot x^t$ deflated by the household consumption price deflator $P_C{}^t$. It is convenient to define γ^t as the *period t chain rate of growth factor for real income*:

(21) $\gamma^t \equiv \rho^t/\rho^{t-1}$; t = 1,2, ...

17 The indexes defined by (13)–(16) were defined by Diewert and Morrison (1986, p. 664) in the nominal GDP function context.

18 This type of index was defined as a true index of value added by Sato (1976, p. 438) and as a real input index by Diewert (1980, p. 456).

19 The theoretical indexes defined by (17)–(20) were defined in Diewert and Morrison (1986, p. 665) in the nominal GDP context.

It turns out that the definitions for γ^t and the technology, output price and input quantity growth factors $\tau(p,x,t)$, $\alpha(p^{t-1},p^t,x,s)$, $\beta(x^{t-1},x^t,p,s)$ defined by (9), (13) and (17), respectively, satisfy some interesting identities, which we will now develop. We have:

$$(22)\ \gamma^t \equiv \rho^t/\rho^{t-1}\ ; \qquad t = 1,2, \ldots .$$
$$= g^t(p^t,x^t)/g^{t-1}(p^{t-1},x^{t-1}) \qquad \text{using definitions (4) and (5)}$$
$$= [g^t(p^t,x^t)/g^{t-1}(p^t,x^t)][g^{t-1}(p^t,x^t)/g^{t-1}(p^{t-1},x^t)][g^{t-1}(p^{t-1},x^t)/g^{t-1}(p^{t-1},x^{t-1})]$$
$$= \tau_P{}^t\ \alpha(p^{t-1},p^t,x^t,t-1)\ \beta_L{}^t \qquad \text{using definitions (11), (13) and (18).}$$

In a similar fashion, we can establish the following companion identity:

$$(23)\ \gamma^t \equiv \tau_L{}^t\ \alpha(p^{t-1},p^t,x^{t-1},t)\ \beta_P{}^t \qquad \text{using definitions (10), (13) and (19).}$$

Thus, multiplying (22) and (23) together and taking positive square roots of both sides of the resulting identity and using definitions (12) and (20), we obtain the following identity:

$$(24)\ \gamma^t \equiv \tau^t\ [\alpha(p^{t-1},p^t,x^t,t-1)\alpha(p^{t-1},p^t,x^{t-1},t)]^{1/2}\ \beta^t\ ; \qquad t = 1,2, \ldots .$$

In a similar fashion, we can derive the following alternative decomposition for γ^t into growth factors:

$$(25)\ \gamma^t \equiv \tau^t\ \alpha^t\ [\beta(x^{t-1},x^t,p^t,t-1)\beta(x^{t-1},x^t,p^{t-1},t)]^{1/2}\ ; \qquad t = 1,2, \ldots .$$

It is quite likely that the real output price growth factor $[\alpha(p^{t-1},p^t,x^t,t-1)\alpha(p^{t-1},p^t,x^{t-1},t)]^{1/2}$ is fairly close to α^t defined by (16) and it is quite likely that the input growth factor $[\beta(x^{t-1},x^t,p^t,t-1)\beta(x^{t-1},x^t,p^{t-1},t)]^{1/2}$ is quite close to β^t defined by (20); ie we have the following approximate equalities:

$$(26)\ [\alpha(p^{t-1},p^t,x^t,t-1)\alpha(p^{t-1},p^t,x^{t-1},t)]^{1/2} \approx \alpha^t\ ; \qquad t = 1,2, \ldots ;$$

$$(27)\ [\beta(x^{t-1},x^t,p^t,t-1)\beta(x^{t-1},x^t,p^{t-1},t)]^{1/2} \approx \beta^t\ ; \qquad t = 1,2, \ldots .$$

Substituting (26) and (27) into (24) and (25), respectively, leads to the following approximate decompositions for the growth of real income into explanatory factors:

$$(28)\ \gamma^t \approx \tau^t\ \alpha^t\ \beta^t\ ; \qquad t = 1,2, \ldots$$

where τ^t is a technology growth factor, α^t is a growth in real output prices factor and β^t is a growth in primary inputs factor.

Rather than look at explanatory factors for the growth in real market sector income, it is sometimes convenient to express the level of real income in period t in terms of an *index of the technology level* or of Total Factor Productivity in period t, T^t, of the *level of real output prices* in period t, A^t, and of the *level of primary input quantities* in period t, B^t.[20] Thus, we use the growth factors τ^t, α^t and β^t as follows to define the levels T^t, A^t and B^t:

(29) $T^0 \equiv 1$; $T^t \equiv T^{t-1}\,\tau^t$; $t = 1,2, \ldots$;

(30) $A^0 \equiv 1$; $A^t \equiv A^{t-1}\alpha^t$; $t = 1,2, \ldots$;

(31) $B^0 \equiv 1$; $B^t \equiv B^{t-1}\beta^t$; $t = 1,2, \ldots$.

Using the approximate equalities (28) for the chain links that appear in (29)–(31), we can establish the following approximate relationship for the level of real income in period t, ρ^t, and the period t levels for technology, real output prices and input quantities:

(32) $\rho^t/\rho^0 \approx T^t\, A^t\, B^t$; $\qquad t = 0,1,2, \ldots$.

In the following section, we note a set of assumptions on the technology sets that will ensure that the approximate real income growth decompositions (28) and (32) hold as exact equalities.

3 The translog GDP function approach

We now follow the example of Diewert and Morrison (1986, p. 663) and assume that the log of the period t (deflated) GDP function, $g^t(p,x)$, has the following translog functional form:[21]

$$\begin{aligned}(33)\ \ln g^t(p,x) \equiv{}& a_0^{\,t} + \sum_{m=1}^{M} a_m^{\,t} \ln p_m^{\,t} + (1/2) \sum_{m=1}^{M}\sum_{k=1}^{M} a_{mk} \ln p_m^{\,t} \ln p_k^{\,t} \\ &+ \sum_{n=1}^{N} b_n^{\,t} \ln x_n^{\,t} + (1/2)\sum_{n=1}^{N}\sum_{j=1}^{N} b_{nj} \ln x_n^{\,t} \ln x_j^{\,t} + \sum_{m=1}^{M}\sum_{n=1}^{M} c_{mn} \ln p_m^{\,t} \ln x_n^{\,t} ; \\ &\qquad t = 0,1,2, \ldots .\end{aligned}$$

Note that the coefficients for the quadratic terms are assumed to be constant over time. The coefficients must satisfy the following restrictions in order for g^t to satisfy the linear homogeneity properties that we have assumed in section 2 above:[22]

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20 This type of levels presentation of the data is quite instructive when presented in graphical form. It was suggested by Kohli (1990) and used extensively by him; see Kohli (1991; 2003; 2004a; 2004b) and Fox and Kohli (1998).

21 This functional form was first suggested by Diewert (1974, p. 139) as a generalization of the translog functional form introduced by Christensen, Jorgenson and Lau (1971). Diewert (1974, p. 139) indicated that this functional form was flexible.

22 There are additional restrictions on the parameters which are necessary to ensure that $g^t(p,x)$ is convex in p and concave in x.

(34) $\sum_{m=1}^{M} a_m{}^t = 1$ for t = 0,1,2, ...;
(35) $\sum_{n=1}^{N} b_n{}^t = 1$ for t = 0,1,2, ...;
(36) $a_{mk} = a_{km}$ for all k,m ;
(37) $b_{nj} = b_{jn}$ for all n,j ;
(38) $\sum_{k=1}^{M} a_{mk} = 0$ for m = 1,...,M ;
(39) $\sum_{j=1}^{N} b_{nj} = 0$ for n = 1,...,N ;
(40) $\sum_{n=1}^{N} c_{mn} = 0$ for m = 1,...,M ;
(41) $\sum_{m=1}^{M} c_{mn} = 0$ for n = 1,...,N .

Recall the approximate decomposition of real income growth going from period t–1 to t given by (28) above, $\gamma^t \approx \tau^t\ \alpha^t\ \beta^t$. Diewert and Morrison (1986, p. 663) showed that[23] if g^{t-1} and g^t are defined by (33)–(41) above and there is competitive profit maximizing behavior on the part of all market sector producers for all periods t, then (28) holds as an exact equality; ie we have

(42) $\gamma^t = \tau^t\ \alpha^t\ \beta^t$; t = 1,2, ...

In addition, Diewert and Morrison (1986; 663-665) showed that τ^t, α^t and β^t could be calculated using empirically observable price and quantity data for periods t–1 and t as follows:

(43) $\ln\alpha^t = \sum_{m=1}^{M} (1/2)[(p_m{}^{t-1}y_m{}^{t-1}/p^{t-1}\cdot y^{t-1}) + (p_m{}^t y_m{}^t/p^t\cdot y^t)] \ln(p_m{}^t/p_m{}^{t-1})$
$= \ln P_T(p^{t-1},p^t,y^{t-1},y^t)$;

(44) $\ln\beta^t = \sum_{n=1}^{N} (1/2)[(w_n{}^{t-1}x_n{}^{t-1}/w^{t-1}\cdot x^{t-1}) + (w_n{}^t x_n{}^t/w^t\cdot x^t)] \ln(x_n{}^t/x_n{}^{t-1})$
$= \ln Q_T(w^{t-1},w^t,x^{t-1},x^t)$;

(45) $\tau^t = \gamma^t/\alpha^t\ \beta^t$

where $P_T(p^{t-1},p^t,y^{t-1},y^t)$ is the Törnqvist (1936) and Törnqvist and Törnqvist (1937) output price index and $Q_T(w^{t-1},w^t,x^{t-1},x^t)$ is the Törnqvist input quantity index.

Since equations (42) now hold as exact identities under our present assumptions, equations (32), the cumulated counterparts to equations (28), will also hold as exact decompositions; ie under our present assumptions, we have

(46) $\rho^t/\rho^0 = T^t\ A^t\ B^t$; t = 1,2, ...

We will implement the real income decompositions (42) and (46) in subsequent sections using Australian data for the years 1960–2004.

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23 Diewert and Morrison established their proof using the nominal GDP function $g^t(P,x)$. However, it is easy to rework their proof using the deflated GDP function $g^t(p,x)$ using the fact that $g^t(p,x) = g^t(P/P_C,x) = g^t(P,x)/P_C$ using the linear homogeneity property of $g^t(P,x)$ in P.

4 The translog GDP function approach and changes in the terms of trade

For some purposes, it is convenient to decompose the aggregate period t contribution factor due to changes in all deflated output prices α^t into separate effects for each change in each output price. Similarly, it can sometimes be useful to decompose the aggregate period t contribution factor due to changes in all market sector primary input quantities β^t into separate effects for each change in each input quantity. In this section, we indicate how this can be done, making the same assumptions on the technology that were made in the previous section.

We first model the effects of a change in a single (deflated) output price, say p_m, going from period t–1 to t. Counterparts to the theoretical Laspeyres and Paasche type price indexes defined by (14) and (15) above for changes in all (deflated) output prices are the following *Laspeyres type measure* $\alpha_{Lm}{}^t$ that chooses the period t–1 reference technology and holds constant other output prices at their period t–1 levels and holds inputs constant at their period t–1 levels x^{t-1} and a *Paasche type measure* $\alpha_{Pm}{}^t$ that chooses the period t reference technology and reference input vector x^t and holds constant other output prices at their period t levels:

$$(47)\ \alpha_{Lm}{}^t \equiv g^{t-1}(p_1{}^{t-1},...,p_{m-1}{}^{t-1},p_m{}^t,p_{m+1}{}^{t-1},..., p_M{}^{t-1},x^{t-1})/g^{t-1}(p^{t-1},x^{t-1})\ ; \quad m = 1,...,M;\ t = 1,2, ... ;$$

$$(48)\ \alpha_{Pm}{}^t \equiv g^t(p^t,x^t)/g^t(p_1{}^t,...,p_{m-1}{}^t,p_m{}^{t-1},p_{m+1}{}^t,..., p_M{}^t,x^t)\ ; \quad m = 1,...,M;\ t = 1,2, ...$$

Since both measures of real output price change are equally valid, it is natural to average them to obtain an *overall measure of the effects on real income of the change in the real price of output m*:[24]

$$(49)\ \alpha_m{}^t \equiv [\alpha_{Lm}{}^t\,\alpha_{Pm}{}^t]^{1/2}\ ; \quad m = 1,...,M\ ;\ t = 1,2, ...$$

Under the assumption that the deflated GDP functions $g^t(p,x)$ have the translog functional forms as defined by (33)–(41) in the previous section, the arguments of Diewert and Morrison (1986, p. 666) can be adapted to give us the following result:

$$(50)\ \ln\alpha_m{}^t = (1/2)[(p_m{}^{t-1}y_m{}^{t-1}/p^{t-1}\cdot y^{t-1}) + (p_m{}^t y_m{}^t/p^t\cdot y^t)]\ \ln(p_m{}^t/p_m{}^{t-1})\ ; \quad m = 1,...,M\ ;\ t = 1,2, ...$$

Note that $\ln\alpha_m{}^t$ is equal to the mth term in the summation of the terms on the right hand side of (43). This observation means that we have the following exact

[24] The indexes defined by (47)–(49) were defined by Diewert and Morrison (1986,p. 666) in the nominal GDP function context.

decomposition of the period t aggregate real output price contribution factor α^t into a product of separate price contribution factors; ie we have under present assumptions:

$$(51)\ \alpha^t = \alpha_1{}^t\alpha_2{}^t \ldots \alpha_M{}^t ; \qquad t = 1,2, \ldots .$$

The above decomposition is useful for analysing how real changes in the price of exports (ie a change in the price of exports relative to the price of domestic consumption) and in the price of imports impact on the real income generated by the market sector. In the empirical illustration which follows later, we let M equal three. The three net outputs are:

- Domestic sales (C+I+G);
- Exports (X) and
- Imports (M).

Since commodities 1 and 2 are outputs, y_1 and y_2 will be positive but since commodity 3 is an input into the market sector, y_3 will be negative. Hence an increase in the real price of exports will *increase* real income but an increase in the real price of imports will *decrease* the real income generated by the market sector, as is evident by looking at the contribution terms defined by (50) for m = 2 (where $y_m{}^t > 0$) and for m = 3 (where $y_m{}^t < 0$).

As mentioned above, it is also useful to have a decomposition of the aggregate contribution of input growth to the growth of real income into separate contributions for each important class of primary input that is used by the market sector. We now model the effects of a change in a single input quantity, say x_n, going from period t–1 to t. Counterparts to the theoretical Laspeyres and Paasche type quantity indexes defined by (18) and (19) above for changes in input n are the following *Laspeyres type measure* $\beta_{Ln}{}^t$ that chooses the period t–1 reference technology and holds constant other input quantities at their period t–1 levels and holds real output prices at their period t–1 levels p^{t-1} and a *Paasche type measure* $\beta_{Pn}{}^t$ that chooses the period t reference technology and reference real output price vector p^t and holds constant other input quantities at their period t levels:

$$(52)\ \beta_{Ln}{}^t \equiv g^{t-1}(p^{t-1},x_1{}^{t-1},\ldots,x_{n-1}{}^{t-1},x_n{}^t,x_{n+1}{}^{t-1},\ldots, x_N{}^{t-1})/g^{t-1}(p^{t-1},x^{t-1}) ; \qquad n = 1,\ldots,N; \ t = 1,2, \ldots ;$$

$$(53)\ \beta_{Pn}{}^t \equiv g^t(p^t,x^t)/g^t(p^t,x_1{}^t,\ldots,x_{n-1}{}^t,x_n{}^{t-1},x_{n+1}{}^t,\ldots, p_N{}^t) ; \qquad m = 1,\ldots,M; \ t = 1,2, \ldots .$$

Since both measures of input change are equally valid, as usual, we average them to obtain *an overall measure of the effects on real income of the change in the quantity of input n*:[25]

(54) $\beta_n{}^t \equiv [\beta_{Pn}{}^t \beta_{Pn}{}^t]^{1/2}$; $\quad n = 1,\ldots,N$; $t = 1,2, \ldots$.

Under the assumption that the deflated GDP functions $g^t(p,x)$ have the translog functional forms as defined by (33)–(41) in the previous section, the arguments of Diewert and Morrison (1986, p. 667) can be adapted to give us the following result:

(55) $\ln\beta_n{}^t = (1/2)[(w_n{}^{t-1}x_n{}^{t-1}/w^{t-1}\cdot x^{t-1}) + (w_n{}^t x_n{}^t/w^t\cdot x^t)] \ln(x_n{}^t/x_n{}^{t-1})$;
$n = 1,\ldots,N$; $t = 1,2, \ldots$.

Note that $\ln\beta_n{}^t$ is equal to the nth term in the summation of the terms on the right hand side of (44). This observation means that we have the following exact decomposition of the period t aggregate input growth contribution factor β^t into a product of separate input quantity contribution factors; ie we have under present assumptions:

(56) $\beta^t = \beta_1{}^t\beta_2{}^t \ldots \beta_N{}^t$; $\quad t = 1,2, \ldots$.

There is another approach to contribution analysis that was suggested in Diewert and Morrison (1986, pp. 674–6) and we outline that approach in the following section.

5 The first order approximation nonparametric approach

Recall definitions (10) and (11) in section 2 that defined the Laspeyres productivity growth contribution factor, $\tau_L{}^t \equiv g^t(p^{t-1},x^{t-1})/g^{t-1}(p^{t-1},x^{t-1})$ and the Paasche contribution factor, $\tau_P{}^t \equiv g^t(p^t,x^t)/g^{t-1}(p^t,x^t)$. The denominator in the definition of $\tau_L{}^t$ is $g^{t-1}(p^{t-1},x^{t-1})$ and this is equal to the observable (in principle) deflated market sector GDP in period t–1, $p^{t-1}\cdot y^{t-1}$, which in turn is equal to deflated factor payments, $w^{t-1}\cdot x^{t-1}$. The numerator in the expression for $\tau_L{}^t$ is $g^t(p^{t-1},x^{t-1})$ and this is not directly observable. However, we can use (7) and (8) in order to form the following first order Taylor series approximation to $g^t(p^{t-1},x^{t-1})$:

(57) $g^t(p^{t-1},x^{t-1}) \approx g^t(p^t,x^t) + \nabla_p g^t(p^t,x^t)\cdot[p^{t-1} - p^t] + \nabla_x g^t(p^t,x^t)\cdot[x^{t-1} - x^t]$
$= p^t\cdot y^t + y^t\cdot[p^{t-1} - p^t] + w^t\cdot[x^{t-1} - x^t]$ using (7) and (8)
$= p^{t-1}\cdot y^t + w^t\cdot[x^{t-1} - x^t]$.

25 The indexes defined by (52)–(54) were defined by Diewert and Morrison (1986, p. 667) in the nominal GDP function context.

The numerator in the definition of $\tau_P{}^t$ is $g^t(p^t,x^t)$ and this is equal to the observable (in principle) deflated market sector GDP in period t, $p^t \cdot y^t$, which in turn is equal to deflated factor payments, $w^t \cdot x^t$. The denominator in the expression for $\tau_P{}^t$ is $g^{t-1}(p^t,x^t)$ and this is not directly observable. Again, we can use (7) and (8) in order to form the following first order Taylor series approximation to $g^{t-1}(p^t,x^t)$:

$$(58)\; g^{t-1}(p^t,x^t) \approx g^{t-1}(p^{t-1},x^{t-1}) + \nabla_p\, g^{t-1}(p^{t-1},x^{t-1}) \cdot [p^t - p^{t-1}] + \nabla_x\, g^{t-1}(p^{t-1},x^{t-1}) \cdot [x^t - x^{t-1}]$$
$$= p^{t-1} \cdot y^{t-1} + y^{t-1} \cdot [p^t - p^{t-1}] + w^{t-1} \cdot [x^t - x^{t-1}] \qquad \text{using (7) and (8)}$$
$$= p^t \cdot y^{t-1} + w^{t-1} \cdot [x^t - x^{t-1}].$$

Using (57) and (58), we have the following (observable) *first order approximations to the theoretical productivity growth factors* $\tau_L{}^t \equiv g^t(p^{t-1},x^{t-1})/g^{t-1}(p^{t-1},x^{t-1})$ and $\tau_P{}^t \equiv g^t(p^t,x^t)/g^{t-1}(p^t,x^t)$:

$$(59)\; \tau_L{}^t \approx \{p^{t-1} \cdot y^t + w^t \cdot [x^{t-1} - x^t]\}/p^{t-1} \cdot y^{t-1}\;;$$

$$(60)\; \tau_P{}^t \approx p^t \cdot y^t/\{p^t \cdot y^{t-1} + w^{t-1} \cdot [x^t - x^{t-1}]\}.$$

Now use the right hand sides of (59) and (60) in order to form the following approximation to $\tau^t \equiv [\tau_L{}^t\, \tau_P{}^t]^{1/2}$:

$$(61)\; \tau^t \approx (p^t \cdot y^t\{p^{t-1} \cdot y^t + w^t \cdot [x^{t-1} - x^t]\}/p^{t-1} \cdot y^{t-1}\{p^t \cdot y^{t-1} + w^{t-1} \cdot [x^t - x^{t-1}]\})^{1/2}; \quad t = 1,2, \ldots .$$

In a similar fashion, we can form *first order Taylor series approximations to the Laspeyres and Paasche real output price contribution factors* $\alpha_L{}^t \equiv g^{t-1}(p^t,x^{t-1})/g^{t-1}(p^{t-1},x^{t-1})$ and $\alpha_P{}^t \equiv g^t(p^t,x^t)/g^t(p^{t-1},x^t)$, respectively, and then use these approximations to form an approximation to $\alpha^t \equiv [\alpha_L{}^t\, \alpha_P{}^t]^{1/2}$. The resulting observable approximations are:

$$(62)\; \alpha_L{}^t \approx p^t \cdot y^{t-1}/p^{t-1} \cdot y^{t-1} = P_L(p^{t-1},p^t,y^{t-1},y^t)\;;$$

$$(63)\; \alpha_P{}^t \approx p^t \cdot y^t/p^{t-1} \cdot y^t = P_P(p^{t-1},p^t,y^{t-1},y^t)\;;$$

$$(64)\; \alpha^t \approx [\{p^t \cdot y^{t-1}/p^{t-1} \cdot y^{t-1}\}\{p^t \cdot y^t/p^{t-1} \cdot y^t\}]^{1/2} = P_F(p^{t-1},p^t,y^{t-1},y^t)$$

where P_L, P_P and P_F are the Laspeyres, Paasche and Fisher (1922) price index formulae. Thus, the average of the first order approximations to $\alpha_L{}^t$ and $\alpha_P{}^t$ turns out to be the superlative Fisher price index for deflated output prices, going from period t−1 to period t, and so it is likely that the Fisher approximation to α^t is a very good one.

We can also form *first order Taylor series approximations to the Laspeyres and Paasche input quantity contribution factors* $\beta_L{}^t \equiv g^{t-1}(p^{t-1},x^t)/g^{t-1}(p^{t-1},x^{t-1})$ and $\beta_P{}^t \equiv$

$g^t(p^t,x^t)/g^t(p^t,x^{t-1})$, respectively, and then use these approximations to form an approximation to $\beta^t \equiv [\beta_L{}^t\, \beta_P{}^t]^{1/2}$. The resulting observable approximations are:

(65) $\beta_L{}^t \approx w^{t-1}\cdot x^t/w^{t-1}\cdot x^{t-1} \qquad = Q_L(w^{t-1},w^t,x^{t-1},x^t)$;

(66) $\beta_P{}^t \approx w^t\cdot x^t/w^t\cdot x^{t-1} \qquad = Q_P(w^{t-1},w^t,x^{t-1},x^t)$;

(67) $\beta^t \approx [\{w^{t-1}\cdot x^t/w^{t-1}\cdot x^{t-1}\}\{w^t\cdot x^t/w^t\cdot x^{t-1}\}]^{1/2} \qquad = Q_F(w^{t-1},w^t,x^{t-1},x^t)$

where P_L, P_P and P_F are the Laspeyres, Paasche and Fisher (1922) quantity index formulae. Thus the average of the first order approximations to $\beta_L{}^t$ and $\beta_P{}^t$ turns out to be the superlative Fisher input quantity index, going from period t–1 to period t, and so it is likely that the Fisher approximation to the aggregate input growth contribution factor β^t is a very good one.

The same methodological approach can be applied to the problem of approximating the *contribution to real market sector income growth of the change in the real price of output m* defined by (49) above, $\alpha_m{}^t \equiv [\alpha_{Lm}{}^t\, \alpha_{Pm}{}^t]^{1/2}$. The resulting first order approximations are:

(68) $\alpha_{Lm}{}^t \approx \{p^{t-1}\cdot y^{t-1} + y_m{}^{t-1}[p_m{}^t - p_m{}^{t-1}]\}/p^{t-1}\cdot y^{t-1}$; $\qquad m = 1,...,M$; $t = 1,2, ...$;

(69) $\alpha_{Pm}{}^t \approx p^t\cdot y^t/\{p^t\cdot y^t + y_m{}^t[p_m{}^{t-1} - p_m{}^t]\}$;

(70) $\alpha_m{}^t \approx [\alpha_{Lm}{}^t\, \alpha_{Pm}{}^t]^{1/2}$.

Finally, the first order approximation approach can be applied to the individual input n contribution terms defined by (54) above, $\beta_n{}^t \equiv [\beta_{Pn}{}^t\, \beta_{Pn}{}^t]^{1/2}$. The resulting first order approximations are:

(71) $\beta_{Ln}{}^t \approx \{w^{t-1}\cdot x^{t-1} + w_n{}^{t-1}[x_n{}^t - x_n{}^{t-1}]\}/w^{t-1}\cdot x^{t-1}$; $\qquad n = 1,...,N$; $t = 1,2, ...$;

(72) $\beta_{Pn}{}^t \approx w^t\cdot x^t/\{w^t\cdot x^t + w_n{}^t[x_n{}^{t-1} - x_n{}^t]\}$;

(73) $\beta_n{}^t \approx [\beta_{Ln}{}^t\beta_{Pn}{}^t]^{1/2}$.

Why is the approach explained in this section necessary, given that we have a perfectly good translog approach that was outlined in the previous section? There are two answers to this very reasonable question:

- The present approach is a completely nonparametric approach (at first glance) whereas the translog approach rests on very specific assumptions about the technology.

- The present approach may be preferred by statistical agencies that use Fisher ideal indexes to do their basic aggregation, since it appears that this approach is more consistent with the use of Fisher indexes.

In the following section, we implement the translog and first order approximation approaches using Australian data.

6 Deflated GDP translog approach for Australia

It is not an easy task to obtain consistent data on the outputs produced and the inputs used by the market sector of an economy. In this report we use a modified version of the Australian database developed by Diewert and Lawrence (2005).

The Diewert Lawrence (D–L) total factor productivity (TFP) database was constructed for the Department of Communications, Information Technology and the Arts (DCITA). The modified version used here contains value, price and quantity information on a total of 32 output and input categories. These are made up of an aggregate consumer commodity, one government consumption commodity, 10 investment commodities, 3 inventory change commodities, one export commodity, one import commodity, labour input, 9 capital stocks and 3 inventory stocks and 2 land stocks. Data on these variables cover the 45 year period from 1959–60 to 2003–04.

The main differences between the D–L database and that used by the Australian Bureau of Statistics in producing its multifactor productivity (MFP) estimates are the following:[26]

- Broader coverage of the economy — D–L include 16 of the 17 major industrial sectors whereas the ABS 'market sector' only covers 12 of the 17 sectors. D–L exclude Government Administration and Defence whereas the ABS also excludes Health, Education, Business and Property Services and Personal services. With the changing composition of the economy, the private sector in Australia accounts for significant proportions of Health, Education and Personal Services output and nearly all of the relatively large Business and Property Services sector's output. The D–L approach of measuring output from sources of final demand enables them to cover more of the desired market–oriented parts of the economy than the ABS sectoral value added approach where measurement problems are more problematic.

[26] Diewert and Lawrence (2005) obtained the full cooperation of the ABS in constructing their database.

- Diewert and Lawrence built up an output measure from final consumption components rather than sectoral gross value added. This final demand approach allows a more accurate output measure to be used as interindustry flows of intermediates are netted out and more accurate records are available for final demand consumption components as compared to the estimates for business gross outputs and intermediate input usage.
- Diewert and Lawrence expressed both outputs and inputs in terms of producer prices. From the viewpoint of production theory (which is the theoretical basis for making productivity comparisons), the appropriate prices are the prices that producers face, which should not include final demand tax wedges. However, some commodity taxes (such as property taxes and tariffs on imports) fall on inputs to the production sector and so these taxes should be included in producer prices for productivity purposes. Subsidies also create problems in trying to determine what the 'correct' producer prices are for subsidised outputs.
- Diewert and Lawrence attempted to construct consistent capital and inventory input series and attempted to measure inventory change in a consistent manner.[27] The US Bureau of Labor Statistics methodology currently used by the ABS for forming stocks and flows is not completely consistent. Diewert and Lawrence used instead the Jorgenson[28] geometric depreciation approach which is consistent. They also smoothed the depreciation rates used by the ABS and pushed back the ABS estimates for some capital stocks that start at substantial nonzero values part way through the time period.

A more extensive discussion of the D–L database can be found in Appendix A of this report, which reproduces Appendix A of Diewert and Lawrence (2005) but also includes the data modifications made for this study. Diewert and Lawrence (2005) used an exogenous real interest rate in their user costs of capital stock components and, hence, their data did not balance; ie the value of inputs was not identically equal to the value of outputs for each year. But the methodology developed in the previous sections assumes that the value of market sector outputs is equal to the value of market sector primary inputs in each period. Hence, the modified version of the Diewert Lawrence database used in this report contains a balancing real rate of return calculated for each year that makes the value of inputs equal to the value of outputs.[29] The balancing real rate of return ranged between a high of 6.8 per cent

27 They used the inventory methodology developed by Diewert and Smith (1994) and Diewert (2005).

28 See Jorgenson and Griliches (1967) (1972) and Jorgenson (1989; 1996a; 1996b).

29 We also dropped artistic originals as an investment good and as a capital stock component for the purposes of the present exercise. Thus the 17 net outputs in the present data base are: 1 Consumption (excluding housing); 2 Government consumption; 3 Exports; 4 Non Residential and Other Construction (NROC); 5 Software; 6 Mineral Exploration; 7 Dwellings (as an

in 1964 to a low of –0.1 per cent in 1975 and averaged about 3 per cent.[30] The present version of the database also has an improved treatment of capital taxes compared to the version listed in Diewert and Lawrence (2005).

The basic price and quantity data for market sector net output (C + G + I + X – M) are listed in Tables 1 (prices) and 2 (quantities) below. The 13 investment aggregates were aggregated using a chained Törnqvist price index.

In Table 3, we list the prices for labour W_L, capital services W_K and a single stage chained Törnqvist price index for the 17 components of GDP that are in our database, P_Y. We also list a two stage aggregate output price for the components of GDP, P_{Y2S}, where the chained Törnqvist price index formula is applied to the 5 components already listed in Tables 1 and 2, C + G + I + X – M. Table 4 lists the corresponding quantity aggregates.

investment output of the market sector); 8 Computers; 9 Electrical machinery; 10 Industrial machinery; 11 Motor vehicles; 12 Other transport equipment; 13 Other machinery; 14 Non farm inventory change; 15 Farm inventory change; 16 Livestock inventory change; 17 Imports (quantities are indexed with a negative sign). The primary inputs in the data base for this study are 18 Labour and the services of the following 14 capital stock components: 19 NROC; 20 Software; 21 Mineral exploration; 22 Computers; 23 Electrical machinery; 24 Industrial machinery; 25 Motor vehicles; 26 Other transport equipment; 27 Other machinery; 28 Non farm inventories; 29 Farm inventories; 30 Livestock inventories; 31 Commercial land and 32 Rural land.

30 The balancing real rate was negative for only one year and when capital taxes were added to the user costs, all user costs were positive. However, it should be mentioned that the user costs were constructed by setting the anticipated rates of asset inflation equal to the anticipated general inflation rate. This has the effect of eliminating the negative user cost problem but it is not an entirely satisfactory solution.

Table 1 **Market sector net output price indexes for Australia, 1960–2004**

Year	P_C	P_G	P_I	P_X	P_M
1960	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0362	1.0568	1.0218	0.9619	1.0090
1962	1.0420	1.0910	1.0405	0.9648	1.0005
1963	1.0538	1.0961	1.0474	0.9947	1.0128
1964	1.0650	1.1317	1.0587	1.0842	1.0013
1965	1.0996	1.1829	1.0908	1.0495	1.0145
1966	1.1323	1.2029	1.1175	1.0646	1.0266
1967	1.1643	1.2698	1.1541	1.0656	1.0328
1968	1.2061	1.3251	1.1780	1.0430	1.0540
1969	1.2385	1.3619	1.2056	1.0683	1.0570
1970	1.2867	1.4211	1.2511	1.1217	1.0957
1971	1.3617	1.5762	1.3066	1.0923	1.1426
1972	1.4467	1.7303	1.3971	1.1367	1.2660
1973	1.5330	1.8517	1.4582	1.3750	1.2937
1974	1.7175	2.1177	1.6224	1.6475	1.4204
1975	2.0366	2.7641	2.0013	1.9240	1.8346
1976	2.3336	3.1535	2.3199	2.0502	2.0685
1977	2.5977	3.5690	2.5593	2.2910	2.3884
1978	2.8347	3.8774	2.7643	2.3797	2.6898
1979	3.0634	4.0835	2.9262	2.6385	2.9688
1980	3.3590	4.4132	3.1926	3.2088	3.4598
1981	3.6991	4.9394	3.5129	3.4642	3.7612
1982	4.0510	5.6431	3.8818	3.5477	3.9037
1983	4.4658	6.1954	4.2861	3.8191	4.2559
1984	4.7772	6.4748	4.4874	3.9986	4.3652
1985	5.0334	6.8655	4.6626	4.2860	4.7480
1986	5.4571	7.3223	5.1051	4.4996	5.4952
1987	5.9426	7.6770	5.5437	4.6260	5.9720
1988	6.4021	7.9082	5.7826	4.9527	5.9347
1989	6.7808	8.0877	6.0424	5.2120	5.4640
1990	7.1283	8.8417	6.3730	5.4626	5.7011
1991	7.6285	9.4988	6.5263	5.3251	5.8415
1992	7.9551	9.9174	6.4900	5.1661	5.8199
1993	8.1367	10.2318	6.5509	5.3152	6.2140
1994	8.1864	10.1748	6.6201	5.2294	6.2630
1995	8.2625	10.0621	6.6236	5.2620	6.1332
1996	8.4476	10.2891	6.6529	5.3946	6.0746
1997	8.5616	10.2574	6.4846	5.1833	5.6679
1998	8.7176	10.1879	6.5047	5.4055	5.9023
1999	8.7276	10.4700	6.5343	5.2139	6.0028
2000	8.9031	10.7449	6.5402	5.3586	5.9076
2001	9.2524	11.1730	6.7139	6.0897	6.5294
2002	9.4525	11.5638	6.6869	6.1368	6.4665
2003	9.6603	11.9537	6.6895	5.9773	6.1603
2004	9.8142	12.4349	6.6855	5.7093	5.4527

Table 2 **Market sector net outputs for Australia, 1960–2004 ($1960m)**

Year	y_C	y_G	y_I	y_X	y_M
1960	7,635	1,279	3,810	2,151	-2,500
1961	7,784	1,324	4,009	2,258	-2,813
1962	7,957	1,365	4,050	2,565	-2,412
1963	8,417	1,438	4,349	2,508	-2,830
1964	9,034	1,527	5,144	2,921	-3,148
1965	9,490	1,666	5,002	2,913	-3,748
1966	9,721	1,860	5,203	2,955	-3,852
1967	10,193	1,991	5,728	3,280	-3,917
1968	10,729	2,218	7,425	3,438	-4,304
1969	11,313	2,240	6,953	3,663	-4,452
1970	12,012	2,379	7,180	4,263	-4,823
1971	12,460	2,489	7,416	4,676	-4,971
1972	12,912	2,537	6,190	5,026	-4,597
1973	13,567	2,612	7,032	5,127	-4,659
1974	14,396	2,760	8,663	4,816	-6,063
1975	14,927	2,988	7,172	5,282	-6,209
1976	15,032	3,302	7,596	5,500	-5,903
1977	15,662	3,326	7,475	5,888	-6,465
1978	15,864	3,419	7,992	6,020	-6,162
1979	16,147	3,532	8,843	6,447	-6,662
1980	16,358	3,625	9,080	6,902	-6,669
1981	16,897	3,803	10,455	6,567	-7,297
1982	17,713	3,824	9,993	6,724	-8,151
1983	17,944	3,971	10,043	6,760	-7,465
1984	18,198	4,163	10,649	7,279	-7,917
1985	18,558	4,502	11,069	8,400	-9,222
1986	19,271	4,723	11,270	8,719	-9,200
1987	19,375	4,878	11,788	9,644	-8,765
1988	20,017	5,010	13,158	10,515	-9,738
1989	20,963	5,284	15,156	10,682	-12,102
1990	22,032	5,323	14,210	11,209	-12,769
1991	22,044	5,471	12,350	12,518	-12,039
1992	22,427	5,665	12,198	13,646	-12,478
1993	22,788	5,733	13,088	14,556	-13,263
1994	23,255	5,741	13,943	15,970	-14,151
1995	24,463	6,003	15,564	16,748	-16,490
1996	25,401	6,200	15,916	18,462	-17,155
1997	26,117	6,360	16,512	20,396	-18,858
1998	27,468	6,817	19,384	21,150	-20,691
1999	28,892	7,111	20,374	21,581	-21,690
2000	30,116	7,359	21,295	23,650	-24,478
2001	30,953	7,442	20,076	25,386	-24,169
2002	31,958	7,521	21,866	25,119	-24,710
2003	33,169	7,777	26,181	24,984	-28,041
2004	35,143	8,041	27,978	25,214	-31,713

Table 3 **Prices indexes of labour, capital services, domestic consumption, single stage and two stage output, 1960–2004**

Year	W_L	W_k	P_D	P_Y	P_{Y2S}
1960	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0294	0.9212	1.0339	1.0265	1.0265
1962	1.0544	1.0784	1.0465	1.0416	1.0416
1963	1.0877	1.0383	1.0562	1.0545	1.0545
1964	1.1628	1.2476	1.0698	1.0873	1.0873
1965	1.2747	0.9900	1.1052	1.1144	1.1144
1966	1.3360	0.9687	1.1347	1.1454	1.1454
1967	1.4357	1.0917	1.1720	1.1831	1.1831
1968	1.5226	1.3755	1.2091	1.2128	1.2129
1969	1.6424	1.2107	1.2401	1.2490	1.2492
1970	1.7968	1.2486	1.2885	1.3006	1.3009
1971	1.9916	1.1719	1.3659	1.3629	1.3632
1972	2.1681	1.0138	1.4602	1.4404	1.4409
1973	2.3690	1.3188	1.5429	1.5698	1.5703
1974	2.8208	1.4002	1.7299	1.7887	1.7889
1975	3.5837	0.9889	2.1032	2.1314	2.1323
1976	4.1963	1.3705	2.4160	2.4232	2.4243
1977	4.7375	1.5371	2.6901	2.6796	2.6808
1978	5.1944	1.7481	2.9252	2.8669	2.8682
1979	5.4254	2.1519	3.1297	3.0670	3.0684
1980	5.9495	2.5219	3.4189	3.3760	3.3775
1981	6.7056	2.7443	3.7738	3.7224	3.7240
1982	7.7935	2.4032	4.1723	4.1184	4.1203
1983	8.9788	2.8699	4.5985	4.5310	4.5331
1984	9.3510	3.4959	4.8693	4.8219	4.8241
1985	9.7986	3.4500	5.1150	5.0433	5.0456
1986	10.4510	3.6944	5.5456	5.3369	5.3394
1987	10.9905	4.5787	5.9944	5.7000	5.7026
1988	11.6330	5.4498	6.3467	6.1444	6.1473
1989	12.4990	5.9138	6.6558	6.6581	6.6612
1990	13.5134	5.2957	7.0471	7.0604	7.0641
1991	14.3305	5.4088	7.4514	7.3900	7.3940
1992	14.8456	5.9896	7.6766	7.5703	7.5744
1993	15.5162	6.1442	7.8374	7.6587	7.6629
1994	15.6322	6.1609	7.8784	7.6534	7.6576
1995	15.8826	6.3258	7.9053	7.7366	7.7408
1996	16.6601	6.6376	8.0427	7.9461	7.9505
1997	17.7214	6.4145	8.0429	8.0125	8.0170
1998	18.1886	7.2341	8.1223	8.0922	8.0967
1999	19.1044	6.8199	8.1740	8.0293	8.0338
2000	19.7110	6.9870	8.3009	8.2575	8.2620
2001	20.6324	7.2646	8.5984	8.6101	8.6146
2002	21.6551	7.6072	8.7427	8.8025	8.8070
2003	22.6363	7.9266	8.8970	9.0286	9.0331
2004	23.5199	8.3542	9.0286	9.3965	9.4012

Table 4 **Quantities of labour, capital services, domestic consumption, single stage and two stage output, 1960–2004 ($1960m)**

Year	X_L	X_K	y_D	y_Y	y_{Y2S}
1960	8,286	4,089	12,724	12,375	12,375
1961	8,684	4,296	13,118	12,564	12,564
1962	8,720	4,508	13,372	13,495	13,495
1963	8,950	4,716	14,205	13,876	13,876
1964	9,155	4,943	15,701	15,462	15,462
1965	9,371	5,222	16,161	15,359	15,358
1966	9,665	5,511	16,798	15,936	15,935
1967	9,835	5,804	17,923	17,290	17,290
1968	10,038	6,102	20,368	19,522	19,521
1969	10,225	6,490	20,517	19,737	19,733
1970	10,451	6,838	21,590	21,003	20,999
1971	10,840	7,184	22,389	22,018	22,013
1972	11,049	7,554	21,723	21,946	21,939
1973	11,214	7,845	23,261	23,513	23,506
1974	11,547	8,125	25,797	24,570	24,566
1975	12,077	8,599	25,206	24,296	24,285
1976	11,911	8,901	26,124	25,660	25,648
1977	11,736	9,197	26,648	26,024	26,013
1978	11,846	9,459	27,457	27,231	27,219
1979	12,174	9,736	28,681	28,365	28,353
1980	12,364	10,091	29,230	29,327	29,314
1981	12,641	10,403	31,272	30,442	30,429
1982	12,582	10,859	31,667	30,147	30,133
1983	12,161	11,372	32,138	31,303	31,288
1984	12,310	11,760	33,204	32,398	32,383
1985	12,881	12,153	34,395	33,341	33,325
1986	13,336	12,610	35,575	34,843	34,827
1987	13,673	13,089	36,357	36,878	36,861
1988	14,123	13,553	38,423	38,758	38,740
1989	14,623	14,074	41,537	39,953	39,934
1990	15,180	14,723	41,815	40,098	40,077
1991	14,958	15,290	40,359	40,198	40,176
1992	14,703	15,587	40,872	41,166	41,144
1993	14,682	15,780	42,082	42,405	42,382
1994	15,166	16,052	43,294	43,899	43,875
1995	15,686	16,358	46,250	45,577	45,552
1996	16,077	16,841	47,777	47,777	47,750
1997	15,989	17,368	49,227	49,268	49,241
1998	16,334	17,984	53,554	52,790	52,760
1999	16,437	18,772	56,244	55,054	55,024
2000	16,845	19,544	58,605	56,748	56,716
2001	17,110	20,385	58,654	58,201	58,170
2002	17,059	21,063	61,225	60,169	60,138
2003	17,357	21,727	66,148	62,592	62,561
2004	17,609	22,601	69,993	64,169	64,137

Table 5 **Decomposition of market sector real income growth into translog Productivity, real output price change and input quantity contributions factors**

Year	γ^t	τ^t	$\alpha_D{}^t$	$\alpha_X{}^t$	$\alpha_M{}^t$	$\beta_L{}^t$	$\beta_K{}^t$	$\alpha_T{}^t$
1961	1.0058	0.9680	0.9977	0.9874	1.0056	1.0325	1.0159	0.9929
1962	1.0839	1.0545	1.0067	0.9996	1.0027	1.0027	1.0159	1.0023
1963	1.0292	0.9953	0.9979	1.0033	0.9998	1.0174	1.0154	1.0032
1964	1.1369	1.0802	1.0023	1.0137	1.0042	1.0148	1.0166	1.0179
1965	0.9861	0.9602	1.0006	0.9882	1.0039	1.0157	1.0186	0.9921
1966	1.0356	0.9991	0.9969	0.9974	1.0039	1.0220	1.0161	1.0012
1967	1.0899	1.0553	1.0047	0.9954	1.0045	1.0122	1.0157	0.9999
1968	1.1174	1.0954	0.9958	0.9909	1.0029	1.0138	1.0167	0.9938
1969	1.0139	0.9782	0.9988	0.9996	1.0045	1.0123	1.0210	1.0041
1970	1.0667	1.0312	1.0002	1.0018	1.0004	1.0151	1.0167	1.0022
1971	1.0380	1.0069	1.0017	0.9857	1.0028	1.0261	1.0147	0.9885
1972	0.9915	0.9700	1.0063	0.9964	0.9922	1.0142	1.0132	0.9886
1973	1.1019	1.0493	0.9972	1.0249	1.0063	1.0110	1.0099	1.0314
1974	1.0627	1.0133	1.0008	1.0126	1.0036	1.0216	1.0095	1.0162
1975	0.9937	0.9431	1.0258	0.9971	0.9824	1.0361	1.0121	0.9796
1976	1.0479	1.0616	1.0026	0.9864	1.0034	0.9887	1.0062	0.9897
1977	1.0075	1.0196	1.0003	1.0007	0.9924	0.9882	1.0066	0.9931
1978	1.0259	1.0326	0.9964	0.9908	0.9932	1.0075	1.0058	0.9840
1979	1.0312	1.0133	0.9898	1.0049	0.9954	1.0213	1.0066	1.0002
1980	1.0379	1.0129	0.9962	1.0219	0.9861	1.0117	1.0090	1.0077
1981	1.0393	1.0131	1.0024	0.9958	1.0031	1.0167	1.0078	0.9989
1982	1.0005	0.9841	1.0101	0.9869	1.0135	0.9964	1.0100	1.0002
1983	1.0363	1.0555	0.9998	0.9956	1.0027	0.9738	1.0102	0.9982
1984	1.0297	1.0171	0.9895	0.9961	1.0094	1.0092	1.0083	1.0054
1985	1.0216	0.9866	0.9969	1.0035	0.9924	1.0343	1.0085	0.9958
1986	1.0200	1.0089	1.0000	0.9932	0.9828	1.0263	1.0093	0.9761
1987	1.0381	1.0289	0.9923	0.9879	1.0005	1.0185	1.0100	0.9884
1988	1.0516	1.0168	0.9823	0.9987	1.0201	1.0230	1.0104	1.0187
1989	1.0546	0.9946	0.9898	0.9986	1.0350	1.0243	1.0118	1.0336
1990	1.0124	0.9646	1.0075	0.9994	1.0019	1.0267	1.0134	1.0013
1991	0.9805	1.0027	0.9877	0.9797	1.0108	0.9894	1.0105	0.9902
1992	1.0060	1.0310	0.9878	0.9839	1.0108	0.9878	1.0056	0.9945
1993	1.0189	1.0273	0.9981	1.0014	0.9896	0.9990	1.0037	0.9910
1994	1.0282	1.0068	0.9991	0.9946	0.9996	1.0231	1.0051	0.9941
1995	1.0399	1.0082	0.9940	0.9992	1.0084	1.0241	1.0056	1.0076
1996	1.0531	1.0214	0.9950	1.0007	1.0090	1.0176	1.0086	1.0097
1997	1.0260	1.0261	0.9866	0.9860	1.0228	0.9961	1.0089	1.0084
1998	1.0628	1.0447	0.9917	1.0064	0.9938	1.0152	1.0103	1.0002
1999	1.0336	1.0251	1.0054	0.9903	0.9954	1.0045	1.0128	0.9858
2000	1.0392	1.0012	0.9953	1.0020	1.0109	1.0175	1.0118	1.0129
2001	1.0290	1.0019	0.9967	1.0262	0.9810	1.0111	1.0124	1.0067
2002	1.0345	1.0259	0.9952	0.9959	1.0096	0.9979	1.0098	1.0055
2003	1.0441	1.0181	0.9957	0.9867	1.0216	1.0121	1.0095	1.0080
2004	1.0503	1.0028	0.9988	0.9846	1.0417	1.0100	1.0123	1.0256
Average	1.0376	1.0149	0.9981	0.9975	1.0036	1.0123	1.0111	1.0010

Table 6 **Decomposition of market sector real income levels into translog Productivity, real output price change and input quantity contributions factors**

Year	ρ^t/ρ^0	T^t	A_D^t	A_X^t	A_M^t	B_L^t	B_K^t	A_T^t
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0058	0.9680	0.9977	0.9874	1.0056	1.0325	1.0159	0.9929
1962	1.0901	1.0207	1.0044	0.9869	1.0084	1.0353	1.0320	0.9952
1963	1.1219	1.0158	1.0023	0.9902	1.0082	1.0533	1.0479	0.9983
1964	1.2756	1.0973	1.0046	1.0037	1.0125	1.0689	1.0653	1.0163
1965	1.2578	1.0536	1.0052	0.9919	1.0164	1.0856	1.0851	1.0082
1966	1.3025	1.0527	1.0020	0.9893	1.0203	1.1095	1.1026	1.0094
1967	1.4197	1.1109	1.0067	0.9848	1.0249	1.1230	1.1200	1.0093
1968	1.5863	1.2169	1.0025	0.9758	1.0279	1.1385	1.1387	1.0030
1969	1.6084	1.1904	1.0012	0.9754	1.0326	1.1525	1.1626	1.0072
1970	1.7156	1.2275	1.0014	0.9771	1.0330	1.1698	1.1820	1.0094
1971	1.7808	1.2359	1.0031	0.9632	1.0359	1.2003	1.1994	0.9978
1972	1.7657	1.1988	1.0093	0.9597	1.0279	1.2173	1.2152	0.9864
1973	1.9457	1.2579	1.0065	0.9836	1.0344	1.2308	1.2273	1.0174
1974	2.0678	1.2746	1.0073	0.9960	1.0381	1.2573	1.2389	1.0339
1975	2.0546	1.2021	1.0333	0.9931	1.0198	1.3027	1.2539	1.0128
1976	2.1532	1.2761	1.0359	0.9796	1.0233	1.2879	1.2617	1.0024
1977	2.1693	1.3011	1.0362	0.9803	1.0155	1.2728	1.2700	0.9954
1978	2.2255	1.3435	1.0325	0.9712	1.0085	1.2823	1.2774	0.9795
1979	2.2949	1.3614	1.0219	0.9759	1.0039	1.3096	1.2858	0.9797
1980	2.3818	1.3789	1.0180	0.9974	0.9899	1.3249	1.2973	0.9873
1981	2.4755	1.3970	1.0204	0.9932	0.9929	1.3470	1.3074	0.9862
1982	2.4767	1.3747	1.0307	0.9802	1.0063	1.3422	1.3204	0.9864
1983	2.5665	1.4510	1.0304	0.9758	1.0090	1.3071	1.3339	0.9846
1984	2.6426	1.4758	1.0196	0.9720	1.0185	1.3191	1.3450	0.9899
1985	2.6996	1.4560	1.0164	0.9753	1.0107	1.3643	1.3563	0.9858
1986	2.7536	1.4690	1.0164	0.9687	0.9933	1.4003	1.3689	0.9622
1987	2.8584	1.5114	1.0085	0.9569	0.9938	1.4261	1.3826	0.9510
1988	3.0060	1.5368	0.9906	0.9557	1.0137	1.4589	1.3970	0.9688
1989	3.1701	1.5285	0.9806	0.9544	1.0492	1.4943	1.4136	1.0013
1990	3.2094	1.4744	0.9879	0.9537	1.0512	1.5343	1.4324	1.0026
1991	3.1468	1.4784	0.9757	0.9343	1.0626	1.5180	1.4475	0.9928
1992	3.1657	1.5241	0.9638	0.9192	1.0740	1.4996	1.4556	0.9873
1993	3.2254	1.5658	0.9621	0.9205	1.0629	1.4980	1.4609	0.9784
1994	3.3164	1.5764	0.9612	0.9155	1.0624	1.5326	1.4684	0.9726
1995	3.4486	1.5893	0.9555	0.9148	1.0712	1.5695	1.4765	0.9800
1996	3.6316	1.6233	0.9507	0.9155	1.0808	1.5971	1.4892	0.9894
1997	3.7259	1.6657	0.9379	0.9026	1.1055	1.5909	1.5025	0.9978
1998	3.9598	1.7402	0.9302	0.9084	1.0986	1.6150	1.5179	0.9979
1999	4.0929	1.7839	0.9351	0.8996	1.0936	1.6222	1.5374	0.9838
2000	4.2532	1.7860	0.9308	0.9014	1.1055	1.6506	1.5555	0.9964
2001	4.3766	1.7894	0.9277	0.9250	1.0845	1.6690	1.5749	1.0031
2002	4.5278	1.8358	0.9232	0.9212	1.0949	1.6654	1.5903	1.0086
2003	4.7272	1.8691	0.9192	0.9090	1.1185	1.6856	1.6054	1.0167
2004	4.9648	1.8743	0.9181	0.8950	1.1651	1.7025	1.6251	1.0428

Figure 1 **Contributions of productivity, terms of trade, real output price change and input quantity factors to market sector real income levels**

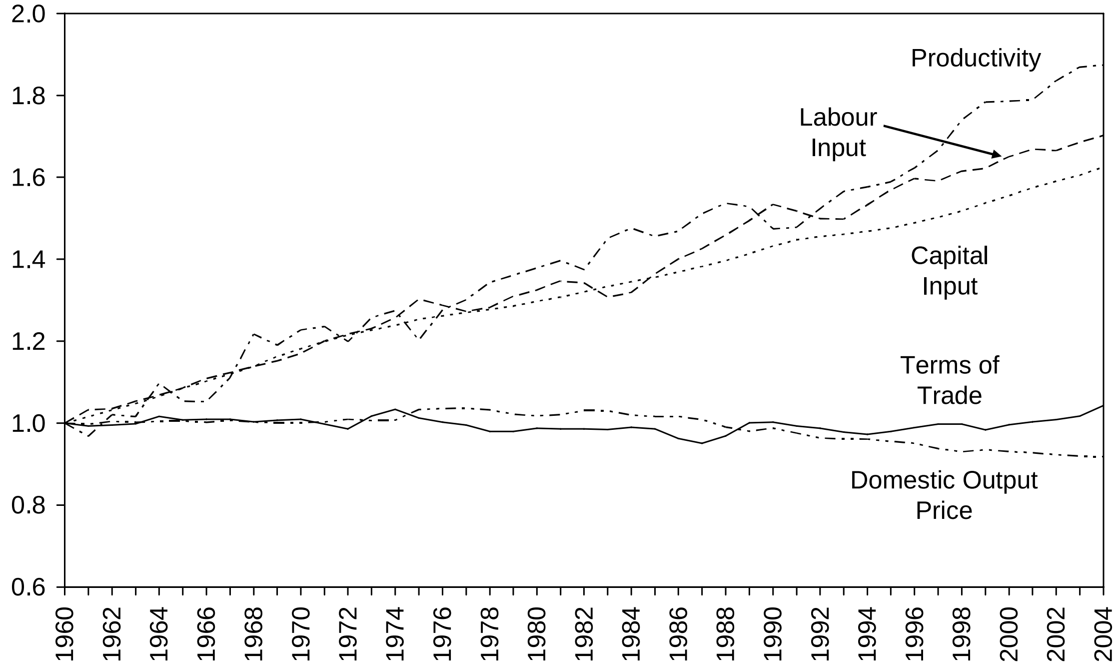
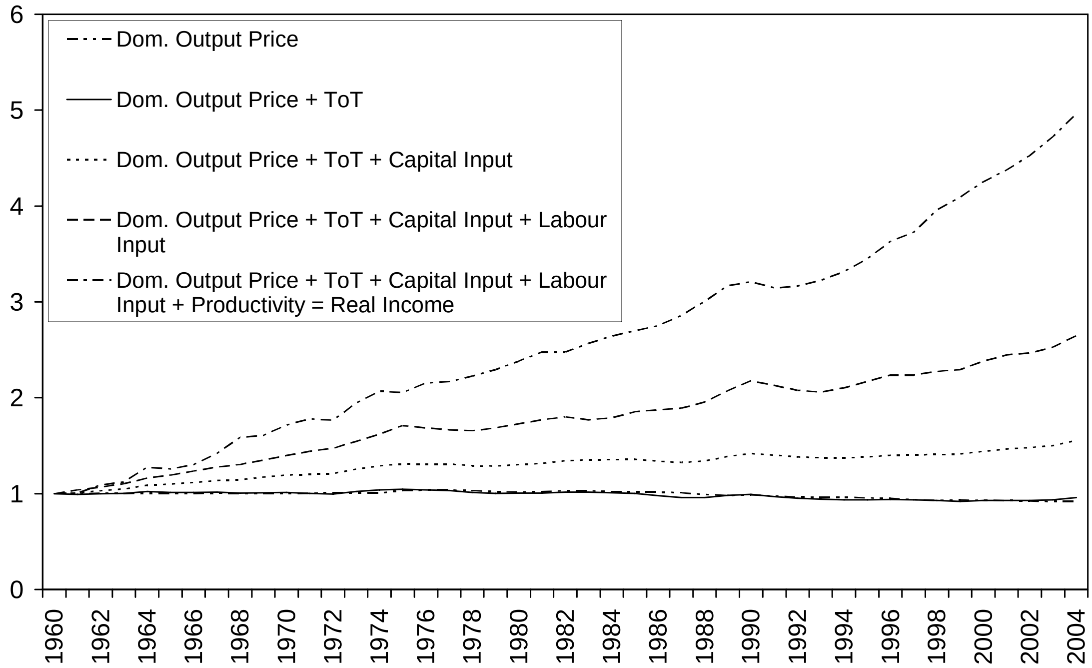


Figure 2 **Cumulative contributions of productivity, terms of trade, real output price change and input quantity factors to market sector real income levels**



From Tables 3 and 4, it can be seen that the single stage and two stage chained Törnqvist GDP aggregates are very close to each other; this is typical for a superlative index number formula.[31] Hence, in what follows, we will implement equations (46)–(54) in section 4 above using the aggregated data listed in the above tables rather than using the original disaggregated data set that consisted of 32 output and input components.

The chain link information on period by period changes in real income that corresponds to (42) (generalised to include separate contribution factors for changes in real domestic, export and import prices, α_D^t, α_X^t and α_M^t respectively and separate contribution factors for growth in labour and capital input, β_L^t and β_K^t respectively) is given in Table 5 below. The last column in Table 5, α_T^t, is the contribution factor for *real changes in the terms of trade* and is simply the product of the export and import price factors, α_X^t and α_M^t.

From the average contribution factors listed in the last row of Table 5, it can be seen that real market sector income in Australia grew at an average annual rate of 3.76 per cent per year. Productivity growth accounted for 1.48 per cent of this growth, labour input growth for 1.23 per cent and capital input 1.11 per cent of this growth on average while the real price effects were negligible on average.

The annual change information in Table 5 can be converted into levels using equations (46) (with obvious extensions to multiple inputs and outputs).[32] Table 6 and Figure 1 give this levels information.

Thus, over the 45 year period, real income ρ^t/ρ^0 (from the gross domestic product point of view) grew almost fivefold (4.9648 times), which is very respectable growth. From Table 6 and Figure 1, it can be seen that productivity growth T^t contributes the most to the overall growth in market sector real income (the growth factor is 1.874), the growth in labour input B_L^t makes the next largest contribution (the growth factor is 1.702) followed closely by the growth in capital service input B_K^t (the growth factor is 1.625) while the change in domestic real prices A_D^t makes a small negative contribution (.918) as does the growth in real export prices A_X^t (.895) and the change in import prices A_M^t makes a modest positive contribution (1.165). The terms of trade cumulated contribution factor grows from 0.9838 in 1999 to 1.0428 in 2004, which represents a six percent increase in real income due to favourable changes in real export and import prices. All of the improvement comes from declining import prices.

31 See Diewert (1978) for a theoretical justification for this empirical result.

32 The last column in Table 6 denoted by A_T^t is the cumulative effect of changes in the real prices of exports and imports and is equal to the product of the entries denoted by A_X^t and A_M^t.

An alternative way of presenting the information in Table 6 and Figure 1 is to progressively cumulate the individual contributors up to market sector real income. Given the logarithmic form of the indexes, this is done by progressively multiplying the levels indexes together. These cumulative effects are presented in Figure 2. The bottom dashed line in Figure 2 shows how market sector real income would have changed if there had only been the observed change in real consumption prices and all else had remained unchanged. The solid line near the bottom of Figure 2 shows how market sector real income would have changed if there had only been the observed change in real consumption prices and the terms of trade and all else had remained unchanged. In this case, because the terms of trade impact is quite small, it is difficult to distinguish these two lines. We next add in the observed growth in the capital stock (but assume labour and productivity remain unchanged) to give us the third line from the bottom, and so on. The cumulated line at the top of Figure 2 now equates to the actual level of market sector real income observed over the period.

By comparing the ‘wedges’ between the progressive cumulative component lines in Figure 2 we have another way of observing the relative contributions of the components to market sector real income. Thus, in this case, we have the largest wedge or increment to real income from productivity growth, the second largest from labour force growth and the third largest from capital stock growth. The terms of trade makes only a very small contribution to real income growth over the period.

We turn now to our second approach to the determination of factors that explain the growth in real income for Australia.

7 Deflated GDP first order approximation approach for Australia

In this section, the disaggregated Diewert and Lawrence modified database was aggregated using Fisher chained indexes. The resulting price and quantity data for domestic production D = C + G + I, exports X and minus imports − M are listed in Tables 7 (prices) and 8 (quantities) below along with the corresponding labour L and capital services K inputs. In particular, the 13 investment aggregates were aggregated in this section using a chained Fisher price index in place of the chained Törnqvist price index used in the previous section. The differences in the resulting aggregates are small.[33] The prices listed in Table 7 (with the exception of the first column) are prices that were deflated by the price of consumption P_C, which is also listed as the first column in Table 7.

[33] The price of consumption, P_C, is the same as in the previous section.

The Fisher quantity indexes for the three net outputs (y_D, y_X and y_M) and the two primary inputs (x_L and x_K) are listed in the first 5 columns of Table 8. Year t real market sector income, $\rho^t = p_D{}^t y_D{}^t + p_X{}^t y_X{}^t + p_M{}^t y_M{}^t$, is listed in column 6 and for interest, Australia's real trade balance, $y_T{}^t \equiv p_X{}^t y_X{}^t + p_M{}^t y_M{}^t = (P_X{}^t y_X{}^t + P_M{}^t y_M{}^t)/P_C{}^t$, is listed in the last column. Note that the real trade balance is negative for all years except 1962, 1964 and 1973 and is sometimes substantially negative.

The chain link information on period by period changes in real income that corresponds to the average of the first order approximations model defined by (28), (61), (70) and (73) (generalised to include separate contribution factors for changes in real domestic, export and import prices, $\alpha_D{}^t$, $\alpha_X{}^t$ and $\alpha_M{}^t$, respectively, and separate contribution factors for growth in labour and capital input, $\beta_L{}^t$ and $\beta_K{}^t$, respectively) is given in Table 9 below. The last column in Table 9, $\alpha_T{}^t$, is the contribution factor for *real changes in the terms of trade* and is formed in a manner analogous to (68)–(70), except that there are three terms in the numerator of (68), representing changes in real export and import prices, and three terms in the denominator of (69), in place of two terms in (68) and (69). In this average of first order approximation approach, it is not necessarily the case that $\alpha_X{}^t$ times $\alpha_M{}^t$ equals exactly $\alpha_T{}^t$ or that γ^t equals exactly the product $\tau^t\ \alpha_D{}^t\ \alpha_X{}^t\ \alpha_M{}^t\ \beta_L{}^t\ \beta_K{}^t$, but it turns out empirically, these equalities are very close to being satisfied exactly; ie they are satisfied to 4 significant digits.

Comparing the year by year entries in Tables 5 (translog approach) and 9 (average of first order approximations approach) and the corresponding averages, we see that the two Tables are virtually identical. *Thus both approaches lead to the same empirical results*.

The annual change information in the previous table can be converted into cumulative changes using equations (46) (with obvious extensions to multiple inputs and outputs). Table 10 gives this levels growth information and it is the first order approximation counterpart to Table 6 above, which gave the same information using the translog approach.

In the following section, we note an important limitation of both the translog and first order approximation approaches as indicators of household welfare change.

Table 7 **Market sector deflated chained Fisher Price indexes for Australia, 1960–2004**

Year	P_C	p_D	p_X	p_M	w_L	w_K
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0362	0.9978	0.9283	0.9737	0.9934	0.8891
1962	1.0420	1.0044	0.9259	0.9602	1.0120	1.0351
1963	1.0538	1.0022	0.9439	0.9611	1.0321	0.9853
1964	1.0650	1.0045	1.0180	0.9402	1.0918	1.1716
1965	1.0996	1.0051	0.9544	0.9226	1.1592	0.9005
1966	1.1323	1.0021	0.9402	0.9066	1.1799	0.8556
1967	1.1643	1.0066	0.9152	0.8870	1.2330	0.9378
1968	1.2061	1.0025	0.8647	0.8738	1.2624	1.1407
1969	1.2385	1.0015	0.8626	0.8535	1.3261	0.9778
1970	1.2867	1.0017	0.8718	0.8516	1.3965	0.9707
1971	1.3617	1.0033	0.8022	0.8391	1.4626	0.8609
1972	1.4467	1.0095	0.7857	0.8751	1.4986	0.7011
1973	1.5330	1.0065	0.8969	0.8439	1.5453	0.8607
1974	1.7175	1.0072	0.9592	0.8271	1.6425	0.8156
1975	2.0366	1.0332	0.9447	0.9008	1.7596	0.4933
1976	2.3336	1.0358	0.8785	0.8864	1.7982	0.5963
1977	2.5977	1.0361	0.8819	0.9194	1.8237	0.6008
1978	2.8347	1.0324	0.8395	0.9489	1.8324	0.6261
1979	3.0634	1.0220	0.8613	0.9691	1.7711	0.7131
1980	3.3590	1.0181	0.9553	1.0300	1.7712	0.7621
1981	3.6991	1.0205	0.9365	1.0168	1.8128	0.7530
1982	4.0510	1.0303	0.8758	0.9637	1.9239	0.6025
1983	4.4658	1.0300	0.8552	0.9530	2.0106	0.6526
1984	4.7772	1.0196	0.8370	0.9138	1.9574	0.7430
1985	5.0334	1.0165	0.8515	0.9433	1.9467	0.6959
1986	5.4571	1.0164	0.8245	1.0070	1.9151	0.6874
1987	5.9426	1.0089	0.7784	1.0049	1.8494	0.7823
1988	6.4021	0.9915	0.7736	0.9270	1.8171	0.8642
1989	6.7808	0.9814	0.7686	0.8058	1.8433	0.8854
1990	7.1283	0.9886	0.7663	0.7998	1.8957	0.7543
1991	7.6285	0.9768	0.6981	0.7657	1.8785	0.7199
1992	7.9551	0.9650	0.6494	0.7316	1.8662	0.7645
1993	8.1367	0.9632	0.6532	0.7637	1.9069	0.7667
1994	8.1864	0.9624	0.6388	0.7650	1.9095	0.7641
1995	8.2625	0.9567	0.6369	0.7423	1.9223	0.7773
1996	8.4476	0.9520	0.6386	0.7191	1.9722	0.7977
1997	8.5616	0.9393	0.6054	0.6620	2.0699	0.7605
1998	8.7176	0.9316	0.6201	0.6771	2.0864	0.8423
1999	8.7276	0.9364	0.5974	0.6878	2.1890	0.7931
2000	8.9031	0.9321	0.6019	0.6636	2.2140	0.7964
2001	9.2524	0.9290	0.6582	0.7057	2.2299	0.7968
2002	9.4525	0.9246	0.6492	0.6841	2.2909	0.8166
2003	9.6603	0.9206	0.6188	0.6377	2.3432	0.8326
2004	9.8142	0.9195	0.5817	0.5556	2.3965	0.8637

Table 8 **Market Sector chained Fisher quantity indexes for Australia, 1960–2004**

Year	y_D	y_X	y_M	x_L	x_K	ρ^t	y_T
1960	12,724	2,151	-2,500	8,286	4,089	12,375	-349
1961	13,118	2,258	-2,813	8,684	4,295	12,564	-620
1962	13,372	2,565	-2,412	8,720	4,508	13,495	57
1963	14,205	2,508	-2,830	8,950	4,715	13,876	-334
1964	15,701	2,921	-3,148	9,155	4,942	15,463	13
1965	16,161	2,913	-3,748	9,371	5,222	15,360	-617
1966	16,798	2,955	-3,852	9,665	5,510	15,937	-630
1967	17,923	3,280	-3,917	9,835	5,803	17,291	-406
1968	20,368	3,438	-4,304	10,038	6,101	19,524	-653
1969	20,512	3,663	-4,452	10,225	6,488	19,733	-517
1970	21,585	4,263	-4,823	10,451	6,837	20,999	-304
1971	22,384	4,676	-4,971	10,840	7,182	22,014	-309
1972	21,718	5,026	-4,597	11,049	7,550	21,942	-51
1973	23,261	5,127	-4,659	11,214	7,841	23,513	435
1974	25,797	4,816	-6,063	11,547	8,121	24,570	-230
1975	25,193	5,282	-6,209	12,077	8,464	24,284	-296
1976	26,111	5,500	-5,903	11,911	8,766	25,647	-172
1977	26,635	5,888	-6,465	11,736	9,058	26,011	-289
1978	27,444	6,020	-6,162	11,846	9,317	27,219	-280
1979	28,671	6,447	-6,662	12,174	9,590	28,356	-295
1980	29,221	6,902	-6,669	12,364	9,942	29,319	-82
1981	31,263	6,567	-7,297	12,641	10,249	30,435	-343
1982	31,657	6,724	-8,151	12,582	10,693	30,139	-485
1983	32,128	6,760	-7,465	12,161	11,199	31,295	-298
1984	33,195	7,279	-7,917	12,310	11,582	32,391	-239
1985	34,387	8,400	-9,222	12,881	11,969	33,334	-307
1986	35,568	8,719	-9,200	13,336	12,419	34,838	-380
1987	36,351	9,644	-8,765	13,673	12,892	36,874	-219
1988	38,419	10,515	-9,738	14,123	13,349	38,755	-139
1989	41,545	10,682	-12,102	14,623	13,864	39,953	-227
1990	41,815	11,209	-12,769	15,180	14,501	40,090	-228
1991	40,358	12,518	-12,039	14,958	15,059	40,190	-63
1992	40,871	13,646	-12,478	14,703	15,352	41,158	-33
1993	42,081	14,556	-13,263	14,682	15,542	42,396	-76
1994	43,293	15,970	-14,151	15,166	15,809	43,890	-76
1995	46,251	16,748	-16,490	15,686	16,111	45,570	-191
1996	47,779	18,462	-17,155	16,077	16,589	47,770	-65
1997	49,233	20,396	-18,858	15,989	17,110	49,265	-16
1998	53,563	21,150	-20,691	16,334	17,718	52,788	-103
1999	56,254	21,581	-21,690	16,437	18,496	55,054	-232
2000	58,624	23,650	-24,478	16,845	19,259	56,755	-226
2001	58,674	25,386	-24,169	17,110	20,088	58,212	-38
2002	61,246	25,119	-24,710	17,059	20,757	60,181	-63
2003	66,175	24,984	-28,041	17,357	21,413	62,605	-251
2004	70,027	25,214	-31,713	17,609	22,276	64,182	-301

Table 9 **Decomposition of market sector real income growth into approximate productivity, real output price change and input quantity contribution factors**

Year	γ^t	τ^t	$\alpha_D{}^t$	α_X	α_M	$\beta_L{}^t$	$\beta_K{}^t$	$\alpha_T{}^t$
1961	1.0058	0.9680	0.9977	0.9874	1.0056	1.0325	1.0159	0.9929
1962	1.0839	1.0545	1.0067	0.9996	1.0027	1.0027	1.0159	1.0023
1963	1.0292	0.9953	0.9979	1.0033	0.9998	1.0174	1.0154	1.0032
1964	1.1369	1.0802	1.0023	1.0137	1.0042	1.0148	1.0166	1.0179
1965	0.9861	0.9602	1.0006	0.9882	1.0039	1.0157	1.0186	0.9921
1966	1.0356	0.9992	0.9969	0.9974	1.0039	1.0220	1.0161	1.0012
1967	1.0899	1.0553	1.0047	0.9954	1.0045	1.0122	1.0157	0.9999
1968	1.1174	1.0954	0.9958	0.9909	1.0029	1.0138	1.0167	0.9938
1969	1.0139	0.9779	0.9990	0.9996	1.0045	1.0123	1.0210	1.0041
1970	1.0667	1.0312	1.0002	1.0018	1.0004	1.0151	1.0167	1.0022
1971	1.0380	1.0069	1.0017	0.9857	1.0028	1.0261	1.0147	0.9885
1972	0.9915	0.9700	1.0063	0.9964	0.9922	1.0142	1.0132	0.9886
1973	1.1019	1.0495	0.9970	1.0249	1.0063	1.0110	1.0099	1.0314
1974	1.0627	1.0133	1.0008	1.0126	1.0036	1.0216	1.0095	1.0162
1975	0.9937	0.9457	1.0263	0.9971	0.9824	1.0361	1.0088	0.9796
1976	1.0479	1.0615	1.0025	0.9864	1.0034	0.9887	1.0063	0.9897
1977	1.0075	1.0196	1.0003	1.0007	0.9924	0.9882	1.0066	0.9931
1978	1.0259	1.0326	0.9964	0.9908	0.9932	1.0075	1.0059	0.9840
1979	1.0312	1.0134	0.9896	1.0049	0.9954	1.0213	1.0066	1.0002
1980	1.0379	1.0129	0.9961	1.0219	0.9861	1.0117	1.0090	1.0077
1981	1.0393	1.0131	1.0024	0.9958	1.0031	1.0167	1.0078	0.9989
1982	1.0005	0.9841	1.0101	0.9869	1.0135	0.9964	1.0099	1.0002
1983	1.0363	1.0555	0.9998	0.9956	1.0027	0.9738	1.0102	0.9982
1984	1.0297	1.0171	0.9894	0.9961	1.0094	1.0092	1.0083	1.0054
1985	1.0216	0.9866	0.9968	1.0034	0.9924	1.0343	1.0085	0.9958
1986	1.0200	1.0090	0.9999	0.9932	0.9828	1.0263	1.0093	0.9761
1987	1.0381	1.0289	0.9922	0.9879	1.0005	1.0185	1.0100	0.9884
1988	1.0516	1.0168	0.9822	0.9987	1.0201	1.0230	1.0104	1.0187
1989	1.0546	0.9946	0.9895	0.9986	1.0353	1.0243	1.0119	1.0339
1990	1.0124	0.9645	1.0077	0.9994	1.0019	1.0267	1.0133	1.0013
1991	0.9805	1.0027	0.9877	0.9796	1.0108	0.9894	1.0105	0.9902
1992	1.0060	1.0310	0.9878	0.9839	1.0108	0.9878	1.0056	0.9945
1993	1.0189	1.0274	0.9981	1.0014	0.9896	0.9990	1.0037	0.9910
1994	1.0282	1.0068	0.9991	0.9946	0.9996	1.0231	1.0051	0.9941
1995	1.0399	1.0082	0.9940	0.9992	1.0084	1.0241	1.0056	1.0076
1996	1.0531	1.0214	0.9950	1.0007	1.0090	1.0176	1.0086	1.0097
1997	1.0260	1.0261	0.9865	0.9860	1.0229	0.9961	1.0090	1.0085
1998	1.0628	1.0448	0.9917	1.0064	0.9938	1.0152	1.0103	1.0002
1999	1.0336	1.0251	1.0053	0.9903	0.9954	1.0045	1.0128	0.9858
2000	1.0392	1.0013	0.9952	1.0020	1.0109	1.0175	1.0118	1.0129
2001	1.0290	1.0019	0.9966	1.0262	0.9810	1.0111	1.0124	1.0067
2002	1.0345	1.0259	0.9952	0.9959	1.0096	0.9979	1.0098	1.0055
2003	1.0441	1.0181	0.9956	0.9867	1.0216	1.0121	1.0095	1.0081
2004	1.0503	1.0026	0.9987	0.9846	1.0418	1.0100	1.0123	1.0258
Average	1.0376	1.0149	0.9981	0.9975	1.0036	1.0123	1.0111	1.0010

Table 10 **Decomposition of market sector real income levels into approximate productivity, real output price change and input quantity contribution factors**

Year	ρ^t/ρ^0	T^t	$A_D{}^t$	$A_X{}^t$	$A_M{}^t$	$B_L{}^t$	$B_K{}^t$	$A_T{}^t$
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0058	0.9680	0.9977	0.9874	1.0056	1.0325	1.0159	0.9929
1962	1.0901	1.0207	1.0044	0.9869	1.0084	1.0353	1.0320	0.9952
1963	1.1219	1.0159	1.0023	0.9902	1.0082	1.0533	1.0479	0.9983
1964	1.2756	1.0973	1.0046	1.0037	1.0125	1.0689	1.0653	1.0162
1965	1.2578	1.0536	1.0052	0.9919	1.0164	1.0856	1.0851	1.0082
1966	1.3025	1.0527	1.0020	0.9893	1.0203	1.1095	1.1026	1.0094
1967	1.4197	1.1110	1.0067	0.9847	1.0249	1.1230	1.1199	1.0093
1968	1.5863	1.2170	1.0024	0.9758	1.0279	1.1385	1.1387	1.0030
1969	1.6084	1.1902	1.0015	0.9754	1.0326	1.1525	1.1625	1.0072
1970	1.7156	1.2273	1.0016	0.9771	1.0330	1.1698	1.1819	1.0094
1971	1.7808	1.2357	1.0033	0.9632	1.0360	1.2003	1.1993	0.9978
1972	1.7657	1.1987	1.0096	0.9597	1.0279	1.2174	1.2151	0.9864
1973	1.9457	1.2580	1.0065	0.9836	1.0343	1.2308	1.2271	1.0174
1974	2.0678	1.2747	1.0073	0.9960	1.0381	1.2574	1.2388	1.0339
1975	2.0546	1.2054	1.0338	0.9931	1.0198	1.3027	1.2498	1.0128
1976	2.1532	1.2796	1.0365	0.9796	1.0233	1.2880	1.2577	1.0024
1977	2.1693	1.3047	1.0367	0.9803	1.0155	1.2728	1.2659	0.9955
1978	2.2255	1.3472	1.0330	0.9712	1.0086	1.2823	1.2733	0.9795
1979	2.2949	1.3653	1.0222	0.9760	1.0039	1.3096	1.2817	0.9798
1980	2.3818	1.3828	1.0183	0.9974	0.9899	1.3250	1.2932	0.9873
1981	2.4755	1.4010	1.0207	0.9932	0.9930	1.3471	1.3033	0.9862
1982	2.4767	1.3788	1.0310	0.9802	1.0064	1.3422	1.3161	0.9864
1983	2.5665	1.4553	1.0307	0.9758	1.0090	1.3071	1.3296	0.9846
1984	2.6426	1.4802	1.0199	0.9720	1.0185	1.3191	1.3406	0.9900
1985	2.6996	1.4604	1.0166	0.9753	1.0108	1.3644	1.3520	0.9858
1986	2.7536	1.4735	1.0166	0.9687	0.9934	1.4003	1.3645	0.9622
1987	2.8584	1.5161	1.0087	0.9569	0.9939	1.4262	1.3782	0.9510
1988	3.0060	1.5415	0.9907	0.9557	1.0138	1.4589	1.3926	0.9688
1989	3.1701	1.5332	0.9804	0.9543	1.0496	1.4944	1.4091	1.0016
1990	3.2094	1.4787	0.9879	0.9537	1.0516	1.5343	1.4279	1.0029
1991	3.1468	1.4826	0.9758	0.9343	1.0629	1.5181	1.4429	0.9930
1992	3.1657	1.5285	0.9639	0.9192	1.0744	1.4996	1.4509	0.9875
1993	3.2254	1.5703	0.9621	0.9205	1.0632	1.4981	1.4563	0.9786
1994	3.3164	1.5809	0.9612	0.9155	1.0627	1.5327	1.4637	0.9728
1995	3.4486	1.5939	0.9554	0.9148	1.0716	1.5696	1.4718	0.9802
1996	3.6316	1.6280	0.9506	0.9154	1.0812	1.5971	1.4845	0.9897
1997	3.7259	1.6706	0.9378	0.9026	1.1059	1.5909	1.4978	0.9981
1998	3.9598	1.7453	0.9300	0.9084	1.0990	1.6150	1.5132	0.9982
1999	4.0929	1.7892	0.9350	0.8996	1.0940	1.6222	1.5327	0.9840
2000	4.2532	1.7915	0.9305	0.9013	1.1059	1.6507	1.5508	0.9967
2001	4.3766	1.7949	0.9273	0.9249	1.0849	1.6690	1.5701	1.0034
2002	4.5278	1.8415	0.9229	0.9212	1.0953	1.6655	1.5855	1.0089
2003	4.7272	1.8748	0.9188	0.9089	1.1190	1.6857	1.6006	1.0170
2004	4.9648	1.8798	0.9177	0.8950	1.1658	1.7026	1.6202	1.0432

8 The deflated NDP translog approach

There is a potential shortcoming with the analysis presented in the previous sections. The problem is that depreciation payments are part of the user cost of capital for each asset but depreciation does not provide households with any sustainable purchasing power. Hence our real income measure defined by (5) above is overstated.

To see why Gross Domestic Product overstates income, consider the model of production that is described by the following quotations:

> We must look at the production process during a period of time, with a beginning and an end. It starts, at the commencement of the Period, with an Initial Capital Stock; to this there is applied a Flow Input of labour, and from it there emerges a Flow Output called Consumption; then there is a Closing Stock of Capital left over at the end. If Inputs are the things that are put in, the Outputs are the things that are got out, and the production of the Period is considered in isolation, then the Initial Capital Stock is an Input. A Stock Input to the Flow Input of labour; and further (what is less well recognized in the tradition, but is equally clear when we are strict with translation), the Closing Capital Stock is an Output, a Stock Output to match the Flow Output of Consumption Goods. Both input and output have stock and flow components; capital appears both as input and as output. (Hicks 1961, p. 23)

> The business firm can be viewed as a receptacle into which factors of production, or inputs, flow and out of which outputs flow ... The total of the inputs with which the firm can work within the time period specified includes those inherited from the previous period and those acquired during the current period. The total of the outputs of the business firm in the same period includes the amounts of outputs currently sold and the amounts of inputs which are bequeathed to the firm in its succeeding period of activity. (Edwards and Bell 1961, pp. 71–2).

Hicks and Edwards and Bell obviously had the same model of production in mind: in each accounting period, the business unit combines the capital stocks and goods in process that it has inherited from the previous period with 'flow' inputs purchased in the current period (such as labour, materials, services and additional durable inputs) to produce current period 'flow' outputs as well as end of the period depreciated capital stock components which are regarded as outputs from the perspective of the current period (but will be regarded as inputs from the perspective of the next period).[34]

All of the 'flow' inputs that are purchased during the period and all of the 'flow' outputs that are sold during the period are the inputs and outputs that appear in the

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[34] For more on this model of production and additional references to the literature, see the Appendices in Diewert (1977; 1980). The usual user cost of capital can be derived from this framework if depreciation is independent of use.

usual definition of cash flow. These are the flow inputs and outputs that are very familiar to national income accountants. But this is not the end of the story: the firm inherits an endowment of assets at the beginning of the production period and at the end of the period, the firm will have the net profit or loss that has occurred due to its sales of outputs and its purchases of inputs during the period. As well, *it will have a stock of assets that it can use when it starts production in the following period*. Just focusing on the flow transactions that occur within the production period will not give a complete picture of the firm's productive activities. Hence, to get a complete picture of the firm's production activities over the course of a period, it is necessary to add the value of the closing stock of assets less the beginning of the period stock of assets to the cash flow that accrued to the firm from its sales and purchases of market goods and services during the accounting period.

We illustrate the above theory by considering a very simple two output, two input model of the market sector. One of the outputs is output in period t, Y^t and the other output is an investment good, I^t. One of the inputs is the flow of noncapital primary input X^t and the other input is K^t, capital services. Suppose that the average prices during period t of a unit of Y^t, X^t and I^t are P_Y^t, P_X^t and P_I^t , respectively. Suppose further that the interest rate prevailing at the beginning of period t is r^t. The value of the beginning of period t capital stock is assumed to be P_I^t, the investment price for period t. In order to induce households to let the business sector use the initial stock of capital, firms have to pay households interest equal to $r^t P_I^t K^t$. Then neglecting balance sheet items, the market sector's period t *cash flow* is:[35]

(74) $CF^t \equiv P_Y^t Y^t + P_I^t I^t - P_X^t X^t - r^t P_I^t K^t$.

K^t is interpreted as the firm's beginning of period t stock of capital it has at its disposal and its end of period stock of capital is defined to be K^{t+1}. These capital stocks are valued at the balance sheet prices prevailing at the beginning and end of period t, P_I^t and P_I^{t+1} , respectively.

The market sector period t *pure profit* is defined as its cash flow plus the value of its end of period t capital stock less the value of its beginning of period t capital stock:

(75) $\prod^t \equiv CF^t + P_I^{t+1} K^{t+1} - P_I^t K^t$.

Now, the end of period depreciated stock of capital is related to the beginning of the period stock by the following equation:

(76) $K^{t+1} = (1 - \delta)K^t$

where $0 < \delta < 1$ denotes the depreciation rate.

[35] For equity financed firms, we need to include an imputed return for equity capital.

Now substitute (74) and (76) into the definition of pure profits (75) and we obtain the following expression:

$$(77)\ \Pi^t \equiv P_Y{}^t\, Y^t + P_I{}^t\, I^t - P_X{}^t\, X^t - r^t\, P_I{}^t\, K^t + P_I{}^{t+1}(1-\delta)K^t - P_I{}^t\, K^t$$
$$= P_Y{}^t\, Y^t + P_I{}^t\, I^t - P_X{}^t\, X^t - \{r^t\, P_I{}^t + \delta P_I{}^{t+1} - (P_I{}^{t+1} - P_I{}^t)\}K^t.$$

The expression that precedes the capital stock K^t, $\{r^t\, P_I{}^t + \delta P_I{}^{t+1} - (P_I{}^{t+1} - P_I{}^t)\}$, can be recognised as the *user cost of capital*;[36] it is the gross rental price that must be paid to a capitalist in order to induce him or her to loan the services of a unit of the capital stock to the production sector.

Some simplifications for (77) occur if we make two additional assumptions:

- Assume that producers and households expect price level stability so that the end of the period price for a new unit of capital $P_I{}^{t+1}$ is expected to be equal to the beginning of the period price for a new unit of capital $P_I{}^t$; in this case, we can interpret r^t as the period t real interest rate.
- Assume that pure profits are zero so that Π^t equals zero.

Substituting these two assumptions into equation (77) leads to the following expression:

$$(78)\ \Pi^t = P_Y{}^t\, Y^t + P_I{}^t\, I^t - P_X{}^t\, X^t - \{r^t\, P_I{}^t + \delta P_I{}^t\}K^t = 0.$$

Equation (78) can be rearranged to yield the following value of output equals value of input equation:

$$(79)\ P_Y{}^t\, Y^t + P_I{}^t\, I^t = P_X{}^t\, X^t + \{r^t\, P_I{}^t + \delta P_I{}^t\}K^t.$$

Equation (79) is essentially the closed economy counterpart to the (gross) value of outputs equals (gross) value of primary inputs equation (4), $P^t \cdot y^t = W^t \cdot x^t$, that we have been using thus far in this study. We now come to the point of this rather long digression: *the (gross) payments to primary inputs that is defined by the right hand side of (79) is not income*, in the sense of Hicks.[37] The owner of a unit of capital cannot spend the entire period t gross rental income $\{r^t\, P_I{}^t + \delta P_I{}^t\}$ on consumption during period t because the depreciation portion of the rental, $\delta P_I{}^t$, is required in order to keep his or her capital intact. Thus, the owner of a new unit of capital at the beginning of period t loans the unit to the market sector and gets the gross return $\{r^t$

36 See Christensen and Jorgenson (1969) for a derivation in continuous time and Diewert (1980, p. 471) for a derivation in discrete time.

37 We will use Hicks' (1946, p. 174) third concept of income here: 'Income No. 3 must be defined as the maximum amount of money which the individual can spend this week, and still be able to expect to spend this week, and still be able to expect to spend the same amount *in real terms* in each ensuing week'.

$P_I^t + \delta P_I^t\}$ at the end of the period plus the depreciated unit of the initial capital stock, which is worth only $(1 - \delta)P_I^t$. Thus δP_I^t of this gross return must be set aside in order to restore the lender of the capital services to his or her original wealth position at the beginning of period t. This means that *period t Hicksian market sector income* is not the value of payments to primary inputs, $P_X^t X^t + \{r^t P_I^t + \delta P_I^t\}K^t$; instead it is the value of payments to labour $P_X^t X^t$ plus the reward for waiting, $r^t P_I^t K^t$. Using this definition of market sector (net) Hicksian income, we can rearrange equation (79) as follows:

(80) Hicksian market sector income $\equiv P_X^t X^t + r^t P_I^t K^t$
$= P_Y^t Y^t + P_I^t I^t - \delta P_I^t K^t$
= Value of consumption + value of gross investment – value of depreciation.

Thus, in this Hicksian net income framework, our new output concept is equal to our old output concept less the value of depreciation. We take the price of depreciation to be the corresponding investment price P_I^t and the quantity of depreciation is taken to be the depreciation rate times the beginning of the period stock, δK^t.

Hence, the overstatement of income problem that is implicit in the approaches used in previous sections can readily be remedied: all we need to do is to take the user cost formula for an asset and decompose it into two parts:

- one part that represents depreciation and foreseen obsolescence, $\delta P_I^t K^t$; and
- the remaining part that is the reward for postponing consumption, $r^t P_I^t K^t$.

In the Diewert Lawrence database used in the previous section, the user costs had the following form:

(81) $u^t = (r^t + \delta^t + \tau^t)P_I^t$

where r^t was the balancing period t real rate of interest, δ^t was a geometric depreciation rate for period t,[38] τ^t was an average capital taxation rate on the asset and P_I^t was the period t investment price for the asset. Thus, in this section we split up each user cost times the beginning of the period stock K^t into the depreciation component $\delta^t P_I^t K^t$ and the remaining term $(r^t + \tau^t)P_I^t K^t$ and we regard the second term as a genuine income component but the first term is treated as an intermediate input cost for the market sector and is an offset to gross investment made by the market sector during the period under consideration. *Thus, in this section, we use a net product approach instead of a gross product approach*. In this section, our

38 We used the geometric depreciation rates that were close to the rates used by the Australian Bureau of Statistics, which were constant except for computers, where an increasing geometric rate was assumed.

investment aggregate I is a *net investment aggregate* (gross investment components are indexed with a positive sign in the aggregate and depreciation components are indexed with a negative sign in the aggregate). Our capital services aggregate is now a 'reward for waiting' capital services aggregate rather than the gross return aggregate that was used in the previous section.[39] Using chained Törnqvist price indexes to do the aggregation, our old gross investment price index P_I is listed in Table 11 below along with the new price for 'waiting' capital services P_{KW}, the price of the depreciation aggregate P_{DEP} and the price of the new net investment aggregate P_{NI}.

Note that the price of waiting capital services increases much more rapidly than the other investment prices. This is due to the fact that land services are included in the capital services aggregate but there is very little investment in land. Hence, the situation is explained by the fact that land prices in Australia have been increasing much more rapidly than the prices of investment goods in recent years. The quantity aggregates that correspond to the price data listed in Table 8 are also listed in Table 11.[40]

Note that gross investment in Australia grew 7.3 fold over the sample period whereas net investment grew only 6.6 fold. Note also that gross investment is well above depreciation or replacement investment for every year. All of the analysis presented in section 2 above applies to the new situation. The counterpart to Table 5 in the previous section using the new framework is Table 12 below.

39 This approach seems to be broadly consistent with an approach advocated by Rymes (1968; 1983), who stressed the role of waiting services: 'Second, one can consider the 'waiting' or 'abstinence' associated with the net returns to capital as the nonlabour primary input.' (Rymes 1968, p. 362). Denison (1974) also advocated a net product approach to productivity measurement.

40 The y_{DEP} entries should have a negative sign attached to them.

Table 11 **Price indexes and quantities (in $1960m) of gross investment, waiting capital services, depreciation and net investment in Australia, 1960–2004**

Year	P_I	P_{KW}	P_{DEP}	P_{NI}	y_I	y_{KW}	y_{DEP}	y_{NI}
1960	1.0000	1.0000	1.0000	1.0000	3,810	2,803	1,286	2,524
1961	1.0218	0.8740	1.0227	1.0213	4,009	2,912	1,381	2,629
1962	1.0405	1.0958	1.0460	1.0375	4,050	3,027	1,477	2,573
1963	1.0474	1.0312	1.0554	1.0430	4,349	3,145	1,567	2,782
1964	1.0587	1.3414	1.0655	1.0551	5,144	3,272	1,669	3,477
1965	1.0908	0.9321	1.1026	1.0848	5,002	3,435	1,785	3,215
1966	1.1175	0.8849	1.1301	1.1110	5,203	3,571	1,927	3,273
1967	1.1541	1.0565	1.1658	1.1482	5,728	3,706	2,076	3,649
1968	1.1780	1.4897	1.1897	1.1722	7,425	3,862	2,219	5,211
1969	1.2056	1.2017	1.2378	1.1907	6,953	4,102	2,365	4,581
1970	1.2511	1.2361	1.2822	1.2369	7,180	4,291	2,523	4,648
1971	1.3066	1.0752	1.3467	1.2876	7,416	4,479	2,675	4,728
1972	1.3971	0.7712	1.4292	1.3851	6,190	4,666	2,840	3,313
1973	1.4582	1.2228	1.5048	1.4346	7,032	4,766	3,002	3,999
1974	1.6224	1.2602	1.6575	1.6064	8,663	4,891	3,145	5,505
1975	2.0013	0.3578	2.0353	1.9911	7,172	5,064	3,288	3,848
1976	2.3199	0.7976	2.3581	2.3091	7,596	5,179	3,421	4,138
1977	2.5593	0.9177	2.6101	2.5398	7,475	5,295	3,555	3,879
1978	2.7643	1.1170	2.8598	2.7071	7,992	5,389	3,677	4,276
1979	2.9262	1.6637	3.0998	2.8068	8,843	5,500	3,807	5,015
1980	3.1926	2.0942	3.4255	3.0287	9,080	5,646	3,978	5,072
1981	3.5129	2.3097	3.6842	3.3942	10,455	5,782	4,124	6,344
1982	3.8818	1.4351	4.0459	3.7693	9,993	5,964	4,334	5,639
1983	4.2861	1.9701	4.4848	4.1476	10,043	6,110	4,593	5,412
1984	4.4874	2.9648	4.7157	4.3254	10,649	6,265	4,779	5,838
1985	4.6626	2.7337	4.9046	4.4905	11,069	6,428	4,966	6,069
1986	5.1051	2.7731	5.4497	4.8495	11,270	6,583	5,199	6,022
1987	5.5437	4.0100	6.0377	5.1624	11,788	6,732	5,455	6,279
1988	5.7826	5.4679	6.3369	5.3525	13,158	6,898	5,703	7,463
1989	6.0424	6.2512	6.4951	5.6827	15,156	7,107	5,974	9,287
1990	6.3730	4.7698	6.7942	6.0363	14,210	7,367	6,304	7,908
1991	6.5263	4.8212	6.9976	6.1425	12,350	7,552	6,615	5,586
1992	6.4900	5.9708	7.0322	6.0172	12,198	7,645	6,785	5,227
1993	6.5509	6.1246	7.2142	5.9327	13,088	7,715	6,890	6,074
1994	6.6201	6.0223	7.3661	5.9136	13,943	7,797	7,051	6,825
1995	6.6236	6.3742	7.3538	5.9327	15,564	7,888	7,234	8,410
1996	6.6529	6.9707	7.4121	5.9365	15,916	8,028	7,531	8,433
1997	6.4846	6.7011	7.2000	5.8083	16,512	8,188	7,853	8,700
1998	6.5047	8.4034	7.2512	5.8027	19,384	8,352	8,262	11,404
1999	6.5343	7.4461	7.3102	5.8102	20,374	8,589	8,764	11,887
2000	6.5402	7.8703	7.2559	5.8607	21,295	8,812	9,262	12,298
2001	6.7139	8.4973	7.2516	6.1844	20,076	8,994	9,882	10,208
2002	6.6869	9.3291	7.2077	6.1729	21,866	9,145	10,393	11,552
2003	6.6895	10.1808	7.1115	6.2544	26,181	9,306	10,895	15,614
2004	6.6855	11.4384	6.8989	6.3945	27,978	9,563	11,513	16,830

Table 12 **Decomposition of market sector real income growth into productivity, real output price change and input quantity contribution factors using the translog net product approach**

Year	γ^t	τ^t	$\alpha_D{}^t$	$\alpha_X{}^t$	$\alpha_M{}^t$	$\beta_L{}^t$	$\beta_K{}^t$	$\alpha_T{}^t$
1961	0.9995	0.9642	0.9990	0.9859	1.0063	1.0364	1.0091	0.9921
1962	1.0834	1.0614	1.0055	0.9995	1.0031	1.0031	1.0095	1.0026
1963	1.0256	0.9947	0.9979	1.0037	0.9998	1.0196	1.0099	1.0036
1964	1.1462	1.0905	1.0027	1.0154	1.0047	1.0166	1.0108	1.0202
1965	0.9759	0.9555	1.0004	0.9868	1.0044	1.0176	1.0123	0.9911
1966	1.0305	0.9990	0.9971	0.9970	1.0044	1.0249	1.0080	1.0014
1967	1.0912	1.0630	1.0048	0.9948	1.0052	1.0139	1.0077	0.9999
1968	1.1260	1.1085	0.9972	0.9897	1.0033	1.0156	1.0102	0.9930
1969	1.0056	0.9754	0.9969	0.9996	1.0051	1.0139	1.0152	1.0047
1970	1.0671	1.0355	1.0006	1.0020	1.0005	1.0171	1.0101	1.0025
1971	1.0361	1.0078	1.0029	0.9838	1.0032	1.0297	1.0087	0.9870
1972	0.9821	0.9659	1.0073	0.9959	0.9911	1.0162	1.0064	0.9870
1973	1.1096	1.0566	0.9977	1.0285	1.0072	1.0126	1.0033	1.0360
1974	1.0673	1.0151	1.0032	1.0143	1.0041	1.0246	1.0044	1.0185
1975	0.9817	0.9390	1.0244	0.9967	0.9799	1.0413	1.0035	0.9767
1976	1.0473	1.0710	1.0013	0.9844	1.0039	0.9870	1.0013	0.9882
1977	1.0037	1.0226	1.0012	1.0008	0.9912	0.9864	1.0017	0.9921
1978	1.0239	1.0377	0.9952	0.9893	0.9921	1.0086	1.0015	0.9815
1979	1.0301	1.0153	0.9877	1.0056	0.9947	1.0247	1.0022	1.0003
1980	1.0355	1.0149	0.9943	1.0255	0.9839	1.0136	1.0034	1.0089
1981	1.0436	1.0152	1.0065	0.9951	1.0036	1.0193	1.0033	0.9987
1982	0.9922	0.9818	1.0112	0.9848	1.0156	0.9958	1.0034	1.0002
1983	1.0315	1.0650	0.9988	0.9948	1.0031	0.9695	1.0022	0.9979
1984	1.0308	1.0200	0.9906	0.9954	1.0110	1.0107	1.0030	1.0063
1985	1.0208	0.9844	0.9985	1.0040	0.9911	1.0402	1.0033	0.9951
1986	1.0111	1.0105	0.9957	0.9920	0.9798	1.0310	1.0028	0.9719
1987	1.0328	1.0343	0.9877	0.9857	1.0006	1.0219	1.0030	0.9863
1988	1.0578	1.0199	0.9837	0.9984	1.0238	1.0272	1.0041	1.0221
1989	1.0619	0.9937	0.9938	0.9984	1.0413	1.0286	1.0057	1.0396
1990	1.0060	0.9586	1.0097	0.9993	1.0022	1.0315	1.0062	1.0015
1991	0.9753	1.0031	0.9924	0.9760	1.0128	0.9875	1.0036	0.9885
1992	1.0092	1.0367	0.9923	0.9809	1.0128	0.9856	1.0019	0.9935
1993	1.0189	1.0324	0.9973	1.0016	0.9877	0.9988	1.0016	0.9893
1994	1.0264	1.0080	0.9963	0.9936	0.9995	1.0274	1.0018	0.9931
1995	1.0444	1.0097	0.9949	0.9991	1.0099	1.0285	1.0020	1.0090
1996	1.0578	1.0252	0.9966	1.0008	1.0105	1.0207	1.0030	1.0114
1997	1.0306	1.0306	0.9915	0.9836	1.0267	0.9954	1.0033	1.0099
1998	1.0665	1.0523	0.9922	1.0075	0.9927	1.0177	1.0035	1.0002
1999	1.0280	1.0294	1.0051	0.9887	0.9947	1.0052	1.0051	0.9835
2000	1.0410	1.0014	0.9992	1.0023	1.0127	1.0205	1.0044	1.0151
2001	1.0295	1.0022	1.0026	1.0307	0.9778	1.0130	1.0036	1.0078
2002	1.0364	1.0303	0.9990	0.9952	1.0112	0.9975	1.0031	1.0064
2003	1.0493	1.0211	1.0006	0.9846	1.0251	1.0141	1.0033	1.0093
2004	1.0568	1.0032	1.0058	0.9822	1.0483	1.0116	1.0055	1.0297
Average	1.0370	1.0173	0.9991	0.9971	1.0041	1.0142	1.0050	1.0012

Table 13 **Decomposition of market sector real income levels into productivity, real output price change and input quantity contribution factors using the translog net product approach**

Year	ρ^t/ρ^0	T^t	$A_D{}^t$	$A_X{}^t$	$A_M{}^t$	$B_L{}^t$	$B_K{}^t$	$A_T{}^t$
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	0.9995	0.9642	0.9990	0.9859	1.0063	1.0364	1.0091	0.9921
1962	1.0828	1.0234	1.0044	0.9854	1.0094	1.0396	1.0187	0.9946
1963	1.1106	1.0180	1.0023	0.9891	1.0092	1.0600	1.0287	0.9982
1964	1.2729	1.1100	1.0050	1.0042	1.0140	1.0776	1.0398	1.0183
1965	1.2422	1.0606	1.0054	0.9910	1.0184	1.0966	1.0526	1.0092
1966	1.2801	1.0596	1.0025	0.9880	1.0229	1.1239	1.0610	1.0106
1967	1.3969	1.1263	1.0074	0.9829	1.0281	1.1395	1.0692	1.0105
1968	1.5729	1.2485	1.0045	0.9727	1.0315	1.1573	1.0801	1.0034
1969	1.5817	1.2178	1.0014	0.9723	1.0368	1.1734	1.0965	1.0081
1970	1.6878	1.2610	1.0020	0.9743	1.0373	1.1934	1.1076	1.0106
1971	1.7488	1.2708	1.0049	0.9585	1.0406	1.2288	1.1172	0.9975
1972	1.7174	1.2275	1.0123	0.9545	1.0314	1.2487	1.1243	0.9845
1973	1.9056	1.2969	1.0100	0.9818	1.0388	1.2645	1.1281	1.0199
1974	2.0338	1.3166	1.0132	0.9958	1.0431	1.2956	1.1330	1.0387
1975	1.9966	1.2363	1.0380	0.9925	1.0222	1.3490	1.1369	1.0145
1976	2.0911	1.3240	1.0393	0.9770	1.0261	1.3315	1.1384	1.0025
1977	2.0988	1.3539	1.0405	0.9778	1.0171	1.3135	1.1404	0.9946
1978	2.1490	1.4050	1.0356	0.9674	1.0091	1.3248	1.1421	0.9762
1979	2.2136	1.4265	1.0228	0.9729	1.0037	1.3575	1.1446	0.9765
1980	2.2922	1.4478	1.0170	0.9976	0.9875	1.3759	1.1485	0.9852
1981	2.3922	1.4698	1.0236	0.9928	0.9911	1.4025	1.1522	0.9839
1982	2.3735	1.4430	1.0351	0.9777	1.0066	1.3967	1.1561	0.9841
1983	2.4481	1.5368	1.0339	0.9727	1.0097	1.3541	1.1586	0.9821
1984	2.5236	1.5676	1.0242	0.9682	1.0208	1.3687	1.1621	0.9883
1985	2.5762	1.5431	1.0226	0.9721	1.0117	1.4237	1.1660	0.9834
1986	2.6048	1.5593	1.0183	0.9643	0.9913	1.4679	1.1693	0.9559
1987	2.6901	1.6127	1.0058	0.9505	0.9919	1.5000	1.1728	0.9428
1988	2.8455	1.6447	0.9894	0.9490	1.0154	1.5408	1.1777	0.9636
1989	3.0216	1.6343	0.9832	0.9475	1.0573	1.5849	1.1844	1.0018
1990	3.0397	1.5667	0.9927	0.9468	1.0597	1.6347	1.1917	1.0032
1991	2.9645	1.5716	0.9852	0.9240	1.0732	1.6143	1.1960	0.9917
1992	2.9919	1.6293	0.9776	0.9064	1.0869	1.5911	1.1983	0.9852
1993	3.0485	1.6820	0.9749	0.9079	1.0736	1.5892	1.2002	0.9747
1994	3.1289	1.6955	0.9713	0.9021	1.0730	1.6327	1.2024	0.9679
1995	3.2679	1.7119	0.9663	0.9013	1.0836	1.6792	1.2047	0.9766
1996	3.4568	1.7550	0.9630	0.9020	1.0950	1.7139	1.2083	0.9876
1997	3.5624	1.8087	0.9548	0.8872	1.1242	1.7060	1.2123	0.9974
1998	3.7992	1.9034	0.9473	0.8938	1.1161	1.7363	1.2166	0.9976
1999	3.9056	1.9593	0.9521	0.8838	1.1101	1.7453	1.2227	0.9811
2000	4.0657	1.9620	0.9513	0.8858	1.1243	1.7811	1.2281	0.9959
2001	4.1857	1.9664	0.9538	0.9129	1.0994	1.8042	1.2325	1.0036
2002	4.3382	2.0259	0.9528	0.9086	1.1117	1.7997	1.2363	1.0101
2003	4.5521	2.0687	0.9534	0.8946	1.1396	1.8251	1.2404	1.0195
2004	4.8106	2.0753	0.9590	0.8787	1.1947	1.8463	1.2472	1.0498

Figure 3 **Contributions of productivity, terms of trade, real output price change and input quantity factors to market sector real income levels using the net product approach**

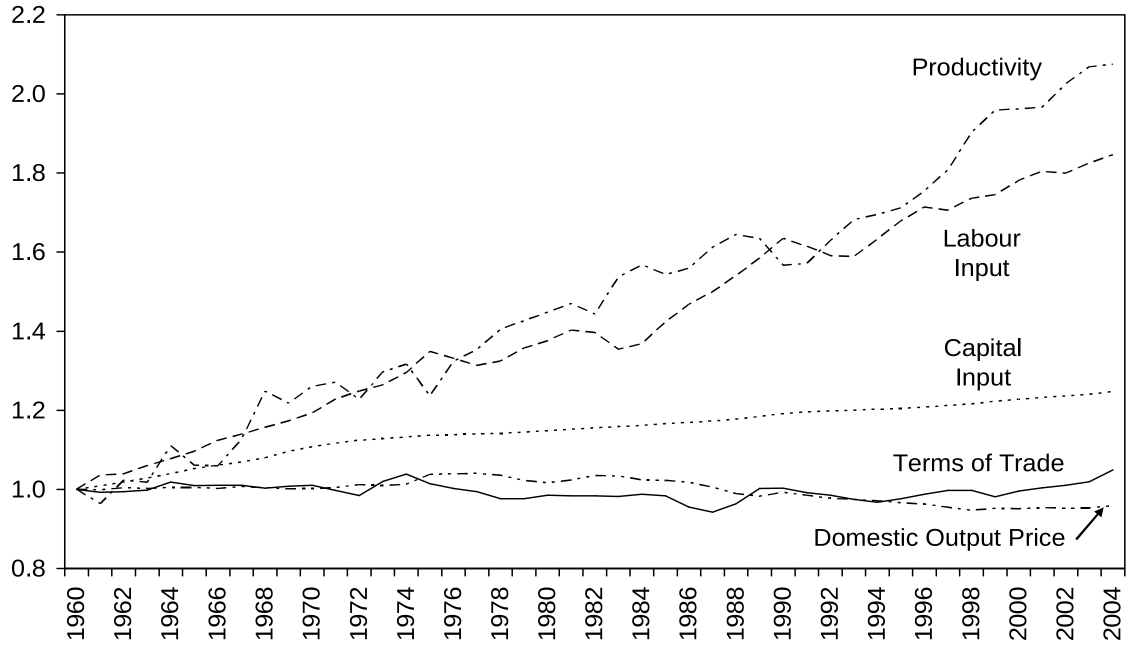
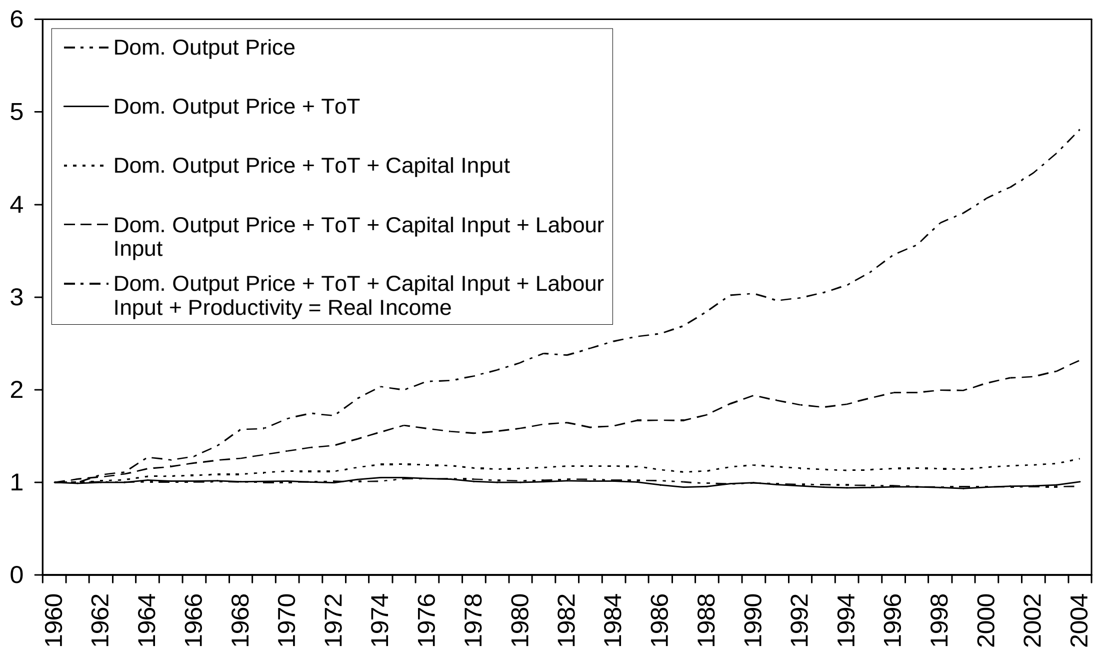


Figure 4 **Cumulative contributions of productivity, terms of trade, real output price change and input quantity factors to market sector real income levels using the net product approach**



The new results are quite interesting. In the previous GDP model, the average rate of increase in real income was 3.76 per cent per year, which has now marginally decreased to 3.70 per cent. However, there are some big shifts in the explanatory factors: productivity growth now accounts for an average contribution of 1.73 per cent per year compared to the old 1.48 per cent; the contribution of labour input growth has increased from 1.23 per cent per year to 1.42 per cent and the contribution of capital services input growth has dramatically decreased from 1.11 per cent per year to 0.50 per cent per year. The contributions of real output price changes (including changes in real export and import prices) are little changed and are generally small.

The above period to period results can also be presented in levels form and Table 13 and Figure 3 are the counterparts of Table 6 and Figure 1 in the GDP framework while Figure 4 presents the cumulative analysis corresponding to Figure 2 in the earlier section.

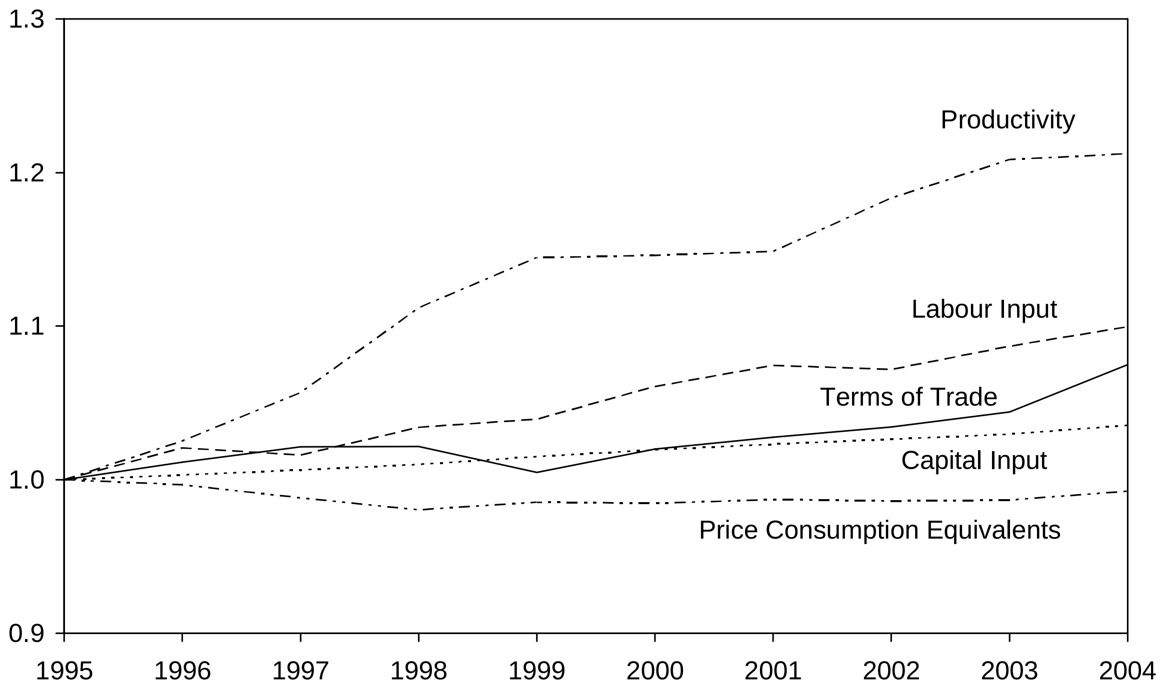
From Table 13 the overall growth in real net income in Australia over the 45 year period was a 4.810 fold increase. From Table 13 and Figure 3 the main explanatory factors were productivity growth (2.075 fold increase in real net income), increases in labour input (1.846 fold increase) and increases in (waiting) capital services (1.247 fold increase). There were small effects due to the relative fall in the price of domestic C + G + I relative to the price of C (0.959 fold increase), the relative fall in the price of exports (0.879 fold increase) and the relative fall in the price of imports (1.195 fold increase). The combined effects of changes in the prices of exports and imports relative to the price of consumption was a 1.050 fold increase in real net income over the sample period; ie improvements in the terms of trade contributed to an overall increase in real net income of 5 per cent over the sample period.

The change in relative contributions is graphically evident in Figure 4 where we now have a larger wedge between the two top lines in the figure representing the increased relative contribution of productivity change and a somewhat larger wedge between the second and third lines form the top representing the slightly larger contribution of labour force growth. The much smaller wedge between the third and fourth lines from the top shows the reduced contribution of capital in the net product framework.

To reiterate, the reduced contribution from capital arises because we had previously overstated the level of real income in the gross product framework as we counted all investment as part of real output. In the net product framework we recognise that part of investment (equal to depreciation of the capital stock) goes to maintain the size of the capital stock and only net investment should be counted as part of real income. This leads to a lower level of real income in the net product framework compared to the gross product framework although it should be noted that both measures of real income grow at roughly similar rates. As only net investment is now counted as a part of real income, capital growth makes a smaller contribution to real income growth in the net product framework.

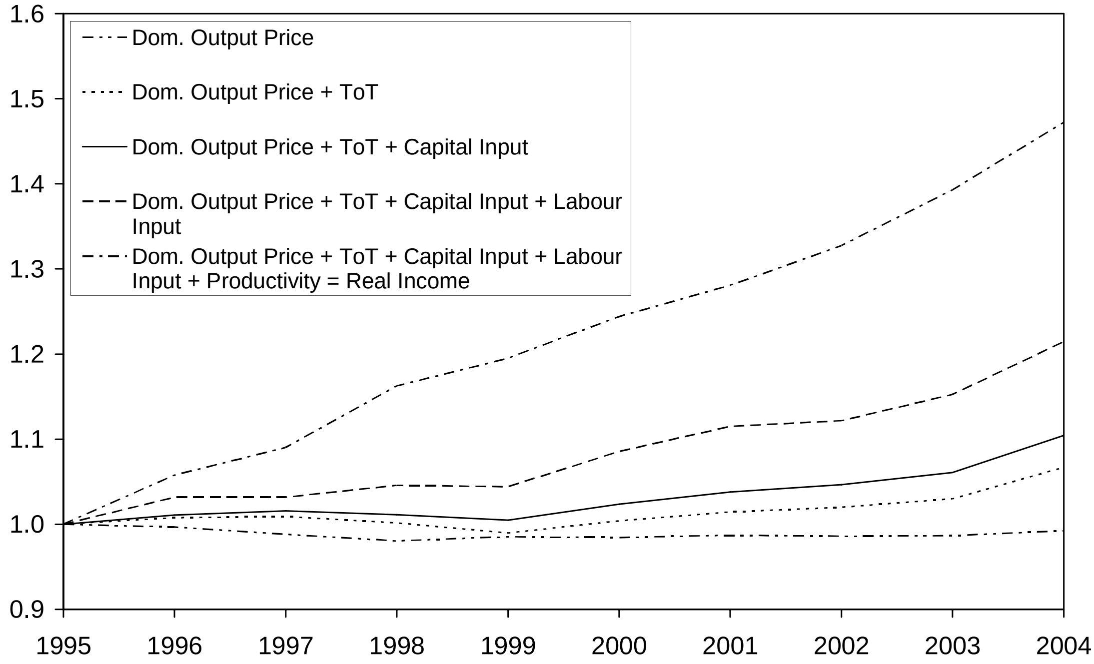
While changes in the terms of trade have made only a small contribution to real income growth over the last four and half decades, it is instructive to examine the last decade separately. This has been a period when cheaper imports have become available, partly due to the increasing use of computerised equipment whose prices have fallen with advances in technology and partly due to the availability of cheaper manufactured goods from China, in particular. On the export side, Australia has also benefited from relatively firm commodity prices over this period. It has also encompassed what many believe to be a sizable acceleration in Australia's rate of productivity growth.

Figure 5 **Contributors to real net income levels, 1995–2004**



In Figures 5 and 6 we represent the individual and cumulative contributions, respectively, to real net income for the period 1994-95 to 2003-04. Over this 10 year period Australia's real net income increased by 47 per cent. From Figure 5 we see that the higher rate of productivity growth contributed almost half of this increase, accounting for an increase in real net income of 21 per cent. Labour force growth was the next largest contributor accounting for an increase in real net income of 10 per cent. This is now followed closely by the terms of trade which accounted for an increase in real net income of 7.5 per cent. Capital growth, on the other hand, now only contributes an increase in real net income of 3.5 per cent while real consumption price changes have a negligible impact. This result highlights the potentially important impact of terms of trade changes on real net income over selected periods and how Australia has benefited from favourable movements in world prices over the last decade.

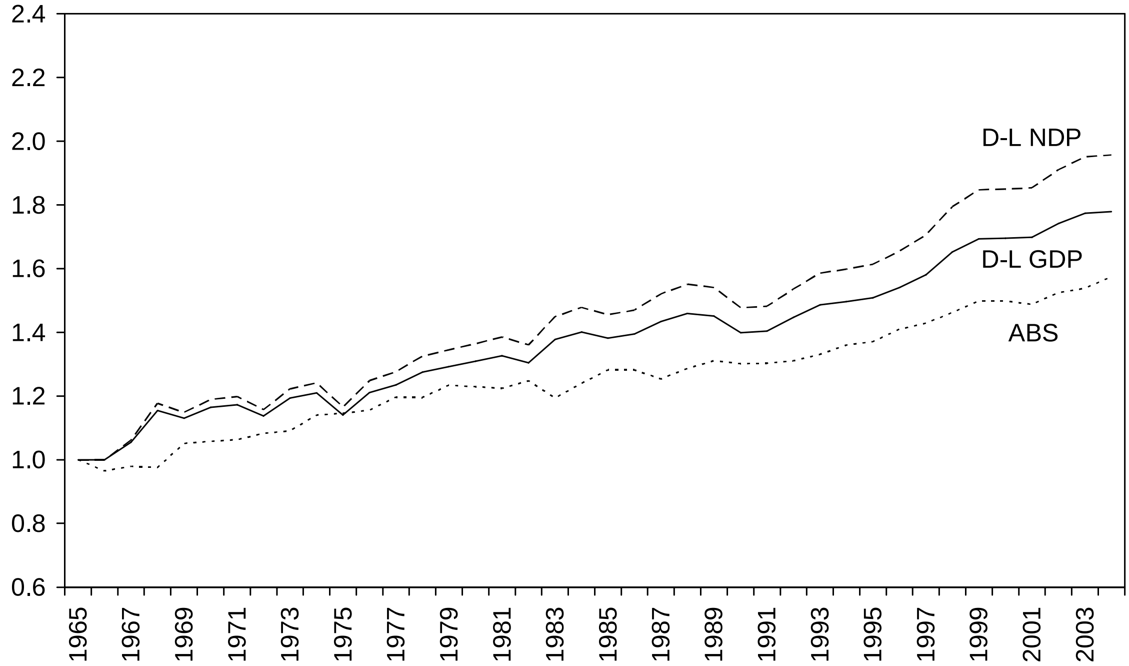
Figure 6 **Cumulative contributions to real net income levels, 1995–2004**



Finally, the impact of using the net product framework on productivity measures is noteworthy. In Figure 7 we present total factor productivity indexes for the Diewert–Lawrence database using the gross and net output frameworks. We also present the ABS Multifactor Productivity index for comparison. As the ABS index runs over a shorter period, the time period used is 1965-66 to 2003-04.

Two interesting results are evident. Firstly, the gross output based Diewert–Lawrence TFP index increases more than does the ABS MFP index. The Diewert–Lawrence database covers a much higher proportion of the economy's output accounting for around 95 per cent of industry gross product whereas the ABS database only covers around two thirds of industry gross product. The Diewert–Lawrence database also builds up its output measure from final consumption components rather than sectoral gross value added and contains a number of methodological differences compared to the ABS database including the use of producer rather than consumer prices. The relatively rapid growth of the service sector components excluded from the ABS database may account for this difference but more work needs to be done to determine the exact sources of this difference.

Figure 7 **Alternative productivity measures, 1966–2004**



The second interesting result in Figure 7 is that the net product based TFP index increases by more than does the gross product based TFP index. This is because the denominator in the net product based measure is smaller than that in the gross product based measure as it excludes the depreciation component. The use of the smaller measure of capital input leads to a higher growth of TFP.

9 Deflated NDP average of first order approximations approach

The results in this section use the net product approach explained in the previous section, except that we use the average of the first order approximations approach explained in section 5 above. As in section 5, we aggregated the disaggregated Diewert and Lawrence data using Fisher chained indexes. The differences in the resulting aggregates were very small compared to the aggregates reported in the previous section so we do not list the Fisher basic data.

Table 14 **Decomposition of market sector real net income growth into approximate productivity, real output price change and input quantity contribution factors**

Year	γ^t	τ^t	$\alpha_D{}^t$	$\alpha_X{}^t$	$\alpha_M{}^t$	$\beta_L{}^t$	$\beta_K{}^t$	$\alpha_T{}^t$
1961	0.9995	0.9642	0.9990	0.9859	1.0063	1.0365	1.0091	0.9921
1962	1.0834	1.0614	1.0054	0.9995	1.0031	1.0031	1.0095	1.0026
1963	1.0256	0.9947	0.9979	1.0037	0.9998	1.0196	1.0099	1.0036
1964	1.1462	1.0904	1.0027	1.0153	1.0047	1.0166	1.0108	1.0202
1965	0.9759	0.9554	1.0004	0.9868	1.0044	1.0176	1.0123	0.9911
1966	1.0305	0.9991	0.9971	0.9970	1.0044	1.0249	1.0080	1.0014
1967	1.0912	1.0630	1.0048	0.9948	1.0051	1.0139	1.0077	0.9999
1968	1.1260	1.1085	0.9972	0.9897	1.0033	1.0156	1.0101	0.9930
1969	1.0056	0.9751	0.9972	0.9996	1.0051	1.0139	1.0152	1.0047
1970	1.0671	1.0355	1.0006	1.0020	1.0005	1.0171	1.0101	1.0025
1971	1.0361	1.0078	1.0029	0.9838	1.0032	1.0297	1.0087	0.9870
1972	0.9821	0.9659	1.0073	0.9959	0.9911	1.0162	1.0064	0.9870
1973	1.1096	1.0569	0.9975	1.0285	1.0072	1.0126	1.0033	1.0360
1974	1.0673	1.0151	1.0032	1.0143	1.0041	1.0246	1.0044	1.0185
1975	0.9817	0.9384	1.0251	0.9967	0.9800	1.0413	1.0036	0.9767
1976	1.0473	1.0710	1.0013	0.9844	1.0039	0.9870	1.0013	0.9882
1977	1.0037	1.0226	1.0012	1.0008	0.9912	0.9864	1.0017	0.9921
1978	1.0239	1.0378	0.9952	0.9893	0.9921	1.0086	1.0015	0.9815
1979	1.0301	1.0155	0.9875	1.0056	0.9947	1.0247	1.0021	1.0003
1980	1.0355	1.0149	0.9943	1.0254	0.9839	1.0136	1.0034	1.0089
1981	1.0436	1.0152	1.0065	0.9951	1.0036	1.0193	1.0033	0.9987
1982	0.9922	0.9817	1.0113	0.9848	1.0157	0.9958	1.0034	1.0003
1983	1.0315	1.0651	0.9988	0.9948	1.0031	0.9695	1.0022	0.9979
1984	1.0308	1.0201	0.9906	0.9954	1.0110	1.0107	1.0030	1.0063
1985	1.0208	0.9844	0.9985	1.0040	0.9911	1.0403	1.0034	0.9951
1986	1.0111	1.0105	0.9957	0.9920	0.9798	1.0310	1.0028	0.9719
1987	1.0328	1.0343	0.9877	0.9857	1.0006	1.0219	1.0030	0.9863
1988	1.0578	1.0199	0.9837	0.9984	1.0238	1.0272	1.0041	1.0222
1989	1.0619	0.9936	0.9934	0.9984	1.0416	1.0286	1.0057	1.0399
1990	1.0060	0.9584	1.0099	0.9993	1.0022	1.0315	1.0062	1.0015
1991	0.9753	1.0031	0.9924	0.9760	1.0128	0.9875	1.0036	0.9884
1992	1.0092	1.0367	0.9923	0.9809	1.0128	0.9856	1.0019	0.9934
1993	1.0189	1.0324	0.9973	1.0016	0.9877	0.9988	1.0016	0.9893
1994	1.0264	1.0080	0.9963	0.9936	0.9995	1.0274	1.0018	0.9931
1995	1.0444	1.0097	0.9949	0.9991	1.0099	1.0285	1.0020	1.0090
1996	1.0578	1.0252	0.9966	1.0008	1.0105	1.0207	1.0030	1.0114
1997	1.0306	1.0307	0.9914	0.9836	1.0268	0.9954	1.0033	1.0099
1998	1.0665	1.0524	0.9921	1.0075	0.9927	1.0177	1.0035	1.0002
1999	1.0280	1.0294	1.0051	0.9887	0.9947	1.0052	1.0051	0.9835
2000	1.0410	1.0015	0.9990	1.0023	1.0127	1.0205	1.0044	1.0151
2001	1.0295	1.0023	1.0026	1.0306	0.9778	1.0130	1.0036	1.0078
2002	1.0364	1.0303	0.9990	0.9952	1.0112	0.9975	1.0031	1.0064
2003	1.0493	1.0211	1.0006	0.9846	1.0252	1.0141	1.0033	1.0094
2004	1.0568	1.0031	1.0057	0.9822	1.0485	1.0116	1.0055	1.0298
Average	1.0370	1.0173	0.9991	0.9971	1.0041	1.0142	1.0050	1.0012

Table 15 **Decomposition of market sector real net income levels into approximate productivity, real output price change and input quantity contribution factors**

Year	ρ^t/ρ^0	T^t	$A_D^{\ t}$	$A_X^{\ t}$	$A_M^{\ t}$	$B_L^{\ t}$	$B_K^{\ t}$	$A_T^{\ t}$
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	0.9995	0.9642	0.9990	0.9859	1.0063	1.0365	1.0091	0.9921
1962	1.0828	1.0235	1.0044	0.9854	1.0094	1.0396	1.0187	0.9946
1963	1.1106	1.0180	1.0023	0.9891	1.0092	1.0600	1.0287	0.9982
1964	1.2729	1.1101	1.0050	1.0042	1.0140	1.0776	1.0398	1.0183
1965	1.2422	1.0606	1.0054	0.9910	1.0184	1.0966	1.0526	1.0092
1966	1.2801	1.0596	1.0025	0.9880	1.0229	1.1239	1.0610	1.0106
1967	1.3969	1.1263	1.0073	0.9828	1.0281	1.1395	1.0692	1.0105
1968	1.5729	1.2486	1.0045	0.9727	1.0315	1.1573	1.0800	1.0034
1969	1.5817	1.2175	1.0017	0.9723	1.0368	1.1734	1.0965	1.0081
1970	1.6878	1.2607	1.0023	0.9743	1.0373	1.1934	1.1076	1.0106
1971	1.7488	1.2705	1.0052	0.9585	1.0406	1.2288	1.1172	0.9974
1972	1.7174	1.2272	1.0126	0.9545	1.0314	1.2487	1.1244	0.9845
1973	1.9056	1.2969	1.0100	0.9818	1.0388	1.2645	1.1281	1.0199
1974	2.0338	1.3165	1.0132	0.9958	1.0431	1.2956	1.1331	1.0387
1975	1.9966	1.2354	1.0386	0.9925	1.0222	1.3491	1.1371	1.0146
1976	2.0911	1.3231	1.0399	0.9771	1.0261	1.3316	1.1385	1.0026
1977	2.0988	1.3530	1.0412	0.9779	1.0172	1.3136	1.1405	0.9946
1978	2.1490	1.4041	1.0362	0.9674	1.0092	1.3249	1.1422	0.9763
1979	2.2136	1.4259	1.0233	0.9729	1.0038	1.3576	1.1447	0.9765
1980	2.2922	1.4472	1.0174	0.9976	0.9876	1.3760	1.1486	0.9852
1981	2.3922	1.4692	1.0240	0.9928	0.9911	1.4026	1.1523	0.9839
1982	2.3735	1.4423	1.0355	0.9777	1.0066	1.3968	1.1562	0.9842
1983	2.4481	1.5361	1.0343	0.9727	1.0098	1.3542	1.1588	0.9821
1984	2.5236	1.5670	1.0245	0.9682	1.0209	1.3687	1.1622	0.9883
1985	2.5762	1.5425	1.0230	0.9721	1.0118	1.4238	1.1661	0.9835
1986	2.6048	1.5587	1.0186	0.9643	0.9913	1.4680	1.1694	0.9559
1987	2.6901	1.6122	1.0060	0.9505	0.9920	1.5001	1.1729	0.9428
1988	2.8455	1.6442	0.9896	0.9490	1.0155	1.5409	1.1778	0.9637
1989	3.0216	1.6337	0.9831	0.9475	1.0578	1.5850	1.1845	1.0021
1990	3.0397	1.5658	0.9928	0.9467	1.0601	1.6348	1.1918	1.0036
1991	2.9645	1.5707	0.9853	0.9240	1.0736	1.6144	1.1961	0.9920
1992	2.9919	1.6283	0.9777	0.9064	1.0873	1.5912	1.1984	0.9855
1993	3.0485	1.6810	0.9750	0.9078	1.0740	1.5893	1.2003	0.9750
1994	3.1289	1.6945	0.9714	0.9020	1.0734	1.6328	1.2025	0.9682
1995	3.2679	1.7109	0.9664	0.9012	1.0840	1.6793	1.2048	0.9769
1996	3.4568	1.7540	0.9631	0.9020	1.0954	1.7140	1.2084	0.9880
1997	3.5624	1.8078	0.9548	0.8872	1.1248	1.7061	1.2124	0.9977
1998	3.7992	1.9024	0.9473	0.8938	1.1166	1.7364	1.2167	0.9979
1999	3.9056	1.9583	0.9521	0.8837	1.1107	1.7454	1.2228	0.9814
2000	4.0657	1.9612	0.9512	0.8857	1.1248	1.7812	1.2282	0.9962
2001	4.1857	1.9656	0.9537	0.9129	1.0999	1.8043	1.2326	1.0040
2002	4.3382	2.0251	0.9527	0.9085	1.1122	1.7998	1.2364	1.0104
2003	4.5521	2.0678	0.9532	0.8946	1.1402	1.8252	1.2405	1.0199
2004	4.8106	2.0741	0.9587	0.8787	1.1955	1.8464	1.2473	1.0502

The chain link information on period by period changes in real income that corresponds to the average of the first order approximations model defined by (28), (61), (70) and (73) (generalised to include separate contribution factors for changes in real domestic, export and import prices, α_D^t, α_X^t and α_M^t , respectively, and separate contribution factors for growth in labour and capital input, β_L^t and β_K^t , respectively) is given in Table 14, which is the deflated net income counterpart to Table 9 above.

Comparing the year by year entries in Tables 13 (translog approach for net income) and 15 (average of first order approximations approach for net income) and the corresponding averages, we see that the two Tables are virtually identical. *Thus both approaches lead to the same empirical results*.

The annual change information in Table 15 can be converted into cumulative changes using equations (46) (with obvious extensions to multiple inputs and outputs). Table 15 gives this levels growth information and it is the first order approximation counterpart to Table 13 above, which gave the same information using the translog approach. Using the Australian data, we see that it does not matter whether we use the translog contributions to real income growth approach or the average of the first order approximations approach: the results are virtually identical.

10 Conclusions

The main conclusion emerging from this study is that, taken over long time periods of several decades, changes in the terms of trade have relatively little impact on Australian welfare. Welfare benefits from improvements in the terms of trade in one period tend to be offset by losses from subsequent deteriorations in the terms of trade. Over the last four and a half decades changes in the terms of trade have increased real income by less than 5 per cent in aggregate. Over the same period real income has increased by almost four fold. Productivity improvements were the largest single source of improvements in real income followed by labour force increases and capital stock increases. This finding is consistent with Industry Commission (1995) which found little overall impact from terms of trade changes in the two and a half decades up to 1993-94.

There is evidence, however, that terms of trade changes can have a more important, albeit usually transitory, impact over shorter periods of time. In particular, improvements in the terms of trade over the decade up to 2003-04 led to an increase in real income of 7.5 per cent. The total increase in real income over the same period was 47 per cent with higher productivity growth accounting for almost half this increase. The Diewert and Lawrence database has not yet been updated to include the 2004-05 financial year but preliminary evidence from ABS (2005) indicates that the (standard) terms of trade has made another substantial improvement in the latest year. After an improvement of 7.5 per cent in 2003-04 due to a substantial fall in import prices combined with a modest fall in export prices, the terms of trade increased by 10 per cent in 2004-05 as import prices remained largely unchanged but export prices rebounded with the growing demand for commodities. This could be expected to make a further significant contribution to real income growth.

The other major conclusion to emerge from this study is that it makes a big difference whether we use the market sector gross domestic product or net domestic product framework. The latter framework is the more relevant one for looking at the sources of real income growth generated by the market sector. Traditional gross domestic product measures tend to overstate the level of real income as they treat investment to cover depreciation as part of real output when only net investment increases sustainable final consumption possibilities. When we move to a net domestic product framework from a gross domestic market sector framework, we find that the role of capital deepening as an explanatory factor for improving living standards is reduced and the role of technical progress (or TFP growth) and labour growth is increased.

Priorities for further research in this area include the following:

- taking into account the changing proportion of the Australian capital stock that is foreign owned;
- developing more comprehensive per capita welfare measures;
- integrating the contributions of resources and intangible capital to real income growth into the framework;
- dealing with the various tax wedges that fall within the market production sector; and
- integrating the present approach with the input–output framework to derive industry contribution factors.

Appendix A: Diewert-Lawrence database

This project uses a modified version of the detailed productivity database developed for DCITA in Diewert and Lawrence (2005). This appendix reproduces the similar appendix in Diewert and Lawrence (2005) but includes the relevant modifications.

The construction of reliable total factor productivity (TFP) estimates requires comprehensive information on the full range of outputs produced by the economy (excluding the government administration and defence sector) as well as on all inputs used in the production process. Furthermore, to be consistent with the underlying economic theory of productivity measurement, output and input quantities need to be valued at the prices actually faced by the production sector. As a result, taxes and subsidies that drive a wedge between producers' and consumers' prices need to be allowed for.

The TFP database we have constructed for this project contains value, price and quantity information on a total of 32 output and input categories. These are made up of an aggregate consumer commodity, one government consumption commodity, 10 investment commodities, 3 inventory change commodities, one export commodity, one import commodity, labour input, 9 capital stocks and 5 inventory stocks. Data on these variables covers the 45 year period from 1959-60 to 2003-04. In our Tables, the entries for the year 1960 refer to the June year that ends on June 30 of 1960, etc. In constructing the database we have drawn on Australian Bureau of Statistics (ABS) data wherever possible. In some cases this has been supplemented by data from the Organisation for Economic Cooperation and Development's Economic Outlook database (OECDEOL) and the Reserve Bank of Australia's Australian Economic Statistics database (RBAAES). A detailed listing of all 32 commodities is presented in Table A1.

An important distinction that arises in all productivity studies is the difference between stocks and flows. Most outputs from the production sector and some of the inputs to it are produced and consumed in the one period. This makes their measurement relatively easy. However, many of the inputs used in the production process are durable assets and last several periods (or decades in some cases). Measuring the amount of these durable items consumed in any one period becomes problematic and requires measurement of the flow of services provided by the asset over its lifetime. Measurement of the stock, or total value of the asset held is also not straight forward due to the presence of inflation and alternative assumptions about depreciation rates. Consequently, in this study considerable time has been spent constructing the major stocks and flows in a consistent manner using economic conventions. This has been particularly important given the focus of the econometric work on modelling the role of ICT inputs in productivity growth.

Table A.1 **Full Listing of Variables Contained in the TFP Database**

Broad category	*Individual components*
Consumer commodity	Aggregate consumption excluding housing services
Government consumption	Government consumption of intermediates
Investment goods	Non–residential and other construction
	Software
	Mineral exploration
	Dwellings
	Computers
	Electrical machinery
	Industrial machinery
	Motor vehicles
	Other transport equipment
	Other machinery
Inventory changes	Non–farm inventories
	Farm inventories
	Livestock
Exports	Aggregate exports
Imports	Aggregate imports
Labour	Person–hours
Capital	Non–residential and other construction
	Software
	Mineral exploration
	Computers
	Electrical machinery
	Industrial machinery
	Motor vehicles
	Other transport equipment
	Other machinery
Inventories	Non–farm inventories
	Farm inventories
	Livestock
	Commercial land
	Rural land

The main differences between the database developed here and that used by the ABS in producing its multifactor productivity (MFP) estimates are the following:

- Broader coverage of the economy — we include 16 of the 17 major industrial sectors whereas the ABS 'market sector' only covers 12 of the 17 sectors. We exclude Government administration and defence whereas the ABS also excludes Health, Education, Business and property services and Personal services. With the changing composition of the economy, the private sector now accounts for significant proportions of Health, Education and Personal services output and nearly all of the relatively large Business and property services sector's output. Our approach of measuring output from sources of final demand enables us to cover more of the desired market–oriented parts of the economy than the ABS sectoral value added approach where measurement problems are more problematic. For clarity, we refer to our 16 sector coverage as the 'expanded market sector'.
- Building up an output measure from final consumption components rather than sectoral gross value added — this allows a more accurate output measure to be used as interindustry flows of intermediates are netted out and more accurate records are available for end consumption components.
- Expressing both outputs and inputs in terms of producer prices — from the viewpoint of production theory (which is the theoretical basis for making productivity comparisons), the appropriate prices are the prices that producers face, which should not include final demand tax wedges. However, some commodity taxes (such as property taxes and tariffs on imports) fall on inputs to the production sector and so these taxes should be included in producer prices for productivity purposes. Subsidies also create problems in trying to determine what the 'correct' producer prices are for subsidised outputs.
- Constructing consistent capital and inventory inputs series — the US Bureau of Labor Statistics methodology currently used by the ABS for forming stocks and flows is not completely consistent. We use instead the Jorgenson geometric depreciation approach which is consistent. We also smooth the depreciation rates used by the ABS and push back ABS estimates for some capital stocks that start at substantial non–zero values part way through the time period.

In the remainder of this appendix we outline the sources for each of the variables in our TFP database, list some of the data used in constructing the variables and, finally, list the values and prices of all 32 variables.

Consumer commodity

The consumer commodity we include in the database is an aggregate of all household final consumption excluding housing services. While it would be ideal to include actual household rent paid as the purchase of rental accommodation from the production sector, there is insufficient data available to reliably separate the actual rental and imputed rental components of the National Accounts. Consequently, we exclude Rent and other dwelling services from household final consumption. The production of new dwellings, alterations and additions by the production sector is captured as an investment output.

ABS (2004, Cat No 5206, Tables 57 and 58) present constant and current dollar series for Total household final consumption and Rent and other dwelling services for the period 1959-60 to 2003-04.

Having value, price and quantity estimates for the Rent and other dwelling services and Total household final consumption categories it was then necessary to recover consistent estimates of the price and quantity of the residual category, Household final consumption excluding housing services. This was done by assuming that the overall price index was a chain Laspeyres index of the two components. This permits the residual or second component price index to be recovered as follows:

$$P_3^t = V_T^{t-1} P_T^t / \left(P_T^{t-1} X_3^{t-1} \right) - \left(P_1^t X_1^{t-1} + P_2^t X_2^{t-1} \right) / X_3^{t-1} \qquad \text{(A1)}$$

X_2^t

where P_T, X_T and V_T are the price, quantity and value of the overall aggregate category, respectively, and 1 and 2 refer to the two components. By setting the period *t*–1 price of Rent and other dwelling services and the residual equal to one, the period *t* price of the residual can be recovered using equation (1) above. The period *t* residual quantity, , is then obtained by dividing the residual value by its price for that period. This permits (1) to be used to recover the residual price for period *t*+1 and so on.

The consumption data components are listed in tables B2 and B3 in current prices and in constant 1959-60 prices. The data presented in tables B2 and B3 are all in consumer prices, ie at the prices which consumers face. The series used in our TFP model are valued at producer prices, ie at the prices producers face. These series are reported later in the appendix after we have described the allocation of consumer taxes.

Government consumption of intermediates

The expanded market sector of the economy supplies intermediate inputs used by the government sector. Consequently, in forming a series for government purchases from the expanded market sector we need to exclude Government administration and defence wages payments and consumption of fixed capital from total government consumption.

Total government consumption in constant and current dollars was obtained from ABS (2004, Cat No 5206, Tables 42 and 43). The derivation of the price and quantity of Government administration and defence labour inputs is described in the labour subsection below while Government administration and defence consumption of fixed capital in current and constant dollars was obtained from ABS (2004, Cat No 5204, Tables 92 and 93). An expanded version of equation (A1) was used to obtain the required residual government consumption commodity.

The relevant series are presented in Table A3.

Investment goods and inventory changes

Estimates of economy wide current dollar investment (or gross fixed capital formation in current dollars) are available from ABS (2004, Cat No 5204, Table 90) for the years 1960–2004 for the following 5 assets: (i) non-dwelling construction; (ii) livestock; (iii) computer software; (iv) mineral and petroleum exploration and (v) dwellings. The same table lists the current dollar purchases of these five asset types by the Government administration and defence industry (there were only purchases of non-dwelling construction and computer software by this general government sector). We will require this information on purchases by the general government sector later. Estimates of economy wide constant dollar investment (gross fixed capital formation, chain volume measures) are available for the same five asset types from ABS (2004, Cat No 5204, Table 91) for the years 1960–2004.

We divided the five value series by the corresponding volume or constant dollar series in order to obtain implicit price indexes for the five investment asset classes. Several problems were encountered:

- The ABS tables did not report the data for the early years for some components in the period 1960–2004 with a sufficient number of digits and so the resulting implicit price indexes sometimes showed unwarranted fluctuations. This was true for computer software, mineral and petroleum exploration and artistic originals.
- The value data and the corresponding chain volume data for computer software started abruptly at 1963 and 1965 respectively and the artistic originals value data and the corresponding chain volume data started abruptly at 1970 and 1972, respectively. It is certainly likely that there was investment in these assets in the years 1960–1962 and 1960–1969, respectively.
- It proved to be difficult to reconcile the ABS information on livestock stocks with the gross fixed capital formation information on livestock investment. A further complication is that the ABS is somehow able to distinguish livestock gross fixed capital formation from changes in livestock inventory.

We discuss the last problem first. We decided to combine livestock investment with livestock changes in inventories. We also found that the implicit prices that were obtained by dividing current dollar inventory change by the corresponding constant dollar inventory change were frequently difficult to interpret. The implicit prices corresponding to inventory change components of GDP can often be nonsensical because normal index number theory breaks down when an aggregate can be either positive or negative. Hence, we made our own estimates of constant dollar inventory change based on deflating inventory stocks and then inventory change series were generated by taking differences between the resulting beginning and end of year stocks. Our methodology for dealing with inventory change will be explained at the end of this section.

Turning to the first problem flagged above, the implicit price series for computer software investment was erratic over the period 1965 to 1980 due to rounding errors in the listing of the current and constant dollar data in Tables 90 and 91. The ABS (2000, Chapter 16, Paragraph 16.66) explained how it constructed its price series for software as follows:

> There is no Australian software price index currently available, although several countries have initiated development work to construct such indexes, and several experimental indexes over a limited time span have been published. Statistics Canada has developed an intuitive software price index in the Canadian SNA Input–Output Tables, which declines by 6% a year. This estimate is constructed by observing the trend of software prices over time for popular PC software. The ABS has chosen to use this index for the time being.

We adopted the ABS methodology by assuming that software prices declined at a 6 percent rate from 1960 to 1978 and then we linked the resulting price series to the 1978 ABS implicit price.

The implicit price for mineral and petroleum exploration was missing for 1960 and so we set it equal to 0.080 as the corresponding implicit prices implied by the ABS data in Tables 90 and 91 for the years 1961-1964 were 0.082, 0.082, 0.085 and 0.087, respectively.

We now turn to the problems involved in extending either the value or volume data for computer software back to 1960. The value of computer software investment in 1963 was $10 million and the corresponding 1973 value was $28 million. The implied annual geometric growth rate over this ten year period was 1.108449 or 10.8449 percent per year. We used this growth rate to extrapolate the value data back to 1960 from the 1963 value for computer software.

The above paragraphs explain how we constructed value, price and quantity (or volume) series for the four investment (or gross fixed capital formation) components: (i) non-dwelling construction; (ii) computer software; (iii) mineral and petroleum exploration; and (iv) dwellings. For purposes of reporting our data in the tables below, we renormalised the price and quantity data so that all price indexes were set equal to 1 in 1960. Thus, the corresponding quantity series can be interpreted as constant 1960 dollar series. These current and constant dollar series can be found in tables A5 and A6.

In order to form investment aggregates that are delivered to the expanded market sector, it is necessary to subtract the value of gross fixed capital formation in the Government administration and defence industry for non-dwelling construction and for computer software. These value data can be found in ABS Table 90. After this subtraction was done, the resulting value series were deflated by the implicit price data described in the paragraph above in order to obtain constant 2003 dollar estimates for market sector investment. These series will be used subsequently in order to construct market sector capital stock series for these assets.

We now turn our attention to the problems associated with the construction of machinery and equipment investment aggregates. Estimates of economy wide current dollar investment (or gross fixed capital formation in current dollars) are available from ABS (2004, Cat No 5204, Table 96) for the years 1960–2004 for the following 6 assets: (i) computers and peripherals; (ii) electrical and electronic equipment; (iii) industrial machinery and equipment; (iv) motor vehicles; (v) other transport equipment; (vi) other machinery and equipment. The same table lists the current dollar purchases of these six asset types by the Government administration and defence industry. In a manner that is similar to that explained in the paragraph above, we will use this information on purchases by the general government sector later in order to obtain machinery and equipment investment aggregates that are delivered to the expanded market sector so that these latter market sector investment aggregates can be used to form expanded market sector capital stock aggregates. Estimates of economy wide constant dollar investment (gross fixed capital formation, chain volume measures) are available for the same six machinery and equipment asset types from ABS (2004, Cat No 5204, Table 97) for the years 1960–2004.

We divided the six value series by the corresponding volume or constant dollar series in order to obtain implicit price indexes for the six machinery and equipment investment asset classes. Again, some problems were encountered:

- The ABS tables did not report the data for computers and peripherals for the years in the period 1971–1985 with a sufficient number of digits and so the resulting implicit price indexes sometimes showed unwarranted fluctuations.

- The value data and the corresponding chain volume data for computers started at 1961 and 1971 but it is likely that there was investment in these assets for the missing years.

The value of gross fixed capital formation for computers in 1961 was $4 million and in 1962 was $9 million. We set the value of computer investment in 1960 equal to $2 million.

In order to deal with the problem of fluctuating computer prices in the early years due to rounding problems, we calculated the annual geometric average rate of decrease in computer prices going from 1972 to 1986, which was 1 minus 0.8626534 or 13.73466 percent per year. We extrapolated prices backwards to 1960 from 1986 using this annual rate of decrease. We then generated new volume estimates for the years 1960–1985 by dividing the value series by these newly generated computer and peripherals prices.

The above paragraphs explain how we constructed value, price and quantity (or volume) series for the six machinery and equipment investment components. We then renormalised the price and quantity data so that all price indexes were set equal to 1 in 1960. Thus, the corresponding quantity series can be interpreted as constant 1960 dollar series. These current and constant dollar investment series can be found in tables A5 and A6.

We conclude this section with a description of our methods used to construct measures of inventory change. Before discussing the data, it is first necessary to provide a theoretical framework for measuring inventory change. As mentioned above, normal index number theory breaks down if the value aggregate switches sign going from the base period to the current period or if the value aggregate approaches 0 in the base period. (To see why there is a problem, consider the problem of calculating a Laspeyres price or quantity index when the base period value for the aggregate approaches 0). The framework described below avoids these technical problems and is based on the work of Diewert and Smith (1994).

Consider a firm that perhaps produces a *noninventory output* during period t, Y^t, uses a *noninventory input* X^t, *sells* the amount S^t of an *inventory item* during period t and makes *purchases* of the *inventory item* during period t in the amount B^t. Suppose that the *average prices* during period t of Y^t, X^t, S^t and B^t are $P_Y{}^t$, $P_X{}^t$, $P_S{}^t$ and $P_B{}^t$, respectively. Then neglecting balance sheet items, the firm's period t *cash flow* is:

(A2) $CF^t \equiv P_Y{}^t\, Y^t - P_X{}^t\, X^t + P_S{}^t\, S^t - P_B{}^t\, B^t.$

Let the firm's *beginning of period* t *stock of inventory* be K^t and let its *end of period stock of inventory* be K^{t+1}. These inventory stocks are valued at the *balance sheet prices* prevailing at the *beginning and end* of period t, $P_K^{\,t}$ and $P_K^{\,t+1}$, respectively. Note that in principle, all four prices involving inventory items, $P_S^{\,t}$, $P_B^{\,t}$, $P_K^{\,t}$ and $P_K^{\,t+1}$ can be different.

The firm's period t *economic income* is defined as its cash flow plus the value of its end of period t stock of inventory items less $(1+r^t)$ times the value of its beginning of period t stock of inventory items:

$$\text{(A3)}\ EI^t \equiv CF^t + P_K^{\,t+1} K^{t+1} - (1+r^t)\, P_K^{\,t} K^t$$

where r^t is the *nominal cost of capital* that the firm faces at the beginning of period t. Thus, in definition (A3), we assume that the firm has to borrow financial capital or raise equity capital at the cost r^t in order to finance its initial holdings of inventory items. This cost could be real (in the case of a firm whose initial capital is funded by debt) or it could be an opportunity cost (in the case of a firm entirely funded by equity capital).

The end of period stock of inventory is related to the beginning of the period stock by the following equation:

$$\text{(A4)}\ K^{t+1} = K^t + B^t - S^t - U^t$$

where U^t denotes inventory items that are *lost, spoiled, damaged or are used internally* by the firm. However, in the case of livestock inventories, there is a *natural growth rate of inventories* over the period so equation (A4) is replaced by:

$$\text{(A5)}\ K^{t+1} = K^t + B^t - S^t + G^t$$

where G^t denotes the natural growth of the stock over period t.

Define the *change in inventory stocks* over period t as:

$$\text{(A6)}\ \Delta K^t \equiv K^{t+1} - K^t\ .$$

Using (A6), both (A4) and (A5) can be written as:

$$\text{(A7)}\ K^{t+1} = K^t + \Delta K^t.$$

Now substitute (A7) into the definition of economic income (A3) and we obtain the following expression:

$$\text{(A8)}\ EI^t \equiv CF^t + P_K^{\,t+1} [K^t + \Delta K^t] - (1+r^t)\, P_K^{\,t} K^t$$

$$= CF^t + P_K^{t+1}\,\Delta K^t - [r^t P_K^t - (P_K^{t+1} - P_K^t)]\,K^t.$$

Thus *economic income is equal to cash flow plus the value of the change in inventory (valued at end of period balance sheet prices) minus the user cost of inventories times the starting stocks of inventories* where this period t *user cost* is defined as:

(A9) $P_I^t \equiv r^t P_K^t - (P_K^{t+1} - P_K^t)$.

Note that the above algebra works for both livestock and ordinary inventory items and can be implemented if we have price and quantity information on balance sheet assets.

Of course, there can be two versions of the user cost:

- an *ex post version* where the actual end of period balance sheet price of inventories is used; or
- an *ex ante version* where at the beginning of period t, we estimate a predicted value for the end of period balance sheet price.

Formula (A9) can be further simplified. Define the period t *asset inflation rate* i_K^t that corresponds to the inventory asset K under consideration by:

(A10) $1+i_K^t \equiv P_K^{t+1}/P_K^t$.

Substitution of (A10) into (A9) leads to the following formula for the *user cost of inventories*:

(A11) $P_u^t = (r^t - i_K^t)\,P_K^t \equiv r_K^{t}{*}\,P_K^t$

Note that $r_K^{t}{*} \equiv r^t - i_K^t$ is the nominal interest rate r^t less an asset specific (anticipated or ex post) inflation rate i_K^t. Thus, this difference can be set equal to an asset specific *real interest rate*. Substituting (A11) into (A8) leads to the following formula for economic income:

(A12) $EI^t = CF^t + P_K^{t+1}\,\Delta K^t - r_K^{t}{*}P_K^t\,K^t$.

Using (A12), we see that the value of capital services that the beginning of period t stock of inventories yields is $r_K^{t}{*}P_K^t\,K^t$ and the value of the change in inventories for period t is equal to $P_K^{t+1}\,\Delta K^t$. The ABS (and other sources to be noted later) provide estimates of the beginning of the period value of various inventory stocks in current and constant dollars and so the beginning of period t prices, P_K^t, and the corresponding constant (chained) dollar stocks, K^t, can be identified from this official information for various types of inventories. Then these stock components can be differenced to form the corresponding change in stocks, ΔK^t, and according to our theoretical methodology, these measures of stock change should be valued at the end of period t prices, P_K^{t+1}. This is the methodology that we used for three types of inventory change: (i) non–farm inventories; (ii) farm inventories and (iii) livestock inventories. The details of the sources of our data for these three types of inventory are in the inventory section below. The derivation of $r_K^{t}*$ is described later in equation (A16).

The three series on the value of inventory change using the above methodology can be found in Table A4 while the corresponding constant dollar measures can be found in Table A5.

Exports and imports

Constant and current price series for aggregate exports and imports of goods and services were obtained from ABS (2004, Cat No 5206, Tables 42 and 43). They are presented in Table A6 along with the corresponding price indexes.

Labour

We assemble the price and quantity of labour input series from a number of sources. We have the number of hours worked by employed persons by industry from ABS (2004, Cat No 6291, Table 11) covering the years 1985-86 to 2003-04. We subtract the number of hours worked in the Government administration and defence industry from the total number of hours worked by employed persons to obtain the quantity of labour used in the expanded market sector. We extend the total hours worked and Government administration and defence industry hours worked back to 1974-75 using the index series presented in Industry Commission (1997). The total hours worked is indexed back by the IC's All Industries index and the Government administration and defence industry hours worked is indexed back by the IC's Other activities index, the closest proxy available. For the 10 year overlap period the Government administration and defence industry hours worked index moves closely with the IC's Other activities index.

We then index the total hours worked and Government administration and defence industry hours worked series back to 1960-61 using changes from the total employment and General government employment series, respectively, in OECDEOL. The series are then indexed back to 1959-60 using the change in total employment from the RBAAES Butlin series, Table 4.7.

We derive the cost of employees from ABS (2004, Cat No 5204, Table 59) on compensation of employees by industry for 1989-90 to 2003-04 and for all industries for 1959-60 to 2003-04. For the years where industry detail is available we subtract Government administration and defence industry compensation from that for all industries. For the years prior to 1989-90 we scale the total for all industries down by the proportion accounted for by Government administration and defence in 1989-90 multiplied by the ratio of Other activity hours to All industry hours from IC (1997) for 1974-75 to 1989-90 and by the ratio of General government to Total employment from OECDEOL for 1960-61 to 1973-74 — the latter terms reflecting the more rapid growth in government hours worked in the earlier years. We then scale the resulting compensation of employees series up by the ratio of self employed hours worked to employees hours worked to obtain an estimate of the total cost of labour inputs in the expanded market sector.

We form estimates of the hours worked per week by self employed persons for the years 1978-79 to 1999-2000 from ABS Table 6203A in EconData (2000). This table provides the distribution of numbers of self employed by ranges of number of hours worked per week. The number of hours worked is formed by assuming those in each hours per week range work the midpoint number of hours for that range. This series is updated to 2003-04 by assuming self employed hours are the same proportion of total employee hours as they were in 1999-2000. Similarly, the series is backdated to 1974-75 by assuming the same proportion of total employee hours worked as in 1978-79. The self employed hours series is indexed back for the years 1960-61 to 1973-74 using the self employed numbers series in OECDEOL. It is again extended back to 1959-60 using the change in total employment from the RBAAES Butlin series, Table 4.7.

In Table A7 we present the total weekly number of hours worked in the expanded market sector, the total estimated weekly number of hours worked by the self employed (including unincorporated employers) and the value, price and implicit quantity of the labour input for the sector.

Taxation

To allow the formation of a database in producers’ prices we have to identify those taxes and subsidies falling on the production sector. The principal data source we use is ABS (2004, Cat No 5206, Table 72) which contains the main tax aggregates for the entire 45 year period and a detailed breakdown of indirect taxes from 1972-73 onwards.

Aggregate consumption taxes (excluding import duties) are formed by aggregating the following ABS components from 1972-73 onwards: sales tax, goods and services tax, excise duties, gambling taxes, taxes on insurance, motor vehicle taxes, gas and petroleum taxes, tobacco and liquor taxes and other taxes. The 1972-73 value is indexed back to 1960-61 using changes in OECDEOL Indirect taxes less

Import Duties. The 1959–60 value is obtained by indexing the 1959–60 value back by an analogous series from RBAAES.

Import duties are obtained from the ABS source from 1972-73 onwards and from RBAAES Table 2.17 for earlier years.

Business property taxes were assembled from a number of sources. Firstly, land tax was available from the ABS source from 1972-73 onwards. This was indexed back to 1959-60 using changes in RBAAES, Table 2.19, Receipts of state & local general government from other property taxes, fees and fines. Secondly, total municipal rates were formed in an analogous manner from ABS from 1972-73 onwards and the same RBAAES series for earlier years. Next, the ABS supplied us with the value of municipal rates paid by domestic households for the years 1989-90 to 2002-03. This was estimated for earlier years by multiplying estimated total municipal rates by the proportion of domestic municipal rates in total rates in 1989-90. Finally, business property taxes were formed as the sum of estimated land tax plus total municipal rates less estimated domestic municipal rates.

Municipal rates in Australia are generally applied to the ‘unimproved capital value’ of land. In addition, rental properties are subject to an additional land tax. Consequently, the proportion of rates applicable to business properties plus land tax are spread across commercial and rural land.

The ABS line ‘Taxes on financial and capital transactions’ contains mainly stamp duties on property transfers, minor assorted property transfer taxes and the Bank Accounts Debits (BAD) tax. Based on information from the Victorian Budget for 2004 (Cht 3 *State Revenue*), around 10 per cent of Taxes on financial and capital transactions are attributable to the BAD while around 90 per cent are mainly property transfer related. Consequently, we allocate all this item to property transfers.

While commercial and rural land and Nonresidential and other construction (NROC) make up around 60 per cent of the total capital stock of Commercial and Rural land, NROC and Dwellings (based on ABS data), based on data for the three years 1999-2000 to 2001-02 Commercial and Rural land and NROC make up only around 20 per cent of overall property transactions. That is, there is much higher turnover of the stock of Dwellings than of Commercial and Rural land and NROC. The data for the value of sales of dwellings and commercial properties came from Real Estate Institute of Australia (2003) while the data on the value of rural land sales came from Elders (2004). Consequently, we allocate 20 per cent of the ABS line ‘Taxes on financial and capital transactions’ across NROC, Commercial land and Rural land.

The value of subsidies is obtained from ABS (2004, Cat No 5204, Table 40). Based on information from the Productivity Commission, we allocate one third of subsidies as being output related and two thirds as being a general offset to the level of capital taxation.

Consumption taxes are assumed to apply to the consumer commodity and government consumption. Import duties only apply to the imports while subsidies are assumed to apply to the production of the consumer commodity, government consumption and exports. Business property taxes are assumed to apply to non–residential and other construction, commercial land and rural land. Tax and subsidy rates are formed by dividing the value of the tax or subsidy by the value of items it is spread over. Taking the consumer commodity as an example, producer prices are formed as follows:

(A13) $PP_C = CP_C\,(1 + s)\,(1 - t_c)$

where PP_C and CP_C are the consumer commodity producer price and consumer price, respectively, and s and t_c are the subsidy rate and consumption tax rate, respectively.

Capital taxes are formed by summing individual taxes from 'net tax instalments' and 'other' less net tax instalments times the scale up factor for self employed hours relative to employee hours worked, plus company taxes, non-resident taxes, plus one fifth of taxes on financial and capital transactions, less two thirds of subsidies.

In Table A8 we present the values of consumption taxes, import duties, subsidies, business property taxes and capital taxes and the corresponding tax and subsidy rates.

Capital stocks and capital service flows

Recall that in the Investment Goods and Inventory Changes section above, we described how investment aggregates that were delivered to the expanded market sector were formed for 10 reproducible capital stock components. In this section, we denote these constant 2003 chained dollar investment demands by the expanded market sector for asset n in year t by Q_n^t, where n = 1,…,10 and t = 1960, 1961,…, 2004.

Economy wide net capital stock (in constant 2003 chained dollars) estimates for the Australian economy are available for most years in our sample from the ABS. The source for the first five assets (non-dwelling construction, computer software, mineral and petroleum exploration and dwellings) is ABS (2004, Cat No 5204, Table 89) and the source for the next six assets (computers and peripherals, electrical and electronic equipment, industrial machinery and equipment, motor vehicles, other transport equipment, and other machinery and equipment) is ABS (2004, Cat No 5204, Table 95). These two tables also have industry estimates for the net capital stock in constant 2003 chained dollars so we subtracted the net capital stock estimates for government administration and defence from the corresponding total economy estimates to obtain net capital stock estimates for the above 11 asset classes for our expanded market sector. Denote the resulting expanded market sector beginning of year t constant chained 2003 dollar estimated net capital stock for asset n by K_n^t for n = 1,2,…,11.

The ABS constructed its net capital stocks using a variety of methods and it is unlikely that the ABS user costs for these 11 capital stock inputs are exactly consistent with the ABS methodology used to construct these net stocks; for additional materials on obtaining consistent stock and flow estimates, see Hulten (1990) (1996), Diewert and Lawrence (2000) and Diewert (2004). In order to make our capital input flow estimates consistent with our stock estimates, we decided to use the geometric (or declining balance) depreciation model pioneered by Dale Jorgenson and his associates due to its simplicity; see Jorgenson (1989) (1996), Jorgenson and Griliches (1967) (1972) and Christensen and Jorgenson (1969) for examples of the use of this method.

If we have estimates for the beginning of year t constant chained dollar net capital stock for the expanded market sector, K_n^t, and say 10 years later at the beginning of year t+10, K_n^{t+10}, for a capital stock component n and if we have the corresponding annual constant chained dollar investments for the years t, t+1, … , t+9, Q_n^t, Q_n^{t+1}, … , Q_n^{t+9}, and if there is a constant annual geometric depreciation rate δ_n over these years, then the beginning and end of decade net stocks of capital for this asset class are related by the following equation if the geometric model of depreciation is true:

(A14) $K_n^{t+10} = Q_n^{t+9} + (1-\delta_n)\, Q_n^{t+8} + (1-\delta_n)^2\, Q_n^{t+7} + (1-\delta_n)^3\, Q_n^{t+6} + \ldots + (1-\delta_n)^9\, Q_n^t + (1-\delta_n)^{10}\, K_n^t$.

The above equation implicitly assumes that investments made in year t do not contribute to production until the following year.

We can now explain how we constructed capital stocks that were consistent with the geometric model of depreciation. For each of the 11 asset classes, we took benchmark data on beginning and ending capital stocks from Tables 89 and 95 that corresponded to our expanded market sector, took the corresponding expanded market sector investment data and used equation (A14) (or a modification of it to cover different starting and ending periods) and found for the geometric depreciation rate δ_n that solved equation (A14) or its counterpart. Once this balancing depreciation rate has been found, we can build up the corresponding geometric capital stock for all of the years in the decade by using the following equation in a recursive manner:

(A15) $K_n^{t+1} = Q_n^t + (1-\delta_n)\, K_n^t$.

The resulting internally generated capital stock series will be exactly consistent with the corresponding official ABS series at the two endpoints but will not necessarily be consistent in between the endpoints. Our strategy was to pick the reference endpoint capital stocks to be as far apart as possible initially and we then compared our constructed geometric depreciation rate stocks with the corresponding ABS stock. If we found that our internally generated series did not track the corresponding ABS series well, we then chose reference endpoint capital stocks that were closer together and estimated constant geometric rates between these new more closely spaced endpoints. We continued this process until our stocks were reasonably close to the corresponding ABS net capital stock series. In some cases where ABS reference stocks were not available for the early years in our sample, we extrapolated the stocks backwards using the last available ABS stocks and the depreciation rates that were estimated by our procedure that pertained to the last available ABS stocks.

The resulting geometric depreciation rates are listed in Table A9. Given these depreciation rates, the expanded market sector constant 2003 dollar investment series Q_n^t and the 2004 expanded market sector constant 2003 dollar ABS end of 2004 capital stock estimates, equation (A15) can be rearranged to recursively define beginning of the year capital stocks back to 1960. These capital stock estimates were then multiplied by the corresponding constant 2003 chained dollar investment prices that were described earlier in order to obtain current dollar geometric net capital stock series for each of our 10 reproducible capital assets. These current dollar estimates can be found in Table A10. The 2003 chained dollar investment prices were then renormalised so that they equalled unity in 1960 and thus they became chained 1960 capital stock prices, P_{Kn}^t. These 1960 chained prices were then divided into the corresponding capital stock values in order to obtain the constant 1960 chained dollar capital stock estimates that appear in Table A11.

In order to calculate r^t, we use the beginning of period user cost, assuming that the asset price inflation rate is expected to equal the general inflation rate, i. This user cost for asset k is:

$$
\begin{aligned}
\text{(A16) } u_k^t &\equiv P_k^t + [\tau + \tau_k - (1-\delta_k)]\, P_k^t(1+i^t)/(1+r^t)(1+i^t) \\
&= P_k^t + [\tau + \tau_k - (1-\delta_k)]\, P_k^t/(1+r^t) \\
&= [(1+r^t) + \tau + \tau_k - (1-\delta_k)]\, P_k^t/(1+r^t) \\
&= [r^t + \delta_k + \tau + \tau_k] P_k^t/(1+r^t).
\end{aligned}
$$

where τ is the general capital tax rate and τ_k is the asset specific capital tax rate. Now for each year t, we find the balancing real rate of return r^t by solving the following equation:

$$\text{(A17)}\ [\textstyle\sum_{j=1}^{18} p_j^t q_j^t\,](1+r^t) = \sum_{k=1}^{14} [r^t + \delta_k + \tau + \tau_k] V_k^t.$$

In the first summation, an input gets a negative sign for the corresponding quantity.

The relevant information on user costs and user cost components can be found in Tables A8, A9 and A12.

Inventory stocks

Data on chain volume (stock) measures of inventories and land for the years 1963-64 to 2003-04 were obtained from data the ABS supplies annually to the Productivity Commission and from which the Productivity Commission then derives industry MFP measures. These data are contained in a spreadsheet the ABS labels 'Prodcom2004.xls'. The ABS also supplied us with corresponding price indices by industry for the years 1963-64 to 2002-03. The price indices were updated to 2003-04 by assuming the same percentage change as occurred in 2002-03 and backdated to 1959-60 by assuming the same percentage change in each of the years before 1963-64 as occurred on average over the 5 years 1963-64 to 1968-69.

The chain volume measures were initially summed across the corporate and unincorporated sectors for each industry (because each sector has the same price index) and then aggregated over industries using the price indexes supplied by ABS. The resulting aggregates were then compared with data available from alternative sources including other ABS tables and an earlier Australian database assembled by Diewert and Lawrence (1999; 2002). Where the alternative series coincided reasonably closely the 'Prodcom2004.xls' based source was used. Where a series from this source diverged from alternative sources which appeared more reliable over some periods, a composite series was formed.

The 'Prodcom2004.xls' based series were used for commercial land and farm and non–farm inventories as these series coincided closely with alternative information available. However, the 'Prodcom2004.xls' based series for agricultural land and livestock exhibited erratic behaviour compared to alternative series. Consequently, we have formed an agricultural land value series from 'Prodcom2004.xls' for the years 1959-60 to 1966-67, from Diewert and Lawrence (1999) for the years 1967-68 to 1987-88 and from ABS (2004, Cat No 5204, Table 83) for the years 1988-89 to 2003-04. A livestock series is formed by joining series from 'Prodcom2004.xls' for the years 1959-60 to 1966-67, from Diewert and Lawrence

(1999) for the years 1967-68 to 1987-88 and from ABS (2004, Cat No 5204, Table 81) for the years 1988-89 to 2003-04. The Diewert and Lawrence (1999) agricultural land series was based on unpublished data compiled by Robert Dippelsman while the corresponding livestock series were built up from ABS data on the numbers of four different types of livestock and corresponding price indexes from ABARE's *Commodity Statistical Bulletins*.

In Table A9 we present the depreciation rates used in the study while in tables A10 and A11 we present the current and constant price estimates, respectively, of the capital and inventory stocks. In Table A12 we present the current price estimates of the user costs of capital and inventories.

TFP database

The data listed in tables A1 to A12 which are used to form the TFP database are in consumer prices. As noted at the outset, the data used in the TFP database itself are all in producer prices. The values, price indexes and quantities of the 32 output and input variables in the TFP database are listed in tables A13, A14 and A15, respectively.

Table A2 **Final consumption components, 1960–2004, current and constant prices**

Year	*Total* *$m*	*Rent, etc* *$m*	*Residual* *$m*	*Total* *$m1960*	*Rent, etc* *$m1960*	*Residual* *$m1960*
1960	9,378	815	8,563	9,378	815	8,563
1961	9,957	934	9,023	9,568	837	8,730
1962	10,260	1,038	9,222	9,805	878	8,924
1963	10,985	1,148	9,837	10,362	920	9,440
1964	11,928	1,260	10,668	11,091	962	10,132
1965	12,931	1,371	11,560	11,644	1,006	10,643
1966	13,746	1,495	12,251	11,960	1,056	10,903
1967	14,848	1,664	13,184	12,558	1,122	11,431
1968	16,212	1,848	14,364	13,212	1,176	12,033
1969	17,656	2,062	15,594	13,925	1,235	12,687
1970	19,532	2,336	17,196	14,772	1,302	13,472
1971	21,515	2,704	18,811	15,352	1,370	13,974
1972	23,853	3,098	20,755	15,937	1,440	14,481
1973	26,690	3,535	23,155	16,743	1,511	15,215
1974	31,692	4,112	27,580	17,741	1,587	16,145
1975	38,688	5,052	33,636	18,418	1,661	16,741
1976	45,460	6,264	39,196	18,675	1,735	16,859
1977	52,831	7,588	45,243	19,484	1,821	17,565
1978	58,875	8,924	49,951	19,872	1,919	17,792
1979	65,686	10,343	55,343	20,325	2,021	18,109
1980	73,828	11,906	61,922	20,785	2,135	18,346
1981	84,097	13,743	70,354	21,563	2,252	18,950
1982	96,451	15,876	80,575	22,595	2,372	19,865
1983	108,702	18,125	90,577	22,982	2,469	20,125
1984	118,840	19,877	98,963	23,403	2,555	20,409
1985	128,746	21,883	106,863	23,895	2,660	20,813
1986	144,503	24,621	119,882	24,969	2,768	21,613
1987	158,640	27,577	131,063	25,233	2,861	21,730
1988	177,450	31,424	146,026	26,063	2,955	22,449
1989	197,426	36,035	161,391	27,255	3,068	23,510
1990	218,729	40,370	178,359	28,582	3,180	24,709
1991	233,726	43,954	189,772	28,770	3,287	24,722
1992	245,463	46,283	199,180	29,351	3,386	25,152
1993	255,545	48,146	207,399	29,896	3,482	25,556
1994	265,897	50,427	215,470	30,589	3,601	26,080
1995	282,870	52,891	229,979	32,089	3,731	27,436
1996	301,069	55,987	245,082	33,308	3,864	28,487
1997	314,566	59,319	255,247	34,274	3,985	29,291
1998	335,102	63,055	272,047	35,917	4,108	30,805
1999	354,419	66,984	287,435	37,649	4,252	32,402
2000	374,921	70,838	304,083	39,174	4,388	33,775
2001	404,270	75,213	329,057	40,314	4,534	34,714
2002	426,155	79,003	347,152	41,626	4,681	35,841
2003	452,045	82,507	369,538	43,213	4,863	37,199
2004	483,416	86,478	396,938	45,612	5,040	39,413

Table A3 **Govt consumption components, 1960–2004, current and constant prices**

Year	*Total $m*	*Wages $m*	*Cons Cap $m*	*Residual $m*	*Total $m1960*	*Wages $m1960*	*Cons Cap $m1960*	*Residual $m1960*
1960	1,804	317	53	1,434	1,804	317	53	1,434
1961	1,952	327	59	1,566	1,875	332	57	1,485
1962	2,089	368	64	1,657	1,947	355	62	1,531
1963	2,215	397	70	1,748	2,037	358	67	1,613
1964	2,426	433	76	1,917	2,139	357	72	1,713
1965	2,766	496	87	2,183	2,331	386	80	1,868
1966	3,146	555	100	2,491	2,577	408	90	2,086
1967	3,556	632	116	2,808	2,759	434	101	2,232
1968	4,111	716	132	3,263	3,042	456	112	2,488
1969	4,358	813	150	3,395	3,093	471	123	2,512
1970	4,839	910	168	3,761	3,250	472	132	2,668
1971	5,547	1,008	189	4,350	3,393	486	142	2,792
1972	6,336	1,245	213	4,878	3,534	550	151	2,846
1973	7,197	1,569	242	5,386	3,654	575	161	2,930
1974	8,592	1,787	285	6,520	3,733	522	170	3,096
1975	11,768	2,247	383	9,138	4,058	579	180	3,351
1976	14,715	2,611	471	11,633	4,410	589	191	3,703
1977	16,695	2,958	538	13,199	4,468	609	200	3,730
1978	18,612	3,282	605	14,725	4,599	629	208	3,834
1979	20,534	3,732	664	16,138	4,763	659	215	3,961
1980	23,116	4,325	762	18,029	4,879	669	221	4,065
1981	27,123	5,113	866	21,144	5,111	699	227	4,265
1982	31,042	5,827	985	24,230	5,164	719	233	4,288
1983	35,346	6,400	1,139	27,807	5,324	719	239	4,453
1984	39,266	7,337	1,242	30,687	5,587	759	248	4,669
1985	44,793	8,095	1,335	35,363	6,005	799	258	5,049
1986	49,760	8,814	1,527	39,419	6,257	808	271	5,296
1987	54,287	9,933	1,732	42,622	6,456	827	285	5,470
1988	58,277	11,243	1,883	45,151	6,662	866	301	5,619
1989	63,178	12,637	2,019	48,522	6,829	799	316	5,926
1990	68,597	12,903	2,248	53,446	6,988	868	338	5,969
1991	74,663	13,575	2,444	58,644	7,230	919	363	6,136
1992	79,553	14,272	2,557	62,724	7,380	876	388	6,354
1993	83,037	14,754	2,674	65,609	7,512	909	411	6,429
1994	84,440	15,486	2,844	66,110	7,570	932	437	6,438
1995	87,736	16,019	2,990	68,727	7,817	908	467	6,732
1996	92,956	16,993	3,103	72,860	8,134	972	495	6,953
1997	96,173	18,582	3,120	74,471	8,251	939	521	7,133
1998	101,332	19,229	3,200	78,903	8,562	861	543	7,645
1999	108,266	20,053	3,345	84,868	8,909	886	569	7,975
2000	113,305	20,139	3,488	89,678	9,169	884	607	8,253
2001	120,390	21,219	3,633	95,538	9,356	934	645	8,346
2002	127,413	23,684	3,787	99,942	9,554	993	680	8,434
2003	136,819	25,530	4,072	107,217	9,970	1,074	724	8,722
2004	146,807	27,626	4,103	115,078	10,294	1,098	766	9,018

Table A4 **Investment goods and inventory changes, 1960–2004, current prices**

Year	*Non-Res & Oth Const.* *$m*	*Software* *$m*	*Mineral Exploration* *$m*	*Dwellings* *$m*	*Computers* *$m*	*Electrical machinery* *$m*
1960	1,164	7	21	666	2	201
1961	1,274	8	25	731	4	211
1962	1,394	9	36	669	9	225
1963	1,463	10	52	741	14	251
1964	1,673	12	63	850	19	266
1965	1,926	12	82	997	30	307
1966	2,179	14	95	1,018	40	352
1967	2,311	14	103	1,086	50	370
1968	2,454	15	128	1,222	65	410
1969	2,803	16	158	1,403	75	426
1970	3,067	16	210	1,608	85	448
1971	3,483	17	253	1,694	106	499
1972	3,805	21	220	1,984	132	548
1973	3,933	28	211	2,374	150	555
1974	4,669	42	209	2,920	178	593
1975	5,941	56	203	2,904	258	774
1976	6,677	105	178	4,060	318	904
1977	7,563	151	222	5,124	345	911
1978	8,153	188	285	5,599	434	1,113
1979	9,092	217	369	5,862	560	1,357
1980	9,932	253	617	6,850	648	1,461
1981	11,669	366	912	8,649	839	1,830
1982	14,300	473	1,439	9,549	1,027	2,219
1983	15,376	529	1,423	8,361	1,134	2,383
1984	15,452	760	1,295	9,609	1,319	2,563
1985	17,361	1,051	1,257	11,492	1,527	2,765
1986	20,963	1,356	1,190	12,500	2,002	3,364
1987	23,131	1,950	755	12,025	2,419	3,759
1988	25,765	2,408	1,302	13,600	2,726	3,782
1989	28,030	2,624	1,334	18,763	3,218	4,144
1990	31,844	3,573	1,192	20,450	3,690	4,354
1991	29,552	3,886	1,186	19,068	3,561	3,687
1992	26,046	4,056	1,075	19,228	3,710	3,479
1993	24,514	5,060	1,244	22,262	4,275	3,639
1994	25,252	5,316	1,301	24,803	5,076	4,106
1995	28,056	5,386	1,582	26,738	6,048	4,662
1996	31,294	5,411	1,685	23,753	6,377	4,951
1997	34,402	6,344	2,001	23,596	6,413	5,099
1998	36,803	7,328	2,049	28,021	7,947	5,229
1999	40,457	9,162	1,706	30,833	8,195	5,412
2000	38,882	10,883	1,400	37,335	9,495	4,955
2001	33,885	12,718	1,727	33,322	8,561	6,649
2002	37,045	12,282	1,523	39,957	9,027	5,632
2003	44,937	12,235	1,727	47,926	9,818	7,242
2004	50,134	12,235	1,731	55,345	9,861	7,344

Table A4 (continued)

Year	*Industrial machinery* *$m*	*Motor vehicles* *$m*	*Oth transp. equipment* *$m*	*Other machinery* *$m*	*Non–farm inventories* *$m*	*Farm inventories* *$m*	*Livestock* *$m*
1960	385	485	90	344	194	209	41
1961	436	504	83	366	214	202	39
1962	454	489	90	374	235	196	34
1963	501	540	96	405	258	190	35
1964	523	654	91	431	504	478	-117
1965	656	711	110	521	193	-67	-22
1966	745	719	126	578	230	-367	85
1967	774	779	131	592	324	-156	232
1968	822	794	166	640	472	1,215	344
1969	917	905	153	683	513	-26	357
1970	998	884	160	720	882	-563	468
1971	1,166	937	152	822	10	-33	584
1972	1,240	1,016	201	882	203	-1,756	152
1973	1,179	1,214	198	877	461	-1,349	423
1974	1,279	1,394	216	949	1,155	81	371
1975	1,534	1,630	295	1,195	106	-654	111
1976	1,762	2,172	307	1,371	886	-958	-159
1977	1,902	2,553	296	1,407	-620	-520	-203
1978	2,230	2,767	388	1,627	595	-1,085	-202
1979	2,863	3,453	406	1,962	1,009	-1,192	-80
1980	2,888	3,796	479	2,027	1,069	-736	-296
1981	3,772	4,458	629	2,492	796	317	-4
1982	4,829	5,063	746	2,982	-2,244	-699	-893
1983	4,949	4,551	812	3,037	821	-112	-216
1984	5,000	5,441	961	3,189	1,910	1	285
1985	5,686	6,273	1,045	3,561	344	-306	-446
1986	6,377	7,037	1,531	4,036	-1,643	-890	-287
1987	7,199	8,112	1,760	4,447	574	-1,059	280
1988	7,959	9,365	1,479	4,460	3,578	-594	259
1989	8,915	10,399	1,589	5,104	5,644	414	1,401
1990	8,564	10,209	2,103	5,164	-813	952	-719
1991	7,348	8,951	1,604	4,476	-2,282	-1,054	615
1992	6,807	8,527	1,575	4,226	1,275	-868	29
1993	7,810	9,852	1,355	4,549	1,328	-266	117
1994	9,698	8,581	1,312	5,096	2,039	126	-404
1995	11,038	10,998	1,523	5,477	219	959	401
1996	10,871	12,203	1,597	6,301	2,019	-857	282
1997	10,374	12,993	1,699	6,797	-697	-1,781	-163
1998	10,286	13,921	2,445	6,866	4,998	175	15
1999	10,367	14,198	2,542	7,081	3,320	-311	167
2000	10,785	13,298	4,706	7,982	1,664	-1,920	-191
2001	11,280	15,831	2,502	7,677	1,365	-714	-12
2002	11,660	16,412	4,489	8,865	726	-830	-571
2003	12,407	17,713	6,395	8,495	6,327	113	-196
2004	11,840	17,542	6,003	8,248	6,823	124	-185

Table A5 **Investment goods and inventory changes, 1960–2004, constant prices**

Year	*Non-Res & Oth Const. $m1960*	*Software $m1960*	*Mineral Exploration $m1960*	*Dwellings $m1960*	*Computers $m1960*	*Electrical machinery $m1960*
1960	1,164	7	21	666	2	201
1961	1,233	9	24	706	5	207
1962	1,286	10	35	647	12	218
1963	1,335	12	49	715	22	241
1964	1,486	15	58	802	34	255
1965	1,630	16	69	916	63	286
1966	1,812	20	78	907	97	319
1967	1,828	22	82	941	141	327
1968	1,879	25	99	1,029	212	356
1969	2,054	28	118	1,149	283	357
1970	2,148	30	149	1,260	372	361
1971	2,298	34	171	1,263	538	381
1972	2,336	44	135	1,371	777	394
1973	2,227	63	119	1,495	1,024	385
1974	2,266	100	99	1,518	1,408	385
1975	2,224	142	73	1,236	2,366	406
1976	2,126	283	55	1,499	3,381	416
1977	2,182	432	61	1,689	4,252	377
1978	2,174	573	71	1,741	6,201	412
1979	2,274	674	86	1,767	9,275	457
1980	2,205	840	129	1,929	12,441	447
1981	2,297	1,285	174	2,170	18,672	516
1982	2,486	1,756	243	2,131	26,495	582
1983	2,341	2,087	217	1,699	33,914	561
1984	2,221	3,168	187	1,863	45,727	577
1985	2,365	4,644	172	2,078	61,366	608
1986	2,611	6,362	155	2,078	93,265	681
1987	2,677	9,696	94	1,878	125,131	696
1988	2,793	12,699	157	2,002	177,981	684
1989	2,824	14,633	154	2,376	257,256	743
1990	2,994	21,148	130	2,320	308,552	763
1991	2,697	24,368	122	2,087	332,645	643
1992	2,419	26,951	109	2,098	387,827	608
1993	2,307	35,629	123	2,421	487,310	613
1994	2,360	39,535	128	2,653	637,311	686
1995	2,544	42,449	154	2,791	929,542	791
1996	2,751	45,210	161	2,435	1,191,461	837
1997	2,963	56,141	189	2,403	1,667,113	917
1998	3,085	68,738	189	2,828	2,468,415	935
1999	3,309	91,019	155	3,051	3,102,618	978
2000	3,073	115,030	122	3,523	4,864,550	808
2001	2,608	142,986	145	2,795	4,605,740	1,119
2002	2,819	146,867	126	3,300	5,558,598	952
2003	3,302	155,673	138	3,806	7,630,636	1,277
2004	3,497	165,827	135	4,088	10,684,290	1,394

Table A5 (continued)

Year	*Industrial machinery $m1960*	*Motor vehicles $m1960*	*Oth transp. equipment $m1960*	*Other machinery $m1960*	*Non–farm inventories $m1960*	*Farm inventories $m1960*	*Livestock $m1960*
1960	385	485	90	344	188	221	45
1961	427	495	82	359	199	225	45
1962	440	475	86	362	212	230	45
1963	481	521	92	388	225	235	46
1964	502	629	86	412	424	626	-139
1965	612	665	101	485	157	-93	-22
1966	675	653	114	523	181	-502	89
1967	686	691	115	523	247	-203	232
1968	717	693	143	556	349	1,553	362
1969	769	760	128	571	369	-38	381
1970	808	725	128	581	616	-798	490
1971	892	750	115	627	7	-43	624
1972	895	778	144	635	132	-2,220	154
1973	818	897	136	607	286	-1,368	329
1974	833	962	139	616	654	69	381
1975	806	942	154	626	51	-567	179
1976	812	1,057	141	630	373	-775	-248
1977	789	1,117	122	582	-235	-380	-248
1978	828	1,111	143	603	209	-752	-214
1979	967	1,263	136	661	327	-718	-51
1980	885	1,275	146	619	306	-371	-152
1981	1,068	1,392	176	703	206	144	-2
1982	1,271	1,442	195	783	-538	-315	-492
1983	1,169	1,238	190	715	180	-47	-114
1984	1,129	1,391	215	716	395	1	133
1985	1,255	1,561	228	781	68	-118	-196
1986	1,266	1,517	276	784	-301	-329	-131
1987	1,286	1,455	280	775	99	-358	116
1988	1,347	1,558	246	746	573	-177	100
1989	1,503	1,685	293	866	870	114	794
1990	1,400	1,611	366	846	-122	272	-535
1991	1,153	1,378	262	691	-337	-329	476
1992	1,037	1,254	241	654	188	-256	24
1993	1,125	1,333	188	677	192	-74	99
1994	1,356	1,071	169	761	294	35	-309
1995	1,552	1,339	213	824	31	257	314
1996	1,496	1,457	223	927	278	-243	245
1997	1,437	1,632	255	1,006	-98	-530	-129
1998	1,377	1,740	330	998	697	50	11
1999	1,296	1,786	295	1,004	464	-90	112
2000	1,375	1,682	542	1,125	228	-552	-107
2001	1,405	2,070	266	1,091	178	-169	-5
2002	1,403	2,195	448	1,222	94	-173	-252
2003	1,529	2,298	662	1,169	809	22	-92
2004	1,549	2,308	693	1,160	864	22	-91

Table A6 **Aggregate exports and imports, 1960–2004, current and constant prices**

	Exports			Imports		
Year	*$m*	*Price index*	*$m1960*	*$m*	*Price index*	*$m1960*
1960	2,147	1.000	2,147	2,332	1.000	2,332
1961	2,168	0.962	2,254	2,636	1.005	2,624
1962	2,468	0.964	2,561	2,243	0.997	2,250
1963	2,489	0.994	2,504	2,656	1.006	2,640
1964	3,158	1.083	2,916	2,920	0.994	2,936
1965	3,050	1.049	2,908	3,535	1.011	3,497
1966	3,136	1.063	2,949	3,683	1.025	3,593
1967	3,484	1.064	3,274	3,770	1.032	3,653
1968	3,574	1.041	3,432	4,224	1.052	4,015
1969	3,897	1.066	3,656	4,360	1.050	4,153
1970	4,765	1.120	4,256	4,871	1.083	4,499
1971	5,086	1.090	4,667	5,214	1.124	4,637
1972	5,685	1.133	5,017	5,351	1.248	4,288
1973	7,016	1.371	5,117	5,512	1.268	4,346
1974	7,896	1.643	4,807	7,996	1.414	5,656
1975	10,114	1.918	5,273	10,510	1.815	5,792
1976	11,225	2.045	5,490	11,163	2.027	5,507
1977	13,425	2.284	5,877	14,106	2.339	6,030
1978	14,245	2.371	6,009	15,342	2.669	5,748
1979	16,910	2.628	6,436	18,260	2.938	6,214
1980	22,017	3.196	6,890	21,444	3.447	6,221
1981	22,604	3.448	6,556	25,530	3.751	6,807
1982	23,696	3.531	6,711	29,660	3.901	7,603
1983	25,632	3.798	6,748	29,667	4.260	6,963
1984	28,892	3.977	7,266	32,162	4.355	7,385
1985	35,739	4.262	8,385	40,790	4.742	8,602
1986	38,948	4.475	8,703	47,199	5.500	8,582
1987	44,306	4.602	9,627	49,032	5.997	8,176
1988	51,742	4.930	10,496	54,080	5.954	9,083
1989	55,354	5.191	10,663	62,296	5.518	11,289
1990	60,899	5.443	11,189	68,771	5.774	11,911
1991	66,259	5.303	12,495	66,948	5.962	11,230
1992	70,080	5.145	13,622	69,269	5.951	11,639
1993	76,899	5.292	14,530	79,077	6.392	12,371
1994	83,015	5.207	15,942	85,396	6.469	13,200
1995	87,654	5.243	16,718	97,654	6.349	15,381
1996	99,095	5.377	18,429	101,078	6.317	16,002
1997	105,160	5.165	20,360	103,590	5.889	17,591
1998	113,744	5.388	21,112	118,482	6.139	19,301
1999	112,025	5.200	21,542	126,456	6.250	20,233
2000	126,222	5.347	23,607	140,811	6.167	22,834
2001	153,854	6.071	25,341	153,205	6.796	22,545
2002	153,340	6.116	25,074	154,573	6.706	23,049
2003	148,530	5.956	24,939	167,169	6.391	26,157
2004	143,178	5.689	25,168	167,275	5.655	29,582

Table A7 **Expanded market sector labour inputs, 1960–2004**

Year	*Total weekly hours* *’000 hours*	*Self employed weekly hours* *’000 hours*	*Value* *$m*	*Price* *Index*	*Quantity* *$m1960*
1960	146,302	24,264	8,286	1.000	8,286
1961	153,330	25,430	8,939	1.029	8,684
1962	153,899	25,571	9,194	1.054	8,720
1963	157,988	26,237	9,735	1.088	8,950
1964	161,624	26,819	10,645	1.163	9,155
1965	165,384	27,489	11,946	1.275	9,371
1966	170,684	28,281	12,913	1.336	9,665
1967	173,501	28,894	14,119	1.436	9,835
1968	177,882	28,962	15,284	1.523	10,038
1969	182,191	28,822	16,793	1.642	10,225
1970	187,445	28,607	18,778	1.797	10,451
1971	194,625	29,539	21,589	1.992	10,840
1972	198,591	29,951	23,954	2.168	11,049
1973	201,157	30,682	26,565	2.369	11,214
1974	207,706	31,187	32,571	2.821	11,547
1975	211,273	36,660	43,280	3.584	12,077
1976	208,363	36,155	49,981	4.196	11,911
1977	208,092	33,770	55,597	4.738	11,736
1978	207,821	35,575	61,533	5.194	11,846
1979	212,962	36,953	66,046	5.425	12,174
1980	215,600	37,979	73,558	5.950	12,364
1981	220,741	38,638	84,769	6.706	12,641
1982	220,470	37,961	98,061	7.794	12,582
1983	212,148	37,309	109,196	8.979	12,161
1984	214,380	37,995	115,109	9.351	12,310
1985	224,933	39,371	126,219	9.799	12,881
1986	232,141	41,227	139,371	10.451	13,336
1987	239,167	41,524	150,274	10.990	13,673
1988	247,867	42,340	164,288	11.633	14,123
1989	257,848	43,052	182,777	12.499	14,623
1990	269,832	43,233	205,135	13.513	15,180
1991	264,609	43,468	214,362	14.330	14,958
1992	258,473	43,808	218,280	14.846	14,703
1993	257,176	44,351	227,809	15.516	14,682
1994	265,821	45,707	237,081	15.632	15,166
1995	277,775	45,381	249,133	15.883	15,686
1996	284,728	46,500	267,850	16.660	16,077
1997	285,926	44,365	283,351	17.721	15,989
1998	290,565	46,364	297,088	18.189	16,334
1999	295,332	44,644	314,027	19.104	16,437
2000	302,802	45,651	332,035	19.711	16,845
2001	307,568	46,370	353,027	20.632	17,110
2002	306,638	46,229	369,407	21.655	17,059
2003	311,997	47,037	392,892	22.636	17,357
2004	316,529	47,721	414,157	23.520	17,609

Table A8 **Taxes and subsidies, 1960–2004**

Year	*Consumption tax* *$m*	*Import duties* *$m*	*Subsidies* *$m*	*Bus property tax* *$m*	*Capital taxes* *$m*
1960	1,099	168	66	107	795
1961	1,142	202	77	116	803
1962	1,126	170	115	129	798
1963	1,163	210	101	138	849
1964	1,266	232	135	149	1,001
1965	1,367	268	123	161	1,143
1966	1,537	271	167	172	1,067
1967	1,643	275	191	190	1,127
1968	1,797	312	207	207	1,333
1969	1,999	346	289	223	1,407
1970	2,189	414	281	237	1,795
1971	2,358	466	358	258	1,698
1972	2,676	469	465	278	1,789
1973	3,026	515	509	306	2,268
1974	3,675	616	604	349	2,748
1975	4,302	882	773	458	2,603
1976	5,545	1,048	861	563	3,289
1977	6,138	1,334	1,038	642	3,658
1978	6,777	1,232	1,339	696	3,174
1979	7,973	1,518	1,595	755	3,188
1980	9,424	1,630	1,831	838	4,562
1981	10,734	1,916	2,244	944	4,762
1982	12,089	2,158	2,576	1,045	3,922
1983	14,404	2,104	3,178	1,230	3,280
1984	16,591	2,398	3,525	1,334	4,804
1985	18,812	2,995	3,957	1,488	5,787
1986	20,557	3,358	4,352	1,690	5,847
1987	22,145	3,314	4,581	1,879	9,644
1988	24,485	3,711	4,778	2,105	11,876
1989	26,088	3,831	4,642	2,366	13,346
1990	28,799	4,026	4,820	2,842	15,660
1991	29,601	3,377	5,739	3,349	15,911
1992	28,700	3,350	6,017	3,535	13,431
1993	30,421	3,337	6,492	3,315	12,587
1994	34,282	3,231	6,662	3,165	14,819
1995	37,586	3,479	6,309	2,973	16,215
1996	40,970	3,129	6,351	3,310	16,389
1997	42,398	3,295	7,020	3,558	20,114
1998	43,622	3,644	7,200	3,869	22,575
1999	47,138	3,748	6,490	3,615	24,375
2000	47,958	3,799	6,335	3,722	31,636
2001	56,835	4,606	8,442	4,218	34,403
2002	60,083	5,214	9,605	4,317	34,088
2003	65,602	5,572	10,264	4,843	40,725
2004	69,511	5,647	10,732	5,000	45,054

Table A8 (continued)

Year	*Consumption tax rate* %	*Import duty rate* %	*Subsidy rate* %	*Business property tax rate* %	*Capital tax rate on assets* %
1960	10.99	7.20	0.54	1.23	1.76
1961	10.79	7.66	0.60	1.26	1.71
1962	10.35	7.58	0.86	1.34	1.62
1963	10.04	7.91	0.72	1.35	1.67
1964	10.06	7.95	0.86	1.38	1.87
1965	9.95	7.58	0.73	1.42	1.97
1966	10.42	7.36	0.93	1.43	1.71
1967	10.28	7.29	0.98	1.42	1.68
1968	10.20	7.39	0.98	1.49	1.85
1969	10.53	7.94	1.26	1.28	1.71
1970	10.44	8.50	1.09	1.28	2.05
1971	10.18	8.94	1.27	1.29	1.77
1972	10.44	8.76	1.48	1.28	1.68
1973	10.60	9.34	1.43	1.36	1.98
1974	10.78	7.70	1.44	1.44	2.07
1975	10.06	8.39	1.46	1.52	1.56
1976	10.91	9.39	1.39	1.69	1.72
1977	10.50	9.46	1.44	1.68	1.68
1978	10.48	8.03	1.70	1.61	1.30
1979	11.15	8.31	1.80	1.71	1.20
1980	11.79	7.60	1.80	1.73	1.48
1981	11.73	7.50	1.97	1.63	1.33
1982	11.53	7.28	2.00	1.56	0.96
1983	12.17	7.09	2.21	1.55	0.69
1984	12.80	7.46	2.22	1.69	0.95
1985	13.23	7.34	2.22	1.68	1.05
1986	12.90	7.11	2.20	1.69	0.94
1987	12.75	6.76	2.10	1.66	1.38
1988	12.81	6.86	1.97	1.63	1.55
1989	12.43	6.15	1.75	1.61	1.58
1990	12.42	5.85	1.65	1.77	1.70
1991	11.92	5.04	1.82	2.01	1.64
1992	10.96	4.84	1.81	2.14	1.38
1993	11.14	4.22	1.86	2.24	1.29
1994	12.18	3.78	1.83	2.13	1.48
1995	12.58	3.56	1.63	1.89	1.57
1996	12.89	3.10	1.52	1.97	1.51
1997	12.86	3.18	1.61	1.84	1.77
1998	12.43	3.08	1.55	1.89	1.90
1999	12.66	2.96	1.34	1.64	1.93
2000	12.18	2.70	1.22	1.59	2.38
2001	13.39	3.01	1.46	1.69	2.47
2002	13.44	3.37	1.60	1.61	2.34
2003	13.76	3.33	1.64	1.68	2.67
2004	13.58	3.38	1.64	1.61	2.80

Table A9 **Capital depreciation rates, 1960–2004**

Year	*Non-Residential & Other Constr.* %	*Software* %	*Mineral Exploration* %	*Artistic Originals* %	*Computers* %
1960	3.60	12.29	6.26	59.04	9.86
1961	3.60	12.29	6.26	59.04	9.86
1962	3.60	12.29	6.26	59.04	9.86
1963	3.60	12.29	6.26	59.04	9.86
1964	3.60	12.29	6.26	59.04	9.86
1965	3.60	12.29	6.26	59.04	9.86
1966	3.60	12.29	6.26	59.04	9.86
1967	3.60	12.29	6.26	59.04	9.86
1968	3.60	12.29	6.26	59.04	9.86
1969	3.60	12.29	6.26	59.04	9.86
1970	3.60	12.29	6.26	59.04	9.86
1971	3.60	12.29	6.26	59.04	9.86
1972	3.60	12.29	6.26	59.04	9.86
1973	3.60	12.29	6.26	59.04	9.86
1974	3.60	15.00	6.26	59.04	9.86
1975	3.60	17.00	6.26	59.04	9.86
1976	3.60	19.12	6.26	60.71	9.86
1977	3.60	19.12	6.26	60.71	9.86
1978	3.60	19.12	6.26	60.71	9.86
1979	3.60	19.12	6.26	60.71	9.86
1980	3.60	19.12	6.26	60.71	9.86
1981	3.60	19.12	6.26	62.38	9.86
1982	3.60	19.12	6.26	62.38	9.86
1983	3.60	19.12	6.26	62.38	9.86
1984	3.60	19.12	6.26	62.38	9.86
1985	3.60	19.12	6.26	62.38	15.00
1986	3.60	19.12	6.26	62.38	20.00
1987	3.60	19.12	6.26	62.38	24.00
1988	3.60	19.12	6.26	62.38	28.00
1989	3.60	19.12	6.26	62.38	31.00
1990	3.60	20.00	6.26	62.38	34.00
1991	3.60	22.00	6.26	62.38	36.00
1992	3.60	23.00	6.26	62.38	38.00
1993	3.60	24.00	6.26	62.38	39.00
1994	3.60	25.00	6.26	62.38	40.31
1995	3.60	26.00	6.26	62.38	40.40
1996	3.60	27.00	6.26	62.38	40.40
1997	3.60	27.99	6.26	62.38	40.40
1998	3.60	27.99	6.26	62.38	40.40
1999	3.60	27.99	6.26	62.38	40.40
2000	3.60	27.99	6.26	62.38	40.40
2001	3.60	27.99	6.26	62.38	40.40
2002	3.60	27.99	6.26	62.38	40.40
2003	3.60	27.99	6.26	62.38	40.40
2004	3.60	27.99	6.26	62.38	40.40

Table A9 (continued)

Year	*Electrical machinery* %	*Industrial machinery* %	*Motor vehicles* %	*Other transport equipment* %	*Other machinery* %
1960	10.25	11.52	13.66	11.65	13.21
1961	10.25	11.52	13.66	11.65	13.21
1962	10.25	11.52	13.66	11.65	13.21
1963	10.25	11.52	13.66	11.65	13.21
1964	10.25	11.52	13.66	11.65	13.21
1965	10.25	11.52	13.66	11.65	13.21
1966	10.25	11.52	13.66	11.65	13.21
1967	10.25	11.52	13.66	11.65	13.21
1968	10.25	11.52	13.66	11.65	13.21
1969	10.25	11.52	13.66	11.65	13.21
1970	10.25	11.52	13.66	11.65	13.21
1971	10.25	11.52	13.66	11.65	13.21
1972	10.25	11.52	13.66	11.65	13.21
1973	10.25	11.52	13.66	11.65	13.21
1974	10.25	11.52	13.66	11.65	13.21
1975	11.41	11.58	11.58	11.61	13.15
1976	11.41	11.58	11.58	11.61	13.15
1977	11.41	11.58	11.58	11.61	13.15
1978	11.41	11.58	11.58	11.61	13.15
1979	11.41	11.58	11.58	11.61	13.15
1980	11.41	11.58	11.58	11.61	13.15
1981	11.41	11.58	10.41	11.61	13.15
1982	11.41	11.58	10.41	11.61	13.15
1983	11.41	11.58	10.41	11.61	13.15
1984	11.41	11.58	10.41	11.61	13.15
1985	11.41	11.58	10.41	11.61	13.15
1986	11.41	11.58	10.41	11.61	13.15
1987	11.41	11.58	10.41	11.61	13.15
1988	11.41	11.58	10.41	11.61	13.15
1989	11.41	11.58	10.41	11.61	13.15
1990	11.41	11.58	10.41	11.61	13.15
1991	11.41	11.58	10.41	11.61	13.15
1992	11.41	11.58	10.41	11.61	13.15
1993	11.41	11.58	10.41	11.61	13.15
1994	11.41	11.58	10.41	11.61	13.15
1995	11.41	11.58	10.41	11.61	13.15
1996	11.41	11.58	10.41	11.61	13.15
1997	11.41	11.58	10.41	11.61	13.15
1998	11.41	11.58	10.41	11.61	13.15
1999	11.41	11.58	10.41	11.61	13.15
2000	11.41	11.58	10.41	11.61	13.15
2001	11.41	11.58	10.41	11.61	13.15
2002	11.41	11.58	10.41	11.61	13.15
2003	11.41	11.58	10.41	11.61	13.15
2004	11.41	11.58	10.41	11.61	13.15

Table A10 **Capital and inventory stocks, 1960–2004, current prices**

Year	*Non-Res & Other Const.* *$m*	*Software* *$m*	*Mineral Exploration* *$m*	*Computers* *$m*	*Electrical machinery* *$m*	*Industrial machinery* *$m*
1960	10,004	7	44	8	1,181	1,912
1961	11,068	12	63	8	1,278	2,114
1962	12,434	18	85	9	1,368	2,326
1963	13,417	23	119	14	1,458	2,529
1964	14,666	29	168	22	1,550	2,736
1965	16,464	30	240	32	1,693	3,018
1966	17,946	31	315	48	1,865	3,413
1967	20,247	33	404	69	2,057	3,839
1968	22,282	35	495	94	2,234	4,224
1969	24,750	37	615	124	2,484	4,726
1970	27,621	40	771	156	2,732	5,266
1971	31,225	43	980	189	3,043	5,969
1972	35,780	45	1,287	232	3,403	6,819
1973	41,146	51	1,554	287	3,715	7,542
1974	50,422	58	1,980	344	4,123	8,353
1975	68,558	72	2,733	410	5,284	10,719
1976	84,006	94	3,229	523	6,169	12,516
1977	96,004	156	3,606	659	7,027	14,218
1978	107,603	246	3,939	786	7,915	16,119
1979	118,551	362	4,255	961	8,887	18,094
1980	138,176	453	4,856	1,203	10,106	20,732
1981	160,665	559	5,693	1,460	11,220	22,935
1982	187,777	737	7,053	1,816	12,587	25,819
1983	221,984	963	8,910	2,253	14,824	30,772
1984	241,897	1,189	10,290	2,665	16,143	33,566
1985	261,247	1,559	11,584	3,094	17,177	35,441
1986	293,140	2,083	12,681	3,458	19,433	41,091
1987	325,180	2,752	13,643	4,143	22,393	47,408
1988	357,794	3,785	14,016	4,242	23,988	51,796
1989	397,400	5,017	15,094	4,512	25,118	53,909
1990	439,374	6,075	16,484	5,778	26,857	58,281
1991	467,711	7,583	17,651	6,338	28,111	62,559
1992	470,555	8,901	17,991	6,438	28,420	64,444
1993	472,008	9,904	18,328	6,623	29,648	67,425
1994	481,459	11,439	18,522	7,116	30,080	69,433
1995	503,041	12,566	18,870	7,135	30,174	70,651
1996	527,521	13,272	19,647	7,875	31,440	75,057
1997	549,452	13,699	20,339	7,511	30,775	76,680
1998	578,119	14,787	21,544	8,580	32,507	80,860
1999	607,907	16,434	22,528	10,271	33,617	87,473
2000	647,115	19,026	23,933	10,053	38,930	85,966
2001	679,207	22,240	24,580	14,158	38,118	88,794
2002	695,323	26,115	25,118	14,445	40,076	92,909
2003	730,832	28,357	26,007	13,582	39,285	91,555
2004	787,984	29,611	26,691	12,475	38,826	87,826

Table A10 (continued)

Year	*Motor vehicles $m*	*Oth transp. equipment $m*	*Other machin'y $m*	*Non–farm invent's $m*	*Farm invent's $m*	*Livestock $m*	*Commer-cial land $m*	*Rural land $m*
1960	2,173	429	1,770	3,063	10,139	5,767	3,017	5,689
1961	2,401	474	1,895	3,365	9,816	5,395	3,293	5,866
1962	2,596	514	2,017	3,696	9,504	5,047	3,597	6,050
1963	2,746	544	2,122	4,060	9,201	4,439	3,932	6,239
1964	2,915	581	2,231	4,460	8,908	4,536	4,301	6,434
1965	3,250	622	2,402	5,120	8,919	4,883	4,710	6,635
1966	3,610	672	2,641	5,492	8,383	5,826	5,184	6,842
1967	3,914	739	2,896	5,927	8,087	5,593	5,670	7,740
1968	4,210	797	3,109	6,406	8,344	6,106	6,209	7,706
1969	4,589	898	3,423	7,102	9,726	6,153	6,787	10,698
1970	4,968	984	3,734	7,800	8,588	6,404	7,396	11,067
1971	5,281	1,085	4,142	8,928	8,179	7,006	8,117	11,898
1972	5,725	1,173	4,626	9,118	8,882	7,451	8,944	12,828
1973	6,158	1,288	5,038	9,746	7,381	8,041	9,900	12,571
1974	6,966	1,423	5,533	10,722	7,858	10,884	11,254	13,030
1975	8,814	1,821	7,043	12,904	9,416	8,581	13,172	16,900
1976	11,142	2,161	8,219	15,246	8,615	5,601	15,651	17,667
1977	13,328	2,460	9,337	18,349	8,273	5,616	18,618	19,622
1978	15,576	2,761	10,508	19,738	8,642	6,957	21,866	21,441
1979	18,108	3,102	11,714	21,898	8,024	7,842	24,929	19,126
1980	21,139	3,464	13,262	24,819	8,046	13,053	27,590	20,890
1981	24,152	3,833	14,547	29,168	8,864	15,805	30,384	27,559
1982	28,563	4,313	16,139	32,990	10,148	15,629	33,946	32,850
1983	32,037	5,079	18,813	33,409	9,542	13,800	38,009	41,559
1984	35,338	5,539	20,172	37,353	10,282	14,118	42,138	36,654
1985	37,998	5,983	21,002	41,515	10,786	16,287	46,704	42,000
1986	46,438	7,678	24,392	43,751	10,722	16,887	53,358	46,600
1987	58,315	9,402	27,839	45,538	10,283	15,975	62,378	51,100
1988	64,900	9,617	29,503	49,250	10,214	17,864	73,787	55,600
1989	69,175	9,012	29,331	56,309	10,992	19,478	86,944	60,100
1990	74,127	10,115	31,307	64,153	12,260	14,651	98,325	62,300
1991	78,280	11,741	33,866	65,195	12,805	10,444	102,346	64,600
1992	82,503	12,818	33,419	63,888	10,661	10,664	98,408	66,700
1993	89,268	14,172	34,198	65,343	10,437	9,648	91,311	56,600
1994	97,001	14,934	33,746	67,750	10,735	9,844	88,446	59,800
1995	97,524	13,393	33,808	70,008	10,844	10,528	92,320	65,100
1996	99,849	13,356	35,264	72,520	12,268	10,712	99,957	67,800
1997	96,231	12,450	36,424	75,598	10,754	9,915	107,568	86,300
1998	99,363	14,124	38,894	73,043	8,458	10,740	113,649	91,200
1999	101,933	17,372	41,477	78,961	8,936	12,071	120,508	100,500
2000	104,585	17,988	43,156	82,190	8,513	12,824	129,723	104,800
2001	103,012	21,902	44,542	85,494	6,694	15,245	139,880	109,900
2002	105,181	23,233	47,243	90,893	7,412	19,919	148,149	120,200
2003	113,357	24,054	49,231	92,675	7,592	18,677	154,600	133,100
2004	116,773	24,697	49,209	99,959	8,312	17,269	159,666	151,600

Table A11 **Capital and inventory stocks, 1960–2004, constant prices**

Year	*Non-Res & Oth Const.* *$m1960*	*Software* *$m1960*	*Mineral Exploration* *$m1960*	*Computers* *$m1960*	*Electrical machinery* *$m1960*	*Industrial machinery* *$m1960*
1960	10,004	7	44	8	1,181	1,912
1961	10,716	13	62	9	1,254	2,072
1962	11,467	20	83	13	1,324	2,255
1963	12,240	28	112	22	1,398	2,429
1964	13,028	37	154	40	1,486	2,625
1965	13,930	41	203	67	1,577	2,816
1966	14,923	46	259	117	1,688	3,094
1967	16,014	52	321	195	1,818	3,401
1968	17,064	58	383	305	1,941	3,683
1969	18,138	65	458	468	2,079	3,961
1970	19,343	75	547	682	2,204	4,261
1971	20,606	84	662	961	2,324	4,566
1972	21,966	95	791	1,364	2,448	4,919
1973	23,303	113	876	1,960	2,574	5,235
1974	24,475	139	941	2,722	2,676	5,437
1975	25,661	182	981	3,759	2,769	5,630
1976	26,753	253	992	5,562	2,837	5,768
1977	27,703	447	985	8,118	2,907	5,895
1978	28,694	748	984	11,236	2,933	5,987
1979	29,647	1,126	994	15,914	2,992	6,108
1980	30,679	1,504	1,018	23,089	3,089	6,354
1981	31,628	1,963	1,083	32,484	3,165	6,491
1982	32,649	2,736	1,189	46,861	3,302	6,794
1983	33,800	3,798	1,357	67,393	3,491	7,266
1984	34,765	4,958	1,489	92,386	3,634	7,578
1985	35,583	6,890	1,583	124,353	3,779	7,820
1986	36,509	9,775	1,656	161,079	3,937	8,158
1987	37,638	13,686	1,707	214,302	4,147	8,471
1988	38,781	19,960	1,695	276,930	4,340	8,766
1989	40,043	27,977	1,746	360,721	4,501	9,088
1990	41,307	35,956	1,791	483,130	4,705	9,527
1991	42,688	47,548	1,809	592,047	4,904	9,815
1992	43,708	59,142	1,817	672,976	4,969	9,822
1993	44,412	69,739	1,812	755,000	4,995	9,714
1994	45,000	85,075	1,821	893,486	5,025	9,707
1995	45,605	99,040	1,835	1,096,646	5,123	9,932
1996	46,366	110,894	1,874	1,471,372	5,317	10,326
1997	47,319	121,228	1,917	1,952,516	5,537	10,620
1998	48,460	138,710	1,986	2,665,160	5,811	10,821
1999	49,718	163,265	2,050	3,888,731	6,074	10,939
2000	51,137	201,102	2,077	5,150,244	6,349	10,963
2001	52,281	250,042	2,069	7,616,811	6,417	11,060
2002	52,903	312,278	2,085	8,894,428	6,778	11,178
2003	53,698	360,803	2,081	10,555,834	6,926	11,280
2004	54,969	401,332	2,088	13,516,672	7,369	11,491

Table A11 (continued)

Year	*Motor vehicles $m1960*	*Oth transp. equipment $m1960*	*Other machin'y $m1960*	*Non–farm invent's $m1960*	*Farm invent's $m1960*	*Livestock $m1960*	*Commer-cial land $m1960*	*Rural land $m1960*
1960	2,173	429	1,770	3,063	10,139	5,767	3,017	5,689
1961	2,357	468	1,860	3,251	10,360	5,812	3,112	5,689
1962	2,524	494	1,952	3,450	10,585	5,857	3,213	5,689
1963	2,648	522	2,035	3,662	10,816	5,902	3,319	5,689
1964	2,802	552	2,133	3,887	11,051	5,948	3,432	5,689
1965	3,038	574	2,234	4,311	11,677	5,809	3,551	5,689
1966	3,278	607	2,388	4,468	11,584	5,787	3,694	5,689
1967	3,471	649	2,557	4,649	11,081	5,876	3,821	5,689
1968	3,675	688	2,703	4,896	10,879	6,108	3,965	5,689
1969	3,852	749	2,860	5,245	12,431	6,470	4,117	5,689
1970	4,073	788	3,015	5,614	12,394	6,852	4,266	5,689
1971	4,229	823	3,161	6,230	11,596	7,342	4,422	5,689
1972	4,385	841	3,330	6,236	11,553	7,966	4,565	5,689
1973	4,548	885	3,487	6,369	9,333	8,120	4,675	5,689
1974	4,806	917	3,592	6,655	7,965	8,449	4,778	5,689
1975	5,093	948	3,690	7,309	8,034	8,830	4,864	5,689
1976	5,423	989	3,779	7,360	7,467	9,009	4,930	5,689
1977	5,829	1,013	3,860	7,734	6,692	8,761	5,006	5,689
1978	6,254	1,016	3,893	7,498	6,312	8,513	5,082	5,689
1979	6,623	1,039	3,945	7,707	5,560	8,299	5,167	5,689
1980	7,103	1,053	4,052	8,034	4,843	8,248	5,249	5,689
1981	7,541	1,075	4,104	8,340	4,472	8,096	5,345	5,689
1982	8,134	1,125	4,235	8,546	4,616	8,094	5,459	5,689
1983	8,717	1,188	4,431	8,008	4,301	7,602	5,558	5,689
1984	9,032	1,239	4,528	8,188	4,254	7,488	5,630	5,689
1985	9,459	1,308	4,607	8,583	4,255	7,621	5,704	5,689
1986	10,009	1,383	4,736	8,651	4,137	7,425	5,793	5,689
1987	10,458	1,497	4,849	8,350	3,807	7,294	5,877	5,689
1988	10,799	1,603	4,933	8,448	3,450	7,410	5,958	5,689
1989	11,206	1,662	4,977	9,021	3,273	7,510	6,050	5,689
1990	11,694	1,761	5,130	9,892	3,387	8,304	6,155	5,689
1991	12,047	1,921	5,232	9,770	3,659	7,769	6,224	5,689
1992	12,129	1,959	5,175	9,433	3,330	8,245	6,276	5,689
1993	12,074	1,970	5,086	9,621	3,074	8,269	6,320	5,689
1994	12,110	1,929	5,042	9,813	3,000	8,369	6,365	5,689
1995	11,876	1,872	5,083	10,107	3,035	8,059	6,426	5,689
1996	11,923	1,866	5,190	10,138	3,292	8,373	6,500	5,689
1997	12,090	1,870	5,393	10,416	3,049	8,618	6,580	5,689
1998	12,418	1,906	5,654	10,318	2,519	8,489	6,670	5,689
1999	12,821	2,013	5,882	11,015	2,569	8,500	6,777	5,689
2000	13,226	2,072	6,080	11,478	2,479	8,612	6,845	5,689
2001	13,467	2,328	6,328	11,706	1,926	8,505	6,874	5,689
2002	14,066	2,321	6,511	11,885	1,757	8,500	6,920	5,689
2003	14,704	2,491	6,774	11,979	1,584	8,247	7,004	5,689
2004	15,364	2,852	6,920	12,788	1,606	8,155	7,093	5,689

Table A12 **Capital and inventory annual user costs, 1960–2004, current prices**

Year	*Non-Res & Other Const.* *$m*	*Software* *$m*	*Mineral Exploration* *$m*	*Computers* *$m*	*Electrical machinery* *$m*	*Industrial machinery* *$m*
1960	958.2	1.2	5.3	1.2	187.4	326.6
1961	972.6	2.1	7.1	1.1	193.4	345.7
1962	1,255.2	3.3	10.7	1.5	223.7	408.2
1963	1,306.2	4.2	14.6	2.2	233.5	435.5
1964	1,694.1	5.6	23.5	3.9	274.5	517.0
1965	1,461.7	5.2	27.3	4.8	257.8	496.6
1966	1,514.3	5.3	34.5	7.0	276.1	547.1
1967	1,859.9	5.8	47.1	10.5	318.8	641.8
1968	2,524.4	6.8	68.0	16.0	391.0	789.5
1969	2,319.4	6.6	72.9	18.9	389.3	798.1
1970	2,606.1	7.1	91.9	24.0	430.4	893.6
1971	2,618.9	7.1	106.8	27.2	449.2	954.4
1972	2,419.1	6.9	119.8	29.8	450.6	988.0
1973	3,489.8	8.5	170.5	41.5	551.6	1,212.3
1974	4,046.9	11.1	208.5	48.3	594.7	1,308.1
1975	3,036.6	12.8	192.8	43.8	647.3	1,331.2
1976	4,616.3	19.7	260.9	61.1	816.1	1,676.9
1977	5,346.1	32.8	293.9	77.4	934.0	1,913.5
1978	6,254.8	51.9	330.2	94.0	1,067.7	2,201.2
1979	8,069.5	79.5	397.5	123.7	1,278.6	2,633.2
1980	9,980.2	101.2	473.2	159.6	1,494.0	3,099.1
1981	11,456.5	124.2	549.0	192.2	1,647.3	3,405.0
1982	10,268.5	153.1	565.8	210.6	1,652.7	3,433.1
1983	13,163.6	203.4	755.2	270.9	2,007.8	4,218.7
1984	17,079.3	262.7	983.2	348.2	2,353.1	4,947.9
1985	17,164.1	338.1	1,050.6	545.9	2,426.2	5,064.3
1986	18,536.8	447.2	1,119.4	772.0	2,699.2	5,775.4
1987	23,679.5	614.5	1,331.4	1,122.4	3,312.6	7,091.2
1988	29,877.6	878.4	1,507.8	1,348.9	3,777.0	8,239.9
1989	34,586.2	1,178.4	1,672.5	1,577.1	4,031.7	8,740.9
1990	31,563.2	1,405.5	1,590.6	2,130.8	3,949.9	8,667.8
1991	33,113.9	1,897.2	1,688.3	2,457.0	4,111.1	9,252.3
1992	37,688.2	2,375.1	1,881.2	2,654.1	4,391.5	10,063.0
1993	38,797.9	2,752.3	1,950.7	2,800.9	4,632.1	10,643.9
1994	38,994.0	3,280.6	1,944.7	3,098.1	4,661.8	10,874.2
1995	41,660.7	3,746.9	2,017.5	3,123.2	4,732.5	11,196.0
1996	45,194.2	4,112.9	2,155.1	3,459.3	5,012.4	12,088.4
1997	45,237.8	4,350.0	2,163.8	3,290.8	4,814.8	12,122.4
1998	53,887.1	4,819.1	2,519.2	3,820.3	5,411.6	13,592.3
1999	51,697.6	5,256.7	2,454.4	4,522.7	5,343.5	14,047.5
2000	55,990.8	6,125.7	2,640.9	4,451.6	6,249.1	13,940.3
2001	60,423.3	7,207.1	2,773.3	6,296.1	6,209.8	14,611.1
2002	64,565.2	8,531.5	2,930.7	6,451.5	6,671.5	15,617.9
2003	70,359.8	9,357.4	3,120.5	6,110.9	6,669.6	15,693.0
2004	80,446.5	9,903.9	3,349.9	5,661.1	6,796.4	15,516.3

Table A12 (continued)

Year	Motor vehicles $m	Oth transp. equipment $m	Other machin'y $m	Non–farm invent's $m	Farm invent's $m	Livestock $m	Commer-cial land $m	Rural land $m
1960	415.7	73.8	330.9	185.9	615.3	350.0	220.8	416.4
1961	442.1	78.2	340.7	176.6	515.3	283.2	215.4	383.6
1962	508.2	90.9	386.2	244.5	628.7	333.9	285.9	480.9
1963	529.0	94.3	399.6	253.4	574.2	277.0	298.7	473.9
1964	609.4	110.6	457.1	362.0	723.1	368.1	407.8	610.0
1965	601.9	103.1	434.4	273.0	475.6	260.4	319.0	449.3
1966	653.5	108.6	466.7	268.3	409.6	284.6	329.0	434.2
1967	734.6	124.6	531.1	335.8	458.2	316.9	402.2	549.1
1968	871.4	150.0	630.6	505.0	657.8	481.4	580.6	720.5
1969	869.1	152.9	633.7	416.0	569.6	360.4	485.3	764.9
1970	945.2	168.3	694.4	460.7	507.2	378.2	533.4	798.1
1971	953.9	174.8	730.2	431.2	395.0	338.4	499.4	732.1
1972	950.2	171.5	747.3	286.5	279.1	234.2	400.3	574.2
1973	1,117.8	208.7	892.6	477.6	361.7	394.0	625.1	793.8
1974	1,236.4	224.7	957.8	473.9	347.3	481.0	666.0	771.1
1975	1,094.5	226.7	985.8	95.6	69.7	63.5	308.0	395.1
1976	1,492.6	290.2	1,229.6	278.7	157.5	102.4	562.1	634.5
1977	1,793.6	331.9	1,402.5	349.1	157.4	106.8	680.6	717.4
1978	2,126.8	377.9	1,597.9	429.6	188.1	151.4	840.3	823.9
1979	2,635.0	452.4	1,884.3	702.1	257.3	251.4	1,237.4	949.3
1980	3,159.6	518.9	2,185.5	897.9	291.1	472.2	1,489.0	1,127.4
1981	3,308.3	570.2	2,382.3	1,027.1	312.1	556.6	1,582.1	1,435.0
1982	3,465.4	574.9	2,396.4	599.0	184.2	283.7	1,172.9	1,135.0
1983	4,021.8	697.9	2,868.9	774.0	221.1	319.7	1,487.5	1,626.5
1984	4,804.4	818.2	3,281.2	1,289.4	354.9	487.3	2,193.6	1,908.0
1985	4,991.7	856.8	3,323.6	1,215.3	315.8	476.8	2,189.5	1,969.0
1986	5,990.9	1,081.6	3,803.4	1,170.9	287.0	452.0	2,375.6	2,074.8
1987	8,053.3	1,409.4	4,589.8	1,658.1	374.4	581.7	3,360.2	2,752.6
1988	9,586.3	1,532.9	5,140.4	2,313.0	479.7	839.0	4,755.3	3,583.2
1989	10,431.9	1,464.0	5,198.7	2,837.2	553.8	981.4	5,900.3	4,078.6
1990	10,169.4	1,507.5	5,137.0	2,247.0	429.4	513.2	5,300.5	3,358.5
1991	10,674.3	1,740.2	5,529.2	2,227.6	437.5	356.9	5,648.5	3,565.3
1992	11,943.3	2,005.6	5,725.5	2,802.6	467.7	467.8	6,494.0	4,401.6
1993	13,078.3	2,241.7	5,915.9	3,000.2	479.2	443.0	6,310.1	3,911.4
1994	14,086.1	2,343.4	5,797.5	2,998.3	475.1	435.6	5,910.0	3,995.9
1995	14,344.4	2,126.5	5,870.2	3,237.9	501.6	486.9	6,118.8	4,314.7
1996	14,948.8	2,155.2	6,212.2	3,571.9	604.3	527.6	6,998.0	4,746.7
1997	14,114.4	1,972.1	6,312.1	3,443.4	489.8	451.6	7,016.4	5,629.1
1998	15,580.0	2,378.5	7,123.2	4,143.5	479.8	609.2	8,727.9	7,003.9
1999	15,207.2	2,795.2	7,290.9	3,804.1	430.5	581.6	7,955.8	6,634.9
2000	15,762.8	2,922.6	7,655.9	4,058.0	420.3	633.1	8,686.7	7,017.8
2001	15,774.2	3,610.8	8,007.1	4,443.2	347.9	792.3	9,851.1	7,739.8
2002	16,486.4	3,912.6	8,656.1	5,104.8	416.3	1,118.7	10,911.7	8,853.1
2003	18,142.8	4,130.5	9,183.0	5,512.4	451.6	1,110.9	12,026.9	10,354.4
2004	19,311.1	4,370.8	9,434.3	6,527.3	542.8	1,127.7	13,246.3	12,577.1

Table A13 **TFP database outputs and inputs, 1960–2004, current prices**

Year	*Consumer commodity* *$m*	*Govt con- sumption* *$m*	*Exports* *$m*	*Investment - NROC* *$m*	*Investment - Software* *$m*	*Investment - Exploration* *$m*
1960	7,635.3	1,278.6	2,150.9	1,164.0	7.3	21.0
1961	8,065.8	1,399.6	2,172.3	1,274.0	8.1	25.0
1962	8,291.0	1,489.4	2,475.0	1,394.0	9.0	36.0
1963	8,870.5	1,576.6	2,494.9	1,463.0	10.0	52.0
1964	9,621.6	1,728.6	3,166.9	1,673.0	12.0	63.0
1965	10,434.9	1,970.5	3,057.4	1,926.0	12.0	82.0
1966	11,007.8	2,237.8	3,145.7	2,179.0	14.0	95.0
1967	11,867.5	2,527.4	3,495.3	2,311.0	14.0	103.0
1968	12,940.9	2,939.3	3,585.5	2,454.0	15.0	128.0
1969	14,010.8	3,050.1	3,913.2	2,803.0	16.0	158.0
1970	15,455.6	3,380.4	4,782.2	3,067.0	16.0	210.0
1971	16,966.6	3,923.6	5,107.3	3,483.0	17.0	253.0
1972	18,679.7	4,390.5	5,712.9	3,805.0	21.0	220.0
1973	20,797.8	4,837.3	7,049.1	3,933.0	28.0	211.0
1974	24,724.5	5,845.4	7,933.5	4,669.0	42.0	209.0
1975	30,400.9	8,258.8	10,162.8	5,941.0	56.0	203.0
1976	35,080.0	10,411.6	11,276.4	6,677.0	105.0	178.0
1977	40,685.2	11,869.0	13,489.0	7,563.0	151.0	222.0
1978	44,970.2	13,255.7	14,324.8	8,153.0	188.0	285.0
1979	49,463.8	14,423.0	17,010.7	9,092.0	217.0	369.0
1980	54,947.7	15,997.8	22,147.5	9,932.0	253.0	617.0
1981	62,501.6	18,784.6	22,750.7	11,669.0	366.0	912.0
1982	71,753.4	21,577.3	23,852.8	14,300.0	473.0	1,439.0
1983	80,135.7	24,601.9	25,818.7	15,376.0	529.0	1,423.0
1984	86,935.0	26,956.4	29,104.0	15,452.0	760.0	1,295.0
1985	93,410.7	30,910.7	36,001.2	17,361.0	1,051.0	1,257.0
1986	105,167.2	34,580.4	39,230.2	20,963.0	1,356.0	1,190.0
1987	115,141.4	37,445.2	44,613.3	23,131.0	1,950.0	755.0
1988	128,148.2	39,623.6	52,077.9	25,765.0	2,408.0	1,302.0
1989	142,147.5	42,737.0	55,673.7	28,030.0	2,624.0	1,334.0
1990	157,048.8	47,060.3	61,229.9	31,844.0	3,573.0	1,192.0
1991	168,163.1	51,966.9	66,657.8	29,552.0	3,886.0	1,186.0
1992	178,412.2	56,184.6	70,499.2	26,046.0	4,056.0	1,075.0
1993	185,417.1	58,655.2	77,369.8	24,514.0	5,060.0	1,244.0
1994	190,375.0	58,411.2	83,515.6	25,252.0	5,316.0	1,301.0
1995	202,127.1	60,403.0	88,126.3	28,056.0	5,386.0	1,582.0
1996	214,573.7	63,790.2	99,593.0	31,294.0	5,411.0	1,685.0
1997	223,608.0	65,240.5	105,720.2	34,402.0	6,344.0	2,001.0
1998	239,451.5	69,448.9	114,325.6	36,803.0	7,328.0	2,049.0
1999	252,154.4	74,450.5	112,520.4	40,457.0	9,162.0	1,706.0
2000	268,124.8	79,072.4	126,729.5	38,882.0	10,883.0	1,400.0
2001	286,390.8	83,148.3	154,595.0	33,885.0	12,718.0	1,727.0
2002	302,087.1	86,967.9	154,149.5	37,045.0	12,282.0	1,523.0
2003	320,417.4	92,964.8	149,334.6	44,937.0	12,235.0	1,727.0
2004	344,902.3	99,992.6	143,951.9	50,134.0	12,235.0	1,731.0

Table A13 (continued)

Year	*Investment - Dwellings* *$m*	*Investment - Computers* *$m*	*Investment - Elec. mach.* *$m*	*Investment - Indust. mac.* *$m*	*Investment - vehicles* *$m*	*Investment - Oth transp.* *$m*	*Investment - Oth mach.* *$m*
1960	666.0	2.0	201.0	385.0	485.0	90.0	344.0
1961	731.0	4.0	211.0	436.0	504.0	83.0	366.0
1962	669.0	9.0	225.0	454.0	489.0	90.0	374.0
1963	741.0	14.0	251.0	501.0	540.0	96.0	405.0
1964	850.0	19.0	266.0	523.0	654.0	91.0	431.0
1965	997.0	30.0	307.0	656.0	711.0	110.0	521.0
1966	1,018.0	40.0	352.0	745.0	719.0	126.0	578.0
1967	1,086.0	50.0	370.0	774.0	779.0	131.0	592.0
1968	1,222.0	65.0	410.0	822.0	794.0	166.0	640.0
1969	1,403.0	75.0	426.0	917.0	905.0	153.0	683.0
1970	1,608.0	85.0	448.0	998.0	884.0	160.0	720.0
1971	1,694.0	106.0	499.0	1,166.0	937.0	152.0	822.0
1972	1,984.0	132.0	548.0	1,240.0	1,016.0	201.0	882.0
1973	2,374.0	150.0	555.0	1,179.0	1,214.0	198.0	877.0
1974	2,920.0	178.0	593.0	1,279.0	1,394.0	216.0	949.0
1975	2,904.0	258.0	774.0	1,534.0	1,630.0	295.0	1,195.0
1976	4,060.0	318.0	904.0	1,762.0	2,172.0	307.0	1,371.0
1977	5,124.0	345.0	911.0	1,902.0	2,553.0	296.0	1,407.0
1978	5,599.0	434.0	1,113.0	2,230.0	2,767.0	388.0	1,627.0
1979	5,862.0	560.0	1,357.0	2,863.0	3,453.0	406.0	1,962.0
1980	6,850.0	648.0	1,461.0	2,888.0	3,796.0	479.0	2,027.0
1981	8,649.0	839.0	1,830.0	3,772.0	4,458.0	629.0	2,492.0
1982	9,549.0	1,027.0	2,219.0	4,829.0	5,063.0	746.0	2,982.0
1983	8,361.0	1,134.0	2,383.0	4,949.0	4,551.0	812.0	3,037.0
1984	9,609.0	1,319.0	2,563.0	5,000.0	5,441.0	961.0	3,189.0
1985	11,492.0	1,527.0	2,765.0	5,686.0	6,273.0	1,045.0	3,561.0
1986	12,500.0	2,002.0	3,364.0	6,377.0	7,037.0	1,531.0	4,036.0
1987	12,025.0	2,419.0	3,759.0	7,199.0	8,112.0	1,760.0	4,447.0
1988	13,600.0	2,726.0	3,782.0	7,959.0	9,365.0	1,479.0	4,460.0
1989	18,763.0	3,218.0	4,144.0	8,915.0	10,399.0	1,589.0	5,104.0
1990	20,450.0	3,690.0	4,354.0	8,564.0	10,209.0	2,103.0	5,164.0
1991	19,068.0	3,561.0	3,687.0	7,348.0	8,951.0	1,604.0	4,476.0
1992	19,228.0	3,710.0	3,479.0	6,807.0	8,527.0	1,575.0	4,226.0
1993	22,262.0	4,275.0	3,639.0	7,810.0	9,852.0	1,355.0	4,549.0
1994	24,803.0	5,076.0	4,106.0	9,698.0	8,581.0	1,312.0	5,096.0
1995	26,738.0	6,048.0	4,662.0	11,038.0	10,998.0	1,523.0	5,477.0
1996	23,753.0	6,377.1	4,951.0	10,871.0	12,203.0	1,597.0	6,301.0
1997	23,596.0	6,413.1	5,099.0	10,374.0	12,993.0	1,699.0	6,797.0
1998	28,021.0	7,947.1	5,229.0	10,286.0	13,921.0	2,445.0	6,866.0
1999	30,833.0	8,194.9	5,412.0	10,367.0	14,198.0	2,542.0	7,081.0
2000	37,335.0	9,495.1	4,955.0	10,785.0	13,298.0	4,706.0	7,982.0
2001	33,322.0	8,561.1	6,649.0	11,280.0	15,831.0	2,502.0	7,677.0
2002	39,957.0	9,027.2	5,632.0	11,660.0	16,412.0	4,489.0	8,865.0
2003	47,926.0	9,818.3	7,242.0	12,407.0	17,713.0	6,395.0	8,495.0
2004	55,345.0	9,860.5	7,344.0	11,840.0	17,542.0	6,003.0	8,248.0

Table A13 (continued)

Year	*Inventories ch non-farm $m*	*Inventories change farm $m*	*Inventories ch livestock $m*	*Imports $m*	*Labour $m*	*User cost - NROC $m*	*User cost -Software $m*
1960	194.4	209.0	41.4	2,500.0	8,286.2	958.2	1.2
1961	213.5	202.4	38.8	2,838.0	8,939.3	972.6	2.1
1962	234.6	195.9	34.1	2,413.0	9,194.3	1,255.2	3.3
1963	257.7	189.7	34.8	2,866.0	9,735.1	1,306.2	4.2
1964	503.9	477.9	-117.3	3,152.0	10,644.9	1,694.1	5.6
1965	193.3	-67.5	-22.0	3,803.0	11,945.5	1,461.7	5.2
1966	230.3	-366.5	84.8	3,954.0	12,913.1	1,514.3	5.3
1967	323.5	-155.5	232.3	4,045.0	14,119.1	1,859.9	5.8
1968	472.3	1,214.8	344.2	4,536.0	15,284.0	2,524.4	6.8
1969	513.0	-26.2	356.6	4,706.0	16,793.5	2,319.4	6.6
1970	882.3	-562.7	467.6	5,285.0	18,777.9	2,606.1	7.1
1971	9.7	-32.9	584.1	5,680.0	21,588.6	2,618.9	7.1
1972	202.6	-1,755.5	152.3	5,820.0	23,953.9	2,419.1	6.9
1973	460.8	-1,349.3	423.3	6,027.0	26,565.5	3,489.8	8.5
1974	1,155.2	80.6	370.7	8,612.0	32,571.0	4,046.9	11.1
1975	105.9	-653.9	111.2	11,392.0	43,280.2	3,036.6	12.8
1976	885.8	-958.4	-158.9	12,211.0	49,980.9	4,616.3	19.7
1977	-619.9	-520.1	-202.8	15,440.0	55,597.4	5,346.1	32.8
1978	594.8	-1,084.7	-202.1	16,574.0	61,533.2	6,254.8	51.9
1979	1,009.3	-1,192.5	-80.5	19,778.0	66,045.9	8,069.5	79.5
1980	1,069.3	-735.7	-296.5	23,074.0	73,558.3	9,980.2	101.2
1981	796.0	317.4	-3.7	27,446.0	84,768.6	11,456.5	124.2
1982	-2,244.2	-698.7	-893.4	31,818.0	98,060.9	10,268.5	153.1
1983	820.8	-112.5	-215.8	31,771.0	109,195.9	13,163.6	203.4
1984	1,909.9	1.3	285.0	34,560.0	115,109.2	17,079.3	262.7
1985	343.6	-306.4	-445.7	43,785.0	126,219.5	17,164.1	338.1
1986	-1,643.0	-889.8	-286.7	50,557.0	139,371.1	18,536.8	447.2
1987	574.3	-1,059.3	279.6	52,346.0	150,274.4	23,679.5	614.5
1988	3,577.8	-593.9	258.7	57,791.0	164,287.9	29,877.6	878.4
1989	5,644.1	413.8	1,400.9	66,127.0	182,777.3	34,586.2	1,178.4
1990	-812.9	952.0	-718.9	72,797.0	205,135.0	31,563.2	1,405.5
1991	-2,281.7	-1,054.0	615.1	70,325.0	214,361.8	33,113.9	1,897.2
1992	1,275.2	-868.4	28.6	72,619.0	218,280.0	37,688.2	2,375.1
1993	1,327.6	-266.2	116.9	82,414.0	227,809.0	38,797.9	2,752.3
1994	2,038.6	126.3	-404.1	88,627.0	237,081.1	38,994.0	3,280.6
1995	218.7	959.1	401.3	101,133.0	249,132.9	41,660.7	3,746.9
1996	2,019.4	-857.2	282.2	104,207.0	267,850.2	45,194.2	4,112.9
1997	-697.2	-1,781.3	-163.5	106,885.0	283,351.2	45,237.8	4,350.0
1998	4,998.4	175.0	15.3	122,126.0	297,088.2	53,887.1	4,819.1
1999	3,319.8	-310.6	166.6	130,204.0	314,027.4	51,697.6	5,256.7
2000	1,664.2	-1,919.5	-191.4	144,610.0	332,035.5	55,990.8	6,125.7
2001	1,364.7	-713.7	-12.2	157,811.0	353,027.2	60,423.3	7,207.1
2002	726.5	-830.0	-571.5	159,787.0	369,406.6	64,565.2	8,531.5
2003	6,326.9	113.5	-195.6	172,741.0	392,892.4	70,359.8	9,357.4
2004	6,822.6	124.3	-185.3	172,922.0	414,157.4	80,446.5	9,903.9

Table A13 (continued)

Year	*User cost - Exploration $m*	*User cost - Computers $m*	*User cost – Elec. mach. $m*	*User cost – Indust. mac. $m*	*User cost - Vehicles $m*	*User cost - Oth transport $m*
1960	5.3	1.2	187.4	326.6	415.7	73.8
1961	7.1	1.1	193.4	345.7	442.1	78.2
1962	10.7	1.5	223.7	408.2	508.2	90.9
1963	14.6	2.2	233.5	435.5	529.0	94.3
1964	23.5	3.9	274.5	517.0	609.4	110.6
1965	27.3	4.8	257.8	496.6	601.9	103.1
1966	34.5	7.0	276.1	547.1	653.5	108.6
1967	47.1	10.5	318.8	641.8	734.6	124.6
1968	68.0	16.0	391.0	789.5	871.4	150.0
1969	72.9	18.9	389.3	798.1	869.1	152.9
1970	91.9	24.0	430.4	893.6	945.2	168.3
1971	106.8	27.2	449.2	954.4	953.9	174.8
1972	119.8	29.8	450.6	988.0	950.2	171.5
1973	170.5	41.5	551.6	1,212.3	1,117.8	208.7
1974	208.5	48.3	594.7	1,308.1	1,236.4	224.7
1975	192.8	43.8	647.3	1,331.2	1,094.5	226.7
1976	260.9	61.1	816.1	1,676.9	1,492.6	290.2
1977	293.9	77.4	934.0	1,913.5	1,793.6	331.9
1978	330.2	94.0	1,067.7	2,201.2	2,126.8	377.9
1979	397.5	123.7	1,278.6	2,633.2	2,635.0	452.4
1980	473.2	159.6	1,494.0	3,099.1	3,159.6	518.9
1981	549.0	192.2	1,647.3	3,405.0	3,308.3	570.2
1982	565.8	210.6	1,652.7	3,433.1	3,465.4	574.9
1983	755.2	270.9	2,007.8	4,218.7	4,021.8	697.9
1984	983.2	348.2	2,353.1	4,947.9	4,804.4	818.2
1985	1,050.6	545.9	2,426.2	5,064.3	4,991.7	856.8
1986	1,119.4	772.0	2,699.2	5,775.4	5,990.9	1,081.6
1987	1,331.4	1,122.4	3,312.6	7,091.2	8,053.3	1,409.4
1988	1,507.8	1,348.9	3,777.0	8,239.9	9,586.3	1,532.9
1989	1,672.5	1,577.1	4,031.7	8,740.9	10,431.9	1,464.0
1990	1,590.6	2,130.8	3,949.9	8,667.8	10,169.4	1,507.5
1991	1,688.3	2,457.0	4,111.1	9,252.3	10,674.3	1,740.2
1992	1,881.2	2,654.1	4,391.5	10,063.0	11,943.3	2,005.6
1993	1,950.7	2,800.9	4,632.1	10,643.9	13,078.3	2,241.7
1994	1,944.7	3,098.1	4,661.8	10,874.2	14,086.1	2,343.4
1995	2,017.5	3,123.2	4,732.5	11,196.0	14,344.4	2,126.5
1996	2,155.1	3,459.3	5,012.4	12,088.4	14,948.8	2,155.2
1997	2,163.8	3,290.8	4,814.8	12,122.4	14,114.4	1,972.1
1998	2,519.2	3,820.3	5,411.6	13,592.3	15,580.0	2,378.5
1999	2,454.4	4,522.7	5,343.5	14,047.5	15,207.2	2,795.2
2000	2,640.9	4,451.6	6,249.1	13,940.3	15,762.8	2,922.6
2001	2,773.3	6,296.1	6,209.8	14,611.1	15,774.2	3,610.8
2002	2,930.7	6,451.5	6,671.5	15,617.9	16,486.4	3,912.6
2003	3,120.5	6,110.9	6,669.6	15,693.0	18,142.8	4,130.5
2004	3,349.9	5,661.1	6,796.4	15,516.3	19,311.1	4,370.8

Table A13 (continued)

Year	*User cost - Other mach. $m*	*User cost - Non-farm inv. $m*	*User cost - Farm invent. $m*	*User cost - Livestock $m*	*User cost – Comm. land $m*	*User cost - Rural land $m*
1960	330.9	185.9	615.3	350.0	220.8	416.4
1961	340.7	176.6	515.3	283.2	215.4	383.6
1962	386.2	244.5	628.7	333.9	285.9	480.9
1963	399.6	253.4	574.2	277.0	298.7	473.9
1964	457.1	362.0	723.1	368.1	407.8	610.0
1965	434.4	273.0	475.6	260.4	319.0	449.3
1966	466.7	268.3	409.6	284.6	329.0	434.2
1967	531.1	335.8	458.2	316.9	402.2	549.1
1968	630.6	505.0	657.8	481.4	580.6	720.5
1969	633.7	416.0	569.6	360.4	485.3	764.9
1970	694.4	460.7	507.2	378.2	533.4	798.1
1971	730.2	431.2	395.0	338.4	499.4	732.1
1972	747.3	286.5	279.1	234.2	400.3	574.2
1973	892.6	477.6	361.7	394.0	625.1	793.8
1974	957.8	473.9	347.3	481.0	666.0	771.1
1975	985.8	95.6	69.7	63.5	308.0	395.1
1976	1,229.6	278.7	157.5	102.4	562.1	634.5
1977	1,402.5	349.1	157.4	106.8	680.6	717.4
1978	1,597.9	429.6	188.1	151.4	840.3	823.9
1979	1,884.3	702.1	257.3	251.4	1,237.4	949.3
1980	2,185.5	897.9	291.1	472.2	1,489.0	1,127.4
1981	2,382.3	1,027.1	312.1	556.6	1,582.1	1,435.0
1982	2,396.4	599.0	184.2	283.7	1,172.9	1,135.0
1983	2,868.9	774.0	221.1	319.7	1,487.5	1,626.5
1984	3,281.2	1,289.4	354.9	487.3	2,193.6	1,908.0
1985	3,323.6	1,215.3	315.8	476.8	2,189.5	1,969.0
1986	3,803.4	1,170.9	287.0	452.0	2,375.6	2,074.8
1987	4,589.8	1,658.1	374.4	581.7	3,360.2	2,752.6
1988	5,140.4	2,313.0	479.7	839.0	4,755.3	3,583.2
1989	5,198.7	2,837.2	553.8	981.4	5,900.3	4,078.6
1990	5,137.0	2,247.0	429.4	513.2	5,300.5	3,358.5
1991	5,529.2	2,227.6	437.5	356.9	5,648.5	3,565.3
1992	5,725.5	2,802.6	467.7	467.8	6,494.0	4,401.6
1993	5,915.9	3,000.2	479.2	443.0	6,310.1	3,911.4
1994	5,797.5	2,998.3	475.1	435.6	5,910.0	3,995.9
1995	5,870.2	3,237.9	501.6	486.9	6,118.8	4,314.7
1996	6,212.2	3,571.9	604.3	527.6	6,998.0	4,746.7
1997	6,312.1	3,443.4	489.8	451.6	7,016.4	5,629.1
1998	7,123.2	4,143.5	479.8	609.2	8,727.9	7,003.9
1999	7,290.9	3,804.1	430.5	581.6	7,955.8	6,634.9
2000	7,655.9	4,058.0	420.3	633.1	8,686.7	7,017.8
2001	8,007.1	4,443.2	347.9	792.3	9,851.1	7,739.8
2002	8,656.1	5,104.8	416.3	1,118.7	10,911.7	8,853.1
2003	9,183.0	5,512.4	451.6	1,110.9	12,026.9	10,354.4
2004	9,434.3	6,527.3	542.8	1,127.7	13,246.3	12,577.1

Table A14 **TFP database outputs and inputs, 1960–2004, price indexes**

Year	*Consumer commodity Index*	*Govt con-sumption Index*	*Exports Index*	*Investment - NROC Index*	*Investment - Software Index*	*Investment - Exploration Index*
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0366	1.0572	0.9623	1.0329	0.9400	1.0212
1962	1.0442	1.0933	0.9668	1.0844	0.8836	1.0274
1963	1.0551	1.0973	0.9958	1.0962	0.8306	1.0621
1964	1.0672	1.1341	1.0864	1.1257	0.7807	1.0892
1965	1.1010	1.1844	1.0508	1.1819	0.7339	1.1850
1966	1.1353	1.2060	1.0674	1.2026	0.6899	1.2167
1967	1.1677	1.2734	1.0687	1.2644	0.6485	1.2586
1968	1.2096	1.3289	1.0460	1.3058	0.6096	1.2924
1969	1.2444	1.3684	1.0734	1.3646	0.5730	1.3426
1970	1.2914	1.4262	1.1258	1.4279	0.5386	1.4098
1971	1.3682	1.5838	1.0975	1.5154	0.5063	1.4820
1972	1.4557	1.7411	1.1438	1.6289	0.4759	1.6272
1973	1.5420	1.8626	1.3831	1.7657	0.4474	1.7725
1974	1.7277	2.1302	1.6572	2.0601	0.4205	2.1052
1975	2.0490	2.7810	1.9357	2.6717	0.3953	2.7854
1976	2.3467	3.1712	2.0617	3.1401	0.3716	3.2529
1977	2.6132	3.5904	2.3047	3.4655	0.3493	3.6609
1978	2.8564	3.9070	2.3979	3.7500	0.3283	4.0028
1979	3.0889	4.1176	2.6605	3.9988	0.3218	4.2827
1980	3.3869	4.4498	3.2354	4.5040	0.3013	4.7726
1981	3.7339	4.9860	3.4968	5.0798	0.2848	5.2559
1982	4.0902	5.6976	3.5820	5.7514	0.2694	5.9326
1983	4.5149	6.2636	3.8611	6.5675	0.2535	6.5661
1984	4.8302	6.5467	4.0430	6.9581	0.2399	6.9118
1985	5.0893	6.9418	4.3336	7.3418	0.2263	7.3184
1986	5.5168	7.4023	4.5488	8.0293	0.2131	7.6596
1987	6.0039	7.7561	4.6737	8.6397	0.2011	7.9911
1988	6.4624	7.9827	4.9994	9.2260	0.1896	8.2698
1989	6.8350	8.1524	5.2537	9.9242	0.1793	8.6444
1990	7.1804	8.9064	5.5026	10.6368	0.1689	9.2032
1991	7.6932	9.5793	5.3702	10.9565	0.1595	9.7597
1992	8.0220	10.0008	5.2096	10.7658	0.1505	9.9024
1993	8.2074	10.3207	5.3614	10.6280	0.1420	10.1171
1994	8.2561	10.2614	5.2739	10.6992	0.1345	10.1704
1995	8.3222	10.1348	5.3000	11.0305	0.1269	10.2834
1996	8.5024	10.3560	5.4296	11.3773	0.1197	10.4841
1997	8.6224	10.3302	5.2201	11.6118	0.1130	10.6075
1998	8.7758	10.2558	5.4415	11.9299	0.1066	10.8482
1999	8.7737	10.5254	5.2415	12.2270	0.1007	10.9866
2000	8.9430	10.7930	5.3826	12.6544	0.0946	11.5207
2001	9.3086	11.2408	6.1266	12.9915	0.0889	11.8808
2002	9.5187	11.6448	6.1798	13.1434	0.0836	12.0491
2003	9.7306	12.0406	6.0208	13.6100	0.0786	12.5000
2004	9.8854	12.5251	5.7507	14.3351	0.0738	12.7806

Table A14 (continued)

Year	*Investment - Dwellings Index*	*Investment - Computers Index*	*Investment – Elec. mach. Index*	*Investment – Indust. mac. Index*	*Investment - vehicles Index*	*Investment - Oth transp. Index*	*Investment - Oth mach. Index*
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0351	0.8627	1.0193	1.0202	1.0187	1.0144	1.0187
1962	1.0347	0.7442	1.0333	1.0317	1.0286	1.0407	1.0331
1963	1.0371	0.6420	1.0429	1.0408	1.0369	1.0415	1.0426
1964	1.0594	0.5538	1.0426	1.0420	1.0404	1.0523	1.0458
1965	1.0882	0.4777	1.0735	1.0716	1.0697	1.0838	1.0751
1966	1.1225	0.4121	1.1048	1.1031	1.1015	1.1070	1.1060
1967	1.1541	0.3555	1.1313	1.1289	1.1276	1.1385	1.1328
1968	1.1877	0.3067	1.1506	1.1470	1.1454	1.1589	1.1501
1969	1.2210	0.2646	1.1949	1.1930	1.1912	1.1991	1.1969
1970	1.2760	0.2282	1.2395	1.2358	1.2196	1.2489	1.2388
1971	1.3410	0.1969	1.3096	1.3072	1.2489	1.3186	1.3103
1972	1.4473	0.1698	1.3900	1.3862	1.3057	1.3952	1.3892
1973	1.5884	0.1465	1.4433	1.4406	1.3540	1.4549	1.4449
1974	1.9235	0.1264	1.5407	1.5362	1.4495	1.5518	1.5405
1975	2.3504	0.1090	1.9086	1.9039	1.7306	1.9207	1.9087
1976	2.7085	0.0941	2.1744	2.1699	2.0548	2.1844	2.1750
1977	3.0329	0.0811	2.4178	2.4119	2.2865	2.4282	2.4190
1978	3.2166	0.0700	2.6988	2.6923	2.4906	2.7187	2.6990
1979	3.3172	0.0604	2.9704	2.9622	2.7342	2.9856	2.9693
1980	3.5511	0.0521	3.2713	3.2626	2.9761	3.2895	3.2729
1981	3.9856	0.0449	3.5448	3.5334	3.2030	3.5663	3.5441
1982	4.4803	0.0388	3.8114	3.8003	3.5117	3.8334	3.8107
1983	4.9217	0.0334	4.2462	4.2352	3.6754	4.2750	4.2461
1984	5.1587	0.0288	4.4427	4.4292	3.9125	4.4718	4.4552
1985	5.5291	0.0249	4.5455	4.5323	4.0173	4.5739	4.5586
1986	6.0141	0.0215	4.9365	5.0366	4.6395	5.5511	5.1504
1987	6.4030	0.0193	5.4001	5.5965	5.5763	6.2800	5.7414
1988	6.7925	0.0153	5.5270	5.9089	6.0099	6.0002	5.9802
1989	7.8983	0.0125	5.5801	5.9318	6.1730	5.4214	5.8934
1990	8.8165	0.0120	5.7084	6.1175	6.3389	5.7442	6.1023
1991	9.1375	0.0107	5.7323	6.3741	6.4977	6.1119	6.4734
1992	9.1668	0.0096	5.7193	6.5612	6.8023	6.5437	6.4576
1993	9.1956	0.0088	5.9359	6.9411	7.3933	7.1926	6.7235
1994	9.3500	0.0080	5.9866	7.1529	8.0098	7.7433	6.6935
1995	9.5810	0.0065	5.8902	7.1135	8.2118	7.1524	6.6506
1996	9.7542	0.0054	5.9129	7.2684	8.3742	7.1587	6.7951
1997	9.8195	0.0038	5.5583	7.2204	7.9592	6.6578	6.7537
1998	9.9082	0.0032	5.5936	7.4725	8.0013	7.4099	6.8787
1999	10.1050	0.0026	5.5346	7.9966	7.9506	8.6302	7.0514
2000	10.5981	0.0020	6.1320	7.8413	7.9073	8.6799	7.0976
2001	11.9212	0.0019	5.9406	8.0286	7.6494	9.4074	7.0391
2002	12.1077	0.0016	5.9131	8.3115	7.4778	10.0101	7.2560
2003	12.5931	0.0013	5.6716	8.1169	7.7093	9.6556	7.2674
2004	13.5370	0.0009	5.2685	7.6431	7.6005	8.6601	7.1114

Table A14 (continued)

Year	*Inventories ch non-farm Index*	*Inventories change farm Index*	*Inventories ch livestock Index*	*Imports Index*	*Labour Index*	*User cost - NROC Index*	*User cost - Software Index*
1960	1.0350	0.9475	0.9282	1.0000	1.0000	0.0958	0.1782
1961	1.0712	0.8978	0.8616	1.0089	1.0294	0.0908	0.1607
1962	1.1087	0.8507	0.7520	1.0005	1.0544	0.1095	0.1615
1963	1.1475	0.8061	0.7625	1.0128	1.0877	0.1067	0.1492
1964	1.1877	0.7638	0.8407	1.0013	1.1628	0.1300	0.1532
1965	1.2292	0.7237	1.0068	1.0145	1.2747	0.1049	0.1262
1966	1.2750	0.7298	0.9519	1.0266	1.3360	0.1015	0.1157
1967	1.3083	0.7670	0.9997	1.0328	1.4356	0.1161	0.1132
1968	1.3541	0.7824	0.9509	1.0540	1.5226	0.1479	0.1184
1969	1.3894	0.6929	0.9347	1.0570	1.6424	0.1279	0.1010
1970	1.4331	0.7053	0.9543	1.0957	1.7968	0.1347	0.0954
1971	1.4620	0.7688	0.9354	1.1426	1.9916	0.1271	0.0847
1972	1.5302	0.7908	0.9903	1.2660	2.1681	0.1101	0.0726
1973	1.6112	0.9865	1.2882	1.2937	2.3690	0.1498	0.0753
1974	1.7655	1.1720	0.9717	1.4204	2.8208	0.1653	0.0801
1975	2.0715	1.1536	0.6217	1.8346	3.5837	0.1183	0.0707
1976	2.3726	1.2362	0.6410	2.0685	4.1963	0.1726	0.0778
1977	2.6325	1.3691	0.8173	2.3884	4.7375	0.1930	0.0733
1978	2.8412	1.4430	0.9450	2.6898	5.1944	0.2180	0.0694
1979	3.0892	1.6614	1.5825	2.9688	5.4254	0.2722	0.0706
1980	3.4975	1.9823	1.9522	3.4598	5.9495	0.3253	0.0673
1981	3.8603	2.1984	1.9308	3.7612	6.7056	0.3622	0.0633
1982	4.1719	2.2184	1.8153	3.9037	7.7935	0.3145	0.0560
1983	4.5618	2.4166	1.8855	4.2559	8.9788	0.3895	0.0536
1984	4.8369	2.5349	2.1371	4.3652	9.3510	0.4913	0.0530
1985	5.0574	2.5918	2.2743	4.7480	9.7986	0.4824	0.0491
1986	5.4539	2.7007	2.1901	5.4952	10.4510	0.5077	0.0457
1987	5.8297	2.9610	2.4107	5.9720	10.9905	0.6291	0.0449
1988	6.2418	3.3586	2.5936	5.9347	11.6330	0.7704	0.0440
1989	6.4856	3.6196	1.7643	5.4640	12.4990	0.8637	0.0421
1990	6.6731	3.4993	1.3443	5.7011	13.5134	0.7641	0.0391
1991	6.7730	3.2016	1.2934	5.8415	14.3305	0.7757	0.0399
1992	6.7919	3.3950	1.1667	5.8199	14.8456	0.8623	0.0402
1993	6.9042	3.5788	1.1763	6.2140	15.5162	0.8736	0.0395
1994	6.9265	3.5730	1.3063	6.2630	15.6322	0.8665	0.0386
1995	7.1534	3.7262	1.2794	6.1332	15.8826	0.9135	0.0378
1996	7.2578	3.5265	1.1505	6.0746	16.6601	0.9747	0.0371
1997	7.0795	3.3578	1.2651	5.6679	17.7214	0.9560	0.0359
1998	7.1686	3.4783	1.4202	5.9023	18.1886	1.1120	0.0347
1999	7.1604	3.4344	1.4891	6.0028	19.1044	1.0398	0.0322
2000	7.3032	3.4748	1.7924	5.9076	19.7110	1.0949	0.0305
2001	7.6478	4.2180	2.3435	6.5294	20.6324	1.1557	0.0288
2002	7.7367	4.7932	2.2646	6.4665	21.6551	1.2204	0.0273
2003	7.8166	5.1762	2.1177	6.1603	22.6363	1.3103	0.0259
2004	7.8955	5.5899	2.0288	5.4527	23.5199	1.4635	0.0247

Table A14 (continued)

Year	*User cost - Exploration Index*	*User cost - Computers Index*	*User cost – Elec. mach. Index*	*User cost – Indust. mac. Index*	*User cost - Vehicles Index*	*User cost - Oth transport Index*
1960	0.1205	0.1550	0.1587	0.1708	0.1913	0.1721
1961	0.1152	0.1273	0.1542	0.1668	0.1876	0.1672
1962	0.1290	0.1189	0.1689	0.1810	0.2014	0.1840
1963	0.1297	0.1004	0.1670	0.1793	0.1997	0.1807
1964	0.1523	0.0961	0.1847	0.1969	0.2175	0.2002
1965	0.1348	0.0710	0.1635	0.1763	0.1981	0.1798
1966	0.1332	0.0595	0.1636	0.1768	0.1994	0.1789
1967	0.1469	0.0538	0.1754	0.1887	0.2116	0.1918
1968	0.1778	0.0526	0.2014	0.2144	0.2371	0.2181
1969	0.1592	0.0405	0.1873	0.2015	0.2256	0.2041
1970	0.1681	0.0351	0.1953	0.2097	0.2320	0.2136
1971	0.1615	0.0283	0.1933	0.2090	0.2256	0.2126
1972	0.1515	0.0218	0.1841	0.2008	0.2167	0.2040
1973	0.1945	0.0212	0.2143	0.2316	0.2458	0.2358
1974	0.2217	0.0178	0.2222	0.2406	0.2573	0.2451
1975	0.1965	0.0117	0.2338	0.2364	0.2149	0.2392
1976	0.2629	0.0110	0.2877	0.2907	0.2753	0.2934
1977	0.2984	0.0095	0.3213	0.3246	0.3077	0.3276
1978	0.3355	0.0084	0.3640	0.3677	0.3401	0.3721
1979	0.4000	0.0078	0.4274	0.4311	0.3979	0.4354
1980	0.4650	0.0069	0.4836	0.4877	0.4448	0.4928
1981	0.5069	0.0059	0.5204	0.5246	0.4387	0.5306
1982	0.4759	0.0045	0.5004	0.5053	0.4260	0.5110
1983	0.5565	0.0040	0.5751	0.5806	0.4614	0.5874
1984	0.6604	0.0038	0.6476	0.6529	0.5319	0.6606
1985	0.6638	0.0044	0.6420	0.6476	0.5277	0.6550
1986	0.6762	0.0048	0.6857	0.7079	0.5985	0.7820
1987	0.7799	0.0052	0.7989	0.8371	0.7701	0.9413
1988	0.8896	0.0049	0.8702	0.9400	0.8877	0.9564
1989	0.9578	0.0044	0.8957	0.9618	0.9309	0.8807
1990	0.8880	0.0044	0.8395	0.9098	0.8696	0.8561
1991	0.9335	0.0042	0.8383	0.9427	0.8860	0.9059
1992	1.0355	0.0039	0.8837	1.0245	0.9847	1.0238
1993	1.0768	0.0037	0.9274	1.0957	1.0832	1.1377
1994	1.0679	0.0035	0.9278	1.1202	1.1632	1.2151
1995	1.0995	0.0028	0.9238	1.1273	1.2078	1.1357
1996	1.1500	0.0024	0.9427	1.1706	1.2537	1.1552
1997	1.1285	0.0017	0.8696	1.1415	1.1674	1.0546
1998	1.2685	0.0014	0.9312	1.2561	1.2546	1.2479
1999	1.1970	0.0012	0.8798	1.2842	1.1861	1.3886
2000	1.2713	0.0009	0.9843	1.2715	1.1918	1.4102
2001	1.3405	0.0008	0.9678	1.3211	1.1713	1.5509
2002	1.4058	0.0007	0.9844	1.3971	1.1721	1.6858
2003	1.4998	0.0006	0.9629	1.3913	1.2339	1.6580
2004	1.6040	0.0004	0.9222	1.3503	1.2569	1.5327

Table A14 (continued)

Year	*User cost - Other mach.* *Index*	*User cost - Non-farm inv.* *Index*	*User cost - Farm invent.* *Index*	*User cost - Livestock* *Index*	*User cost – Comm. land* *Index*	*User cost - Rural land* *Index*
1960	0.1870	0.0607	0.0607	0.0607	0.0732	0.0732
1961	0.1832	0.0543	0.0497	0.0487	0.0692	0.0674
1962	0.1979	0.0709	0.0594	0.0570	0.0890	0.0845
1963	0.1964	0.0692	0.0531	0.0469	0.0900	0.0833
1964	0.2142	0.0931	0.0654	0.0619	0.1188	0.1072
1965	0.1945	0.0633	0.0407	0.0448	0.0898	0.0790
1966	0.1954	0.0601	0.0354	0.0492	0.0890	0.0763
1967	0.2077	0.0722	0.0413	0.0539	0.1053	0.0965
1968	0.2332	0.1031	0.0605	0.0788	0.1464	0.1267
1969	0.2215	0.0793	0.0458	0.0557	0.1179	0.1345
1970	0.2303	0.0821	0.0409	0.0552	0.1250	0.1403
1971	0.2310	0.0692	0.0341	0.0461	0.1129	0.1287
1972	0.2244	0.0459	0.0242	0.0294	0.0877	0.1009
1973	0.2560	0.0750	0.0388	0.0485	0.1337	0.1395
1974	0.2667	0.0712	0.0436	0.0569	0.1394	0.1356
1975	0.2672	0.0131	0.0087	0.0072	0.0633	0.0695
1976	0.3254	0.0379	0.0211	0.0114	0.1140	0.1115
1977	0.3633	0.0451	0.0235	0.0122	0.1360	0.1261
1978	0.4104	0.0573	0.0298	0.0178	0.1653	0.1448
1979	0.4776	0.0911	0.0463	0.0303	0.2395	0.1669
1980	0.5394	0.1118	0.0601	0.0573	0.2837	0.1982
1981	0.5804	0.1232	0.0698	0.0687	0.2960	0.2523
1982	0.5658	0.0701	0.0399	0.0351	0.2149	0.1995
1983	0.6475	0.0967	0.0514	0.0421	0.2676	0.2859
1984	0.7247	0.1575	0.0834	0.0651	0.3896	0.3354
1985	0.7214	0.1416	0.0742	0.0626	0.3838	0.3461
1986	0.8031	0.1354	0.0694	0.0609	0.4101	0.3647
1987	0.9466	0.1986	0.0983	0.0797	0.5718	0.4839
1988	1.0420	0.2738	0.1391	0.1132	0.7981	0.6299
1989	1.0446	0.3145	0.1692	0.1307	0.9752	0.7170
1990	1.0013	0.2272	0.1268	0.0618	0.8612	0.5904
1991	1.0569	0.2280	0.1196	0.0459	0.9075	0.6267
1992	1.1063	0.2971	0.1404	0.0567	1.0348	0.7737
1993	1.1631	0.3119	0.1559	0.0536	0.9984	0.6876
1994	1.1499	0.3055	0.1584	0.0521	0.9285	0.7024
1995	1.1548	0.3204	0.1653	0.0604	0.9522	0.7585
1996	1.1970	0.3523	0.1835	0.0630	1.0767	0.8344
1997	1.1704	0.3306	0.1606	0.0524	1.0663	0.9895
1998	1.2598	0.4016	0.1905	0.0718	1.3086	1.2312
1999	1.2395	0.3454	0.1676	0.0684	1.1739	1.1663
2000	1.2591	0.3535	0.1696	0.0735	1.2690	1.2336
2001	1.2654	0.3796	0.1806	0.0932	1.4331	1.3605
2002	1.3295	0.4295	0.2369	0.1316	1.5768	1.5563
2003	1.3556	0.4602	0.2851	0.1347	1.7172	1.8202
2004	1.3634	0.5104	0.3380	0.1383	1.8676	2.2109

Table A15 **TFP database outputs and inputs, 1960–2004, constant prices**

Year	*Consumer commodity $m1960*	*Govt con-sumption $m1960*	*Exports $m1960*	*Investment - NROC $m1960*	*Investment - Software $m1960*	*Investment - Exploration $m1960*
1960	7,663.0	1,283.2	2,158.7	1,164.0	7.3	21.0
1961	7,812.5	1,329.2	2,266.5	1,233.4	8.7	24.5
1962	7,985.9	1,370.1	2,574.6	1,285.5	10.2	35.0
1963	8,448.0	1,443.7	2,517.4	1,334.6	12.0	49.0
1964	9,067.0	1,532.9	2,931.7	1,486.2	15.4	57.8
1965	9,524.0	1,671.9	2,923.7	1,629.5	16.4	69.2
1966	9,756.7	1,867.0	2,965.4	1,811.9	20.3	78.1
1967	10,229.6	1,997.7	3,291.9	1,827.8	21.6	81.8
1968	10,768.2	2,226.3	3,450.3	1,879.4	24.6	99.0
1969	11,353.8	2,247.7	3,676.3	2,054.1	27.9	117.7
1970	12,055.8	2,387.5	4,278.8	2,147.8	29.7	149.0
1971	12,505.6	2,498.3	4,692.8	2,298.5	33.6	170.7
1972	12,958.7	2,546.6	5,044.1	2,335.9	44.1	135.2
1973	13,616.0	2,621.8	5,145.2	2,227.4	62.6	119.0
1974	14,448.3	2,770.3	4,833.1	2,266.4	99.9	99.3
1975	14,981.2	2,998.7	5,301.4	2,223.7	141.7	72.9
1976	15,087.0	3,313.6	5,520.2	2,126.4	282.6	54.7
1977	15,719.0	3,337.6	5,909.3	2,182.4	432.3	60.6
1978	15,921.8	3,431.2	6,041.5	2,174.1	572.6	71.2
1979	16,205.6	3,544.8	6,470.6	2,273.7	674.4	86.2
1980	16,417.6	3,638.2	6,927.3	2,205.1	839.8	129.3
1981	16,958.0	3,816.8	6,591.3	2,297.1	1,285.2	173.5
1982	17,777.0	3,837.6	6,748.0	2,486.3	1,756.0	242.6
1983	18,009.7	3,985.4	6,784.9	2,341.2	2,086.8	216.7
1984	18,264.2	4,178.4	7,305.1	2,220.7	3,168.4	187.4
1985	18,625.8	4,518.7	8,430.2	2,364.7	4,644.5	171.8
1986	19,341.5	4,739.8	8,750.3	2,610.8	6,362.3	155.4
1987	19,445.9	4,895.3	9,679.1	2,677.3	9,696.1	94.5
1988	20,089.4	5,028.7	10,553.3	2,792.7	12,699.1	157.4
1989	21,039.4	5,303.4	10,720.6	2,824.4	14,633.3	154.3
1990	22,111.9	5,341.9	11,249.7	2,993.8	21,148.3	129.5
1991	22,124.1	5,490.8	12,563.2	2,697.2	24,367.6	121.5
1992	22,508.9	5,685.8	13,696.0	2,419.3	26,950.7	108.6
1993	22,870.5	5,753.5	14,609.3	2,306.5	35,628.9	123.0
1994	23,339.4	5,761.6	16,028.4	2,360.2	39,535.3	127.9
1995	24,552.1	6,024.8	16,808.6	2,543.5	42,449.2	153.8
1996	25,493.0	6,222.3	18,528.7	2,750.6	45,210.5	160.7
1997	26,212.4	6,383.4	20,470.5	2,962.7	56,140.9	188.6
1998	27,567.4	6,841.6	21,226.8	3,084.9	68,738.3	188.9
1999	28,996.6	7,136.7	21,659.3	3,308.8	91,019.0	155.3
2000	30,225.4	7,385.8	23,735.7	3,072.6	115,030.3	121.5
2001	31,065.5	7,469.0	25,478.8	2,608.2	142,986.3	145.4
2002	32,074.5	7,548.0	25,210.0	2,818.5	146,867.3	126.4
2003	33,289.1	7,805.4	25,074.5	3,301.8	155,672.7	138.2
2004	35,270.8	8,070.5	25,305.2	3,497.3	165,826.9	135.4

Table A15 (continued)

Year	*Investment - Dwellings $m1960*	*Investment - Computers $m1960*	*Investment – Elec. mach. $m1960*	*Investment – Indust. mac. $m1960*	*Investment - vehicles $m1960*	*Investment - Oth transp. $m1960*	*Investment - Oth mach. $m1960*
1960	666.0	2.0	201.0	385.0	485.0	90.0	344.0
1961	706.2	4.6	207.0	427.4	494.7	81.8	359.3
1962	646.5	12.1	217.8	440.1	475.4	86.5	362.0
1963	714.5	21.8	240.7	481.3	520.8	92.2	388.4
1964	802.3	34.3	255.1	501.9	628.6	86.5	412.1
1965	916.2	62.8	286.0	612.2	664.7	101.5	484.6
1966	906.9	97.1	318.6	675.4	652.7	113.8	522.6
1967	941.0	140.6	327.1	685.6	690.9	115.1	522.6
1968	1,028.9	211.9	356.3	716.7	693.2	143.2	556.5
1969	1,149.0	283.5	356.5	768.6	759.7	127.6	570.6
1970	1,260.2	372.4	361.4	807.6	724.8	128.1	581.2
1971	1,263.2	538.4	381.0	892.0	750.3	115.3	627.3
1972	1,370.8	777.2	394.2	894.6	778.2	144.1	634.9
1973	1,494.5	1,023.8	384.5	818.4	896.6	136.1	607.0
1974	1,518.1	1,408.4	384.9	832.6	961.7	139.2	616.0
1975	1,235.5	2,366.3	405.5	805.7	941.9	153.6	626.1
1976	1,499.0	3,381.0	415.8	812.0	1,057.0	140.5	630.3
1977	1,689.5	4,252.1	376.8	788.6	1,116.6	121.9	581.6
1978	1,740.6	6,200.6	412.4	828.3	1,111.0	142.7	602.8
1979	1,767.2	9,274.6	456.8	966.5	1,262.9	136.0	660.8
1980	1,929.0	12,440.8	446.6	885.2	1,275.5	145.6	619.3
1981	2,170.1	18,672.3	516.3	1,067.5	1,391.8	176.4	703.1
1982	2,131.3	26,495.4	582.2	1,270.7	1,441.8	194.6	782.5
1983	1,698.8	33,913.8	561.2	1,168.6	1,238.2	189.9	715.2
1984	1,862.7	45,727.0	576.9	1,128.9	1,390.7	214.9	715.8
1985	2,078.4	61,366.4	608.3	1,254.5	1,561.5	228.5	781.2
1986	2,078.4	93,265.1	681.5	1,266.1	1,516.7	275.8	783.6
1987	1,878.0	125,130.6	696.1	1,286.3	1,454.7	280.3	774.6
1988	2,002.2	177,980.8	684.3	1,346.9	1,558.3	246.5	745.8
1989	2,375.6	257,256.1	742.6	1,502.9	1,684.6	293.1	866.1
1990	2,319.5	308,551.9	762.7	1,399.9	1,610.5	366.1	846.2
1991	2,086.8	332,645.4	643.2	1,152.8	1,377.6	262.4	691.4
1992	2,097.6	387,827.2	608.3	1,037.5	1,253.6	240.7	654.4
1993	2,420.9	487,309.9	613.1	1,125.2	1,332.6	188.4	676.6
1994	2,652.7	637,311.3	685.9	1,355.8	1,071.3	169.4	761.3
1995	2,790.7	929,541.8	791.5	1,551.7	1,339.3	212.9	823.5
1996	2,435.1	1,191,461.2	837.3	1,495.6	1,457.2	223.1	927.3
1997	2,403.0	1,667,113.0	917.4	1,436.8	1,632.4	255.2	1,006.4
1998	2,828.1	2,468,415.3	934.8	1,376.5	1,739.9	330.0	998.2
1999	3,051.3	3,102,617.7	977.8	1,296.4	1,785.8	294.5	1,004.2
2000	3,522.8	4,864,550.2	808.1	1,375.4	1,681.7	542.2	1,124.6
2001	2,795.2	4,605,739.6	1,119.3	1,405.0	2,069.6	266.0	1,090.6
2002	3,300.1	5,558,597.7	952.5	1,402.9	2,194.8	448.4	1,221.8
2003	3,805.7	7,630,636.4	1,276.9	1,528.5	2,297.6	662.3	1,168.9
2004	4,088.4	10,684,290.0	1,394.0	1,549.1	2,308.0	693.2	1,159.8

Table A15 (continued)

Year	*Inventories ch non-farm $m1960*	*Inventories change farm $m1960*	*Inventories ch livestock $m1960*	*Imports $m1960*	*Labour $m1960*	*User cost - NROC $m1960*	*User cost - Software $m1960*
1960	187.8	220.6	44.6	2,500.0	8,286.2	10,004.2	6.6
1961	199.3	225.4	45.0	2,812.8	8,684.2	10,715.5	13.2
1962	211.6	230.3	45.3	2,411.8	8,719.6	11,466.9	20.2
1963	224.6	235.3	45.7	2,829.8	8,950.4	12,239.6	27.9
1964	424.3	625.6	-139.5	3,147.8	9,154.9	13,028.3	36.5
1965	157.3	-93.2	-21.9	3,748.5	9,371.0	13,929.6	41.0
1966	180.6	-502.2	89.1	3,851.7	9,665.3	14,922.9	45.5
1967	247.3	-202.7	232.4	3,916.6	9,834.7	16,013.7	51.5
1968	348.8	1,552.7	362.0	4,303.7	10,038.2	17,064.0	57.5
1969	369.2	-37.8	381.5	4,452.2	10,225.0	18,137.5	65.2
1970	615.7	-797.8	490.1	4,823.4	10,450.6	19,343.1	74.7
1971	6.6	-42.8	624.4	4,971.3	10,840.1	20,605.6	84.0
1972	132.4	-2,219.9	153.8	4,597.3	11,048.5	21,965.9	95.4
1973	286.0	-1,367.7	328.6	4,658.8	11,213.9	23,302.6	113.1
1974	654.3	68.7	381.4	6,063.0	11,546.6	24,475.3	138.6
1975	51.1	-566.8	178.8	6,209.4	12,077.0	25,660.6	181.6
1976	373.3	-775.3	-247.9	5,903.4	11,910.7	26,752.8	253.2
1977	-235.5	-379.9	-248.1	6,464.7	11,735.6	27,702.9	447.0
1978	209.4	-751.7	-213.8	6,161.8	11,846.1	28,694.4	748.0
1979	326.7	-717.8	-50.9	6,662.0	12,173.5	29,646.9	1,125.8
1980	305.7	-371.1	-151.9	6,669.2	12,363.8	30,678.5	1,504.1
1981	206.2	144.4	-1.9	7,297.2	12,641.4	31,628.3	1,963.4
1982	-537.9	-315.0	-492.1	8,150.7	12,582.4	32,648.8	2,736.2
1983	179.9	-46.5	-114.4	7,465.1	12,161.5	33,800.4	3,798.2
1984	394.9	0.5	133.4	7,917.2	12,309.9	34,764.9	4,957.5
1985	67.9	-118.2	-196.0	9,221.9	12,881.4	35,583.2	6,890.3
1986	-301.3	-329.5	-130.9	9,200.2	13,335.6	36,508.7	9,775.3
1987	98.5	-357.8	116.0	8,765.3	13,673.1	37,638.0	13,686.5
1988	573.2	-176.8	99.8	9,737.8	14,122.6	38,781.2	19,959.9
1989	870.3	114.3	794.0	12,102.3	14,623.4	40,043.4	27,977.3
1990	-121.8	272.0	-534.8	12,768.9	15,180.2	41,307.0	35,955.6
1991	-336.9	-329.2	475.5	12,038.9	14,958.5	42,688.1	47,548.2
1992	187.8	-255.8	24.5	12,477.7	14,703.3	43,708.4	59,142.4
1993	192.3	-74.4	99.3	13,262.5	14,682.0	44,411.6	69,739.4
1994	294.3	35.3	-309.3	14,150.9	15,166.2	44,999.6	85,074.7
1995	30.6	257.4	313.6	16,489.5	15,685.9	45,604.8	99,039.8
1996	278.2	-243.1	245.3	17,154.6	16,077.3	46,366.0	110,894.3
1997	-98.5	-530.5	-129.2	18,858.0	15,989.2	47,318.5	121,228.4
1998	697.3	50.3	10.8	20,691.4	16,333.8	48,459.8	138,709.7
1999	463.6	-90.4	111.9	21,690.5	16,437.5	49,718.4	163,264.5
2000	227.9	-552.4	-106.8	24,478.5	16,845.2	51,137.5	201,102.3
2001	178.4	-169.2	-5.2	24,169.2	17,110.4	52,280.7	250,042.3
2002	93.9	-173.2	-252.4	24,709.8	17,058.6	52,902.8	312,277.9
2003	809.4	21.9	-92.3	28,041.0	17,356.7	53,698.3	360,803.4
2004	864.1	22.2	-91.3	31,713.1	17,608.8	54,968.8	401,332.1

Table A15 (continued)

Year	*User cost - Exploration $m1960*	*User cost - Computers $m1960*	*User cost – Elec. mach. $m1960*	*User cost – Indust. mac. $m1960*	*User cost - Vehicles $m1960*	*User cost - Oth transport $m1960*
1960	43.7	7.8	1,180.8	1,912.4	2,173.3	428.7
1961	62.0	9.0	1,253.8	2,072.1	2,356.5	467.7
1962	82.6	12.8	1,324.4	2,254.9	2,523.5	494.0
1963	112.5	22.2	1,397.7	2,429.5	2,648.4	522.0
1964	154.4	40.3	1,486.4	2,625.3	2,801.7	552.4
1965	202.6	67.0	1,576.7	2,816.2	3,038.1	573.5
1966	259.1	116.9	1,688.0	3,093.7	3,277.5	607.3
1967	320.9	195.2	1,818.2	3,401.0	3,470.8	649.4
1968	382.7	305.3	1,941.2	3,682.5	3,675.2	688.0
1969	457.8	467.6	2,078.5	3,961.1	3,852.5	749.3
1970	546.8	682.3	2,204.4	4,261.0	4,073.5	787.9
1971	661.5	961.1	2,323.7	4,566.5	4,228.8	822.6
1972	790.8	1,364.1	2,448.2	4,919.5	4,384.7	840.5
1973	876.5	1,959.6	2,574.2	5,235.2	4,547.9	885.2
1974	940.7	2,721.9	2,676.1	5,437.5	4,805.7	916.8
1975	981.0	3,758.8	2,768.5	5,630.1	5,093.1	947.8
1976	992.5	5,561.8	2,837.1	5,768.0	5,422.6	989.3
1977	985.1	8,117.7	2,906.5	5,894.9	5,829.3	1,013.1
1978	984.0	11,236.2	2,932.9	5,987.1	6,254.2	1,015.7
1979	993.6	15,914.1	2,991.7	6,108.2	6,622.9	1,039.0
1980	1,017.6	23,088.9	3,089.2	6,354.4	7,102.7	1,052.9
1981	1,083.1	32,484.1	3,165.2	6,490.8	7,540.5	1,074.7
1982	1,188.8	46,861.5	3,302.4	6,793.8	8,133.9	1,125.2
1983	1,357.0	67,392.6	3,491.2	7,265.8	8,716.6	1,188.1
1984	1,488.7	92,385.5	3,633.7	7,578.4	9,032.0	1,238.6
1985	1,582.9	124,353.4	3,779.0	7,819.6	9,458.6	1,308.1
1986	1,655.5	161,078.8	3,936.6	8,158.4	10,009.1	1,383.1
1987	1,707.2	214,301.7	4,146.7	8,470.9	10,457.7	1,497.2
1988	1,694.8	276,930.1	4,340.2	8,765.7	10,798.8	1,602.8
1989	1,746.1	360,721.5	4,501.3	9,088.1	11,206.1	1,662.3
1990	1,791.1	483,130.4	4,704.9	9,527.0	11,693.9	1,760.8
1991	1,808.5	592,047.4	4,904.0	9,814.5	12,047.4	1,921.1
1992	1,816.8	672,976.0	4,969.2	9,822.0	12,128.8	1,958.9
1993	1,811.6	754,999.7	4,994.8	9,713.9	12,074.1	1,970.4
1994	1,821.1	893,486.3	5,024.6	9,707.0	12,110.2	1,928.6
1995	1,835.0	1,096,646.3	5,122.8	9,932.0	11,876.1	1,872.5
1996	1,874.0	1,471,371.8	5,317.2	10,326.5	11,923.4	1,865.7
1997	1,917.4	1,952,515.7	5,536.8	10,619.9	12,090.5	1,870.0
1998	1,986.0	2,665,160.5	5,811.5	10,821.0	12,418.5	1,906.1
1999	2,050.5	3,888,731.4	6,073.9	10,938.9	12,820.8	2,012.9
2000	2,077.4	5,150,244.4	6,348.7	10,963.3	13,226.4	2,072.4
2001	2,068.8	7,616,811.1	6,416.5	11,059.7	13,466.8	2,328.1
2002	2,084.7	8,894,427.7	6,777.5	11,178.4	14,065.7	2,320.9
2003	2,080.5	10,555,833.8	6,926.5	11,279.6	14,704.0	2,491.2
2004	2,088.4	13,516,672.1	7,369.4	11,490.9	15,363.8	2,851.8

Table A15 (continued)

Year	*User cost - Other mach. $m1960*	*User cost - Non-farm inv. $m1960*	*User cost - Farm invent. $m1960*	*User cost - Livestock $m1960*	*User cost – Comm. land $m1960*	*User cost - Rural land $m1960*
1960	1,769.7	3,063.3	10,139.4	5,767.5	3,016.8	5,688.7
1961	1,859.9	3,251.1	10,360.0	5,812.1	3,112.4	5,688.7
1962	1,951.9	3,450.4	10,585.4	5,857.1	3,213.1	5,688.7
1963	2,034.8	3,662.0	10,815.8	5,902.4	3,319.4	5,688.7
1964	2,133.4	3,886.6	11,051.1	5,948.1	3,431.8	5,688.7
1965	2,234.1	4,310.9	11,676.8	5,808.6	3,551.4	5,688.7
1966	2,388.3	4,468.2	11,583.6	5,786.7	3,694.2	5,688.7
1967	2,556.5	4,648.8	11,081.3	5,875.8	3,821.5	5,688.7
1968	2,703.5	4,896.1	10,878.6	6,108.2	3,965.0	5,688.7
1969	2,860.2	5,244.8	12,431.3	6,470.2	4,117.4	5,688.7
1970	3,014.6	5,614.1	12,393.5	6,851.7	4,266.1	5,688.7
1971	3,161.3	6,229.7	11,595.7	7,341.7	4,422.4	5,688.7
1972	3,329.8	6,236.4	11,553.0	7,966.1	4,565.4	5,688.7
1973	3,486.7	6,368.8	9,333.1	8,120.0	4,675.1	5,688.7
1974	3,591.6	6,654.8	7,965.4	8,448.6	4,778.2	5,688.7
1975	3,689.7	7,309.1	8,034.1	8,830.0	4,863.8	5,688.7
1976	3,778.9	7,360.2	7,467.3	9,008.8	4,930.2	5,688.7
1977	3,860.0	7,733.5	6,692.0	8,761.0	5,005.6	5,688.7
1978	3,893.2	7,498.1	6,312.1	8,512.9	5,082.3	5,688.7
1979	3,944.9	7,707.4	5,560.5	8,299.0	5,166.6	5,688.7
1980	4,052.0	8,034.1	4,842.7	8,248.2	5,248.8	5,688.7
1981	4,104.4	8,339.9	4,471.6	8,096.3	5,345.5	5,688.7
1982	4,235.2	8,546.1	4,616.0	8,094.4	5,458.6	5,688.7
1983	4,430.8	8,008.1	4,301.0	7,602.2	5,558.2	5,688.7
1984	4,527.7	8,188.1	4,254.5	7,487.8	5,630.1	5,688.7
1985	4,607.2	8,582.9	4,255.0	7,621.1	5,704.0	5,688.7
1986	4,735.9	8,650.9	4,136.8	7,425.2	5,792.5	5,688.7
1987	4,848.7	8,349.6	3,807.3	7,294.3	5,876.7	5,688.7
1988	4,933.4	8,448.1	3,449.6	7,410.3	5,958.4	5,688.7
1989	4,976.9	9,021.3	3,272.7	7,510.0	6,050.2	5,688.7
1990	5,130.3	9,891.6	3,387.1	8,304.0	6,154.5	5,688.7
1991	5,231.6	9,769.8	3,659.1	7,769.2	6,224.0	5,688.7
1992	5,175.1	9,432.9	3,329.9	8,244.8	6,275.8	5,688.7
1993	5,086.3	9,620.6	3,074.1	8,269.3	6,320.3	5,688.7
1994	5,041.7	9,812.9	2,999.7	8,368.6	6,365.2	5,688.7
1995	5,083.4	10,107.2	3,035.1	8,059.3	6,425.6	5,688.7
1996	5,189.6	10,137.8	3,292.5	8,372.9	6,499.8	5,688.7
1997	5,393.1	10,416.0	3,049.4	8,618.2	6,579.8	5,688.7
1998	5,654.2	10,317.6	2,518.9	8,489.0	6,669.9	5,688.7
1999	5,882.1	11,014.8	2,569.2	8,499.8	6,777.0	5,688.7
2000	6,080.4	11,478.5	2,478.8	8,611.7	6,845.4	5,688.7
2001	6,327.8	11,706.3	1,926.3	8,504.9	6,874.0	5,688.7
2002	6,511.0	11,884.8	1,757.1	8,499.7	6,920.3	5,688.7
2003	6,774.2	11,978.7	1,584.0	8,247.3	7,003.7	5,688.7
2004	6,919.7	12,788.1	1,605.9	8,155.0	7,092.5	5,688.7

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