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Australia Post – Past and Forecast Productivity Growth

Prepared for:

Australian Competition and Consumer Commission

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Executive Summary

The Australian Competition and Consumer Commission (ACCC) has requested Meyrick and Associates to provide this report quantifying Australia Post's total factor productivity (TFP) performance over the past five years and the next five year regulatory period as well as reviewing past studies of Australia Post's TFP performance. The report is input to the ACCC's review of Australia Post's draft notification of proposed increases in the price of a range of reserved postal services.

To examine Australia Post's overall TFP performance, we assemble price and quantity data for 7 outputs (reserved letters, other addressed mail, unaddressed mail, money orders, agency services, accommodation and other outputs) and 4 inputs (labour, contractors, capital, and materials and services) covering the 27 year period 1976 to 2002. This study uses the Swan Consultants (Canberra) (1992a) database as a starting point but includes new output detail provided by Australia Post for the period 1976 to 1991. Other data provided by Australia Post are used to extend the enhanced TFP database through to 2002.

Australia Post's output quantity has grown strongly over the period but levelled out in 2001 and declined marginally in 2002. The trend growth rate of aggregate output was a very high 4.5 per cent per annum between 1976 and 2002. The growth rate for the first 16 years up to 1991 was somewhat lower at 3.8 per cent per annum but then accelerated to 5.7 per cent per annum for the last decade, the flattening out and reduction of output in the last few years notwithstanding. This resulted from strong growth in the non-reserved output categories of other revenue, other addressed mail, agency services and unaddressed mail.

Aggregate input quantity, on the other hand, has grown far less strongly with a trend growth rate of 1.5 per cent per annum for the entire period. This was also the trend growth rate for the 16 years up to 1991 but the growth rate then increased to 2.2 per cent per annum for the last decade. The increase in input use also flattened out in 2001 and declined marginally in 2002.

TFP grew by a trend 3 per cent per annum over the whole period. TFP trend growth in the 16 years to 1991 was somewhat lower at 2.3 per cent per annum with three subperiods clearly visible with good growth in the first few years after 1976, then a period of flat TFP performance during the first half of the 1980s and improving performance towards the end of this period up to 1991. This strong TFP performance then continued through the 1990s with a trend TFP growth rate of 3.5 per cent per annum for the last decade. However, in line with the flattening out in both outputs and inputs at the end of the decade, TFP growth has flattened after 2000 and declined marginally in 2002.

We also examine the estimated TFP performance of Australia Post's reserved letter service over the last six years, 1997 to 2002, and the forecast performance for the next five years, 2003 to 2007. Although more limited data is available for Australia Post's reserved service operations and its use and interpretation is subject to important caveats, a similar picture emerges for reserved services. Reserved service TFP growth falls from 3.8 per cent per annum between 1997 and 2002 to a forecast 1.2 per cent per annum over the next five years to 2007. A levelling off in reserved service outputs after 2001 and ongoing modest reductions in total input use bring this about. As in the case of Australia Post as a whole, there is ongoing substitution of capital and materials and services for labour.

Australia Post's Past and Forecast Productivity Performance

1 Introduction

Australia Post has advised the Australian Competition and Consumer Commission (ACCC) of its intention to lodge a pricing notification under section 22 of the *Prices Surveillance Act 1983*. Australia Post's draft price notification proposes increases in the prices of most but not all services reserved to Australia Post under the *Australia Postal Corporation Act*. Services reserved to Australia Post under the Act are described as follows:

- '... Australia Post has the exclusive right to carry letters within Australia, whether the letters originated within or outside Australia.
- The reservation of services to Australia Post ... extends to:
 - The collection, within Australia, of letters for delivery within Australia; and
 - The delivery of letters within Australia.
- Australia Post also has the exclusive right to issue postage stamps within Australia.'

The ACCC has begun its process of assessing the proposal, leading to its decision on whether or not to object to the proposed increases. As input to its assessment process the ACCC has requested Meyrick and Associates to provide this report quantifying Australia Post's total factor productivity (TFP) performance over the past five years and the next five year regulatory period as well as reviewing past studies of Australia Post's TFP performance.

Specifically, the objectives of the consultancy are to:

- provide an assessment of previous studies regarding Australia Post's total factor productivity;
- provide an updated total factor productivity growth analysis on a year-by-year basis for the last 5 years based on relevant inputs and outputs;
- provide an estimate of the implied productivity growth rates for the assumed regulatory period (2002–2007) from the input, cost, output, and revenue data provided by Australia Post; and
- compare the implied productivity growth rates for the next five years with the past improvements and provide an appropriate estimate of the expected productivity gains for the assumed regulatory period.

In the following section of the report we review the previous studies of Australia Post's productivity. These include a series of reports by Swan Consultants (Canberra) (1992a, 1992b and 1992c) and an article by Abbott (2000). The TFP methodology used in the current study is then summarised in section 3. Section 4 then outlines Australia Post's aggregate outputs, inputs and productivity performance over the period 1976–2002 while section 5 outlines the reserved service outputs, inputs and productivity performance for the period 1997–2002 and forecasts for the period 2003–2007. Finally, conclusions are drawn in section 6 and the data used in the study are listed in the appendices along with other technical material.

2 Previous TFP studies of Australia Post

2.1 Swan Consultants (Canberra) (1992)

The most comprehensive previous study of Australia Post's TFP performance was a series of reports prepared by Swan Consultants (Canberra) in 1992. This work was carried out for Australia Post and extended and refined earlier work done by the Industry Commission (1990).

Swan Consultants (Canberra) (1992a) reports a TFP model comprising five separate outputs (postal articles, money orders, agency services, accommodation and other outputs) and four separate inputs (labour, contractors, capital and other inputs) covering the years 1976 to 1991¹. The report uses the Tornqvist TFP indexing approach. Capital stocks are formed by using real investment and retirements data and assumed depreciation rates to index point estimates of the market value of Australia Post's assets forwards and backwards through time.

The report found there were three distinct periods of productivity growth. There was strong TFP growth between 1976 and 1980 reflecting the removal of outdated work practices that prevailed when the Australia Postal Commission took over postal operations from the old Postmaster General's Department. This was followed during the mid-to-late eighties by a period of significant industrial disputation within Australia Post, when the efficient operation of the postal network was disrupted by industrial disputes and poor industrial relations. During this period substantial investments were made in mail handling equipment but the equipment was never commissioned because of union restrictions. Consequently, measured input use grew significantly and productivity remained relatively constant. With the improvement of industrial relations and the corporatisation of Australia Post in 1989, the report found that productivity growth grew significantly and peaked in 1991 at nearly 50 per cent above 1976 levels. Overall average TFP growth was a relatively high 2.6 per cent per annum for the 16 year period.

The study also used econometric techniques involving the estimation of factor requirements functions (see Diewert 1974; Zeitsch, Lawrence and Salerian 1994) to examine the impact of the increasing density of the mail network over this period. A higher growth rate of output compared to delivery points helped improve Australia Post's observed TFP performance over the period without any underlying technological improvements. By using the econometric work to adjust for growth in output and delivery points, the study found that TFP growth which could be attributed solely to technological change was lower than total TFP growth but still led to this adjusted TFP being 40 per cent higher in 1991 compared to 1976. Average adjusted TFP growth fell to a still relatively high 2.2 per cent per annum for the 16 year period.

Swan Consultants (Canberra) (1992b) undertook a more disaggregated TFP analysis using the same source data but for the shorter period 1984 to 1991. This study used around 24 separate mail article categories and around 27 separate input categories. Swan Consultants (Canberra) (1992c) used the multilateral TFP approach to compare the productivity levels of Australia Post and New Zealand Post between 1988 and 1991. New Zealand Post was found to be 12 per cent more efficient than Australia Post in 1988 but this lead had been reduced to one per cent by 1991.

2.2 Abbott (2000)

An article by Abbott (2000) attempted to assess the success of the corporatisation of Australia Post in 1989 in improving Australia Post's performance. The article concentrated on updating the earlier Swan Consultants (Canberra) (1992a) results but using a simplified methodology to assess Australia Post's performance from 1976 to 1999 and using data envelopment analysis (DEA) to compare Australia Post's performance with overseas postal organisations in 1997.

The Abbott TFP study recognises two outputs (postal articles and other outputs) and three inputs (labour, contractors and capital) compared to the five outputs and four inputs of Swan Consultants (Canberra). While the Abbott article provides insufficient information to undertake a detailed assessment of the simplified TFP methodology used, some observations can be made by comparing the data presented in Abbott's (2000, p.13) table 4 with the detailed data reported later in the current study.

¹ Throughout this report financial years are referred to by the year which ends 30 June, ie 1976 is the financial year 1975-76.

While proportional changes in Abbott's postal articles series are broadly consistent with the aggregate of the three postal articles series used in the current study, the increase in Abbott's other outputs constant dollar quantity series falls far short of the aggregate increase observed in the four non-postal article quantity series used in this study. Similarly, while the proportional change in Abbott's labour and contractor quantity series are broadly consistent with the series used in this study, the increase in Abbott's capital quantity series over the period is far less than that reported here. It can also not be reconciled with either the Industry Commission (1990) or Swan Consultants (Canberra) (1992a) series despite statements that these series are used for the relevant periods. One reason for this discrepancy may be Abbott's stated use of depreciation rates originally used in Industry Commission (1990) but significantly revised in Swan Consultants (Canberra) (1992a). Another factor leading to Abbott significantly understating total input use is the exclusion of other inputs, principally comprising materials and services purchases. The quantity of materials and services has increased much faster than the quantities of labour, contractors or capital.

The effects of Abbott's simplifications to the Swan Consultants (Canberra) (1992a) TFP methodology appear to have been to understate the rate of increase in both Australia Post's outputs and, particularly, its inputs. As a result, the reported TFP results in Abbott (2000) appear to be higher at the end of the study's time period in 1999 than those reported in the current study. While the Abbott TFP results provide a rough guide to Australia Post's performance, they are unlikely to be accurate enough to base important policy decisions on.

The data envelopment analysis application reported in Abbott (2000) is also based on a large number of simplifications. Firstly, the study uses 1997 Universal Postal Union statistical data for 22 countries. The data reported by international agencies in such publications are often supplied by the participating countries using differing national definitions and coverage. This makes their use in benchmarking studies questionable without extensive quality control checking. It is preferable to use a smaller range of countries where data has been specifically collected for the exercise on a comparable basis. Secondly, the inclusion of the number of customers as an output variable appears arbitrary and there is no sensitivity analysis given of the effect of this. The input specification is also simplistic. In particular, there is no economic justification for including capital expenditure as a measure of capital input as is done in one of the two specifications reported. No attempt is made to include the increasingly important materials and services input component. Finally, no attempt is made to adjust for operating environment conditions beyond management control – something that would be essential when trying to draw policy conclusions from a comparison of such a diverse range of countries. The scale of operations, climatic and topographic conditions, among other things, are all likely to have an important impact on observed efficiency differences.

3 TFP methodology

TFP is defined as the change in total output divided by the change in total inputs used between two periods. Mathematically, this is given by:

$$(1) \quad TFP = \Delta Q / \Delta I$$

where ΔQ is the change in the quantity of total output provided by Australia Post between the current period and the base period and ΔI is the corresponding change in the quantity of total inputs used by Australia Post.

Most firms have a diverse range of outputs (eg Australia Post provides access to the mail network, letter carriage, financial transaction processing, retail stationery sales, etc) and an even more diverse range of inputs (eg labour, capital, materials and fuel). Calculating TFP requires a means of adding together these diverse output and input quantities into measures of total output and total input quantity. The different types of outputs and inputs cannot be simply added (eg it is not meaningful to add the number of employees to the number of delivery motorbikes). Index number theory is used to overcome this problem.

The selection of the functional form for the input and output indexes has traditionally been based on two principal approaches.

The 'exact index number' approach selects index number formulations on the basis of an assumed underlying production function and assuming price-taking, profit-maximising behaviour on the part of producers. For example, the Tornqvist index used extensively in past TFP studies can be derived by assuming the underlying production function has the 'translog' form and assuming producers are price-taking revenue maximisers and price-taking cost minimisers.

The 'axiomatic' approach to the selection of an appropriate index formulation specifies a number of desirable properties an index formulation should possess. Potential indexes are then evaluated against the specified properties and the index that passes the most tests would be preferred for the analysis.

Diewert (1993) reviewed alternate index number formulations to determine which index was best suited to TFP calculations. An axiomatic procedure was used and Diewert proposed certain tests to evaluate the alternate indexes. These included:

- the constant quantities test: if quantities are the same in two periods, then the output index should be the same in both periods irrespective of the price of the goods in both periods;
- the constant basket test: this states that if prices are constant over two periods, then the level of output in period 1 compared to period 0 is equal to the value of output in period 1 divided by the value of output in period 0;
- the proportional increase in outputs test: this states that if all outputs in period t are multiplied by a common factor, λ , then the output index in period t compared to period 0 should increase by λ also; and
- the time reversal test: this states that if the prices and quantities in period 0 and t are interchanged, then the resulting output index should be the reciprocal of the original index.

The four most popular index formulations were evaluated against these tests. The indexes evaluated included:

- the Laspeyres base period weight index;
- the Paasche current period weight index;
- the Fisher ideal index which is the square root of the product of the Paasche and Laspeyres index; and
- the Tornqvist index which has been used extensively in previous TFP work.

When evaluated against the tests listed above, only the Fisher ideal index passed all four tests. The Laspeyres and Paasche index fail the time reversal test while the Tornqvist index fails the constant basket test.

On the basis of his analysis, Diewert recommended that the Fisher ideal index be used for TFP work although he indicated that the Tornqvist index could also be used as it closely approximates Fisher's ideal index.

In this exercise the Fisher ideal index was chosen as the preferred index formulation. The technical specification of the Fisher ideal index is given in appendix A. To implement the TFP methodology, data is required on the price and quantity of all Australia Post's outputs and inputs. The data used to represent Australia Post's outputs and inputs are discussed in the following section along with the resulting aggregate TFP and partial productivity measures. The data are presented in Appendix B.

4 Australia Post's aggregate outputs, inputs and productivity

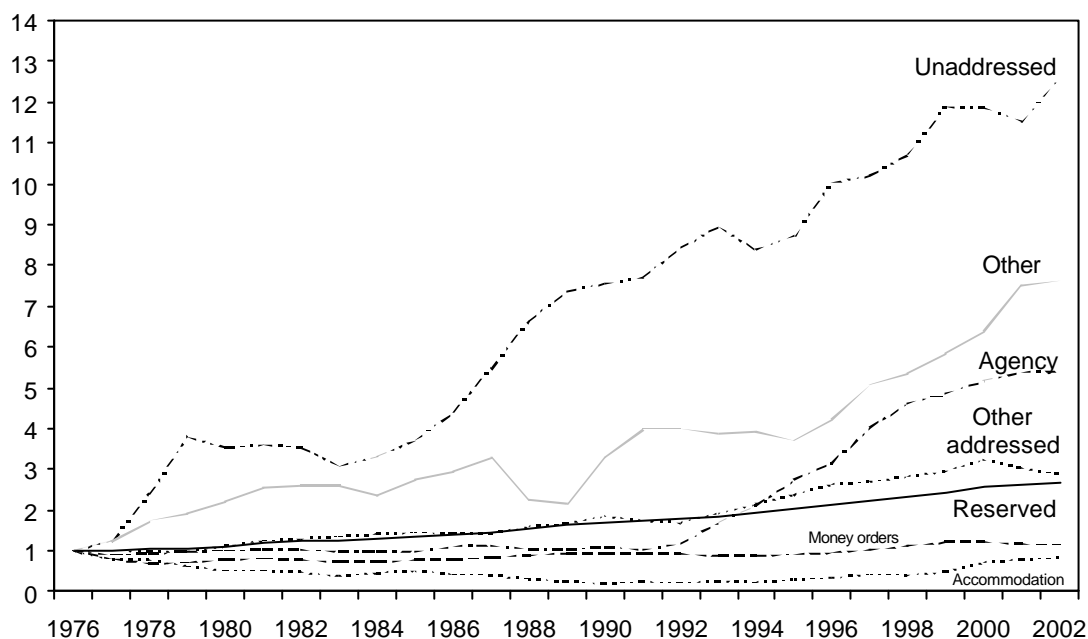
This study uses the Swan Consultants (Canberra) (1992a) database as a starting point but includes new output detail provided by Australia Post for the period 1976 to 1991. Other data provided by Australia Post is used to extend the enhanced TFP database through to 2002. Price and quantity data was assembled for 7 outputs and 4 inputs covering the 27 year period 1976 to 2002. The major outputs and inputs are described in the following sections.

4.1 Outputs

Reserved letters

The reserved letters output covers the definition of reserved letters used in the current ACCC review. As such, it covers domestic letters but not international letters. The quantity of reserved letters is measured by the number of relevant letters handled while the price is derived by dividing the revenue obtained from these letters by their number. The quantity of reserved letters has increased by 165 per cent between 1976 and 2002. The rate of increase has levelled off markedly over the last two to three years. Movements in the quantity indexes for reserved letters and the other output categories are presented in figure 1. The share of reserved letters in Australia Post's total revenue has fallen from 56 per cent in 1976 to 45 per cent in 2002.

Figure 1: Australia Post's aggregate output indexes, 1976–2002



Other addressed mail

The other addressed mail output covers all letters, parcels, etc other than those defined as reserved but also excludes incoming international letters. Incoming international letters are excluded from this output because quantity data has only been collected from 1990 onwards. The revenue obtained from incoming international letters has instead been included as part of the other outputs category. Quantity data on outgoing international mail, on the other hand, has been available for the whole period and is included in this category. The quantity of other addressed mail is measured by the number of relevant items handled while the price is derived by dividing the revenue obtained from these items by their number. The quantity of other addressed mail increased by 180 per cent between 1976 and 2000 but has fallen by 11 per cent in the last two years. The share of other addressed mail in Australia Post's total revenue has increased from 20 per cent in 1976 to 29 per cent in 2002.

Unaddressed mail

The unaddressed mail output covers all letters, pamphlets, etc which Australia Post distributes that do not have individual delivery addresses on them. The quantity of unaddressed mail is measured by the number of relevant items handled while the price is derived by dividing the revenue obtained from these items by their number. The quantity of unaddressed mail increased by 1,150 per cent between 1976 and 2000 and has been Australia Post's most rapidly increasing output by far (see figure 1). However, despite this spectacular quantity growth the share of unaddressed mail in Australia Post's total revenue has only increased from 0.3 per cent in 1976 to one per cent in 2002.

Money orders

The quantity of money orders is measured by the number of money orders issued while the price is derived by dividing the revenue obtained from these items by their number. The quantity of money orders decreased by 25 per cent between 1976 and 1983 before increasing steadily through to 2000 to be 23 per cent above their 1976 level. Their number has fallen by 6 per cent over the last two years. The share of money orders in Australia Post's total revenue has moved little from one per cent over the 27 year period.

Agency services

The quantity of agency services is measured by the number of services for the period from 1991 onwards. This data is not available for the earlier period so the number of agency services up to 1990 is estimated by indexing the 1991 number back by the corresponding change in the constant dollar measure derived by Swan Consultants (Canberra) (1992a). The price is derived by dividing the commission revenue obtained from these services by their number. The quantity of agency services stayed relatively steady up until 1991 before increasing markedly over the past decade to finish up 440 per cent above their 1976 level. This rapid increase reflects Australia Post's success at becoming a centre for financial transactions. The share of agency services in Australia Post's total revenue initially decreased from around 17 per cent in 1976 to only 4 per cent in 1992 before increasing to around 7 per cent in 2002.

Accommodation

The quantity of accommodation provided to organisations outside Australia Post is measured by deflating the amount of rent revenue received by the consumer price index. The implied quantity of accommodation provided decreased by 75 per cent between 1976 and 1990 before increasing steadily since then to be 20 per cent below its 1976 level by 2002. The share of accommodation in Australia Post's total revenue has fluctuated but remained low over the 27 year period falling from around one per cent in 1976 to 0.5 per cent in 2002.

Other outputs

The other outputs category comprises a range of revenue sources for Australia Post including envelop and stationery sales, philatelic sales, private post box rental, redirection fees and incoming international mail. The quantity of other outputs is measured by deflating the relevant revenue received by the consumer price index. The quantity of other outputs has grown strongly, increasing by 666 per cent between 1976 and 2002 making it the second fastest growing output. The share of other outputs in Australia Post's total revenue has also increased strongly from under 4 per cent in 1976 to over 16 per cent in 2002.

4.2 Inputs

Labour

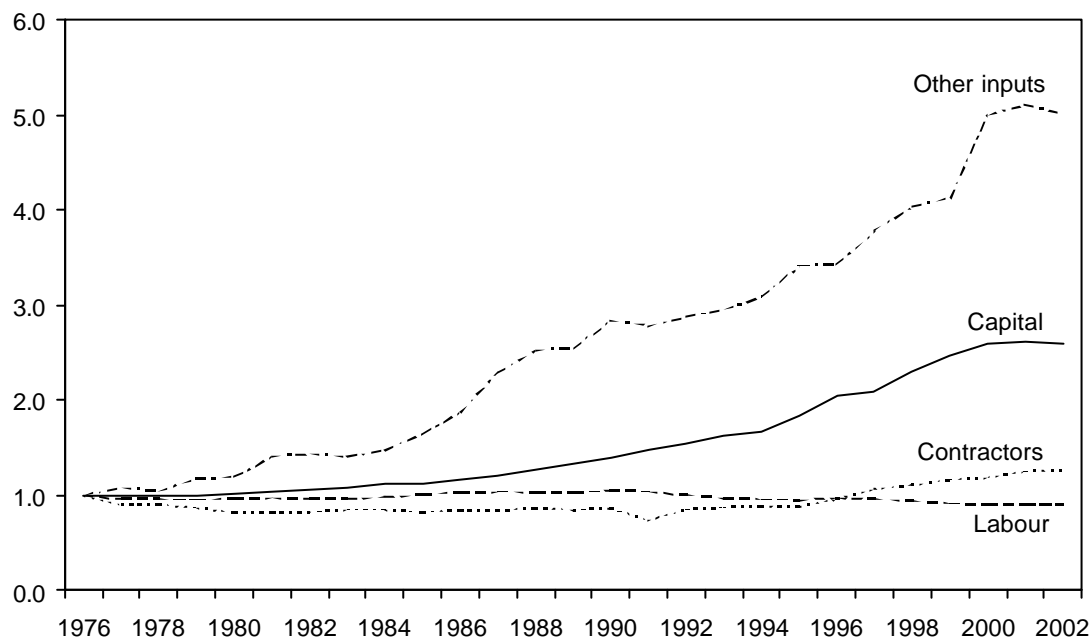
The quantity of labour inputs is measured as the number of full-time equivalent staff employed directly by Australia Post and employed by post office agents. The number of full-time and part-time staff employed by both Australia Post and agencies was relatively consistently available up until 1991. From 1991 onwards the number of part-time agency

staff was not separately recorded and major changes to the recording of agency labour data were made in 1994. Swan Consultants (Canberra) (1992a) estimated the number of full-time equivalents as the number of full-time staff plus half the number of part-time and casual staff employed by both Australia Post and agencies. For the years 1991 to 1993 we take the number of full-time equivalents to be the number of full-time staff employed by Australia Post plus half the number of part-time and casual staff employed by Australia Post plus 0.888 times the number of agency staff. The latter conversion factor for agency staff produces the same total full-time equivalents for 1991 as obtained by Swan Consultants (Canberra) (1992a). For the years from 1995 onwards the number of agency full-time equivalents is derived by deflating the post office agency and licensed post office costs by the Australia Post full-time equivalent wage rate. As 1994 is a transition year in data recording its full-time equivalents are taken to be the average of those for 1993 and 1995.

The cost of labour is taken to be Australia Post's wages and salary costs plus post office agency and licensed post office costs. The costs of redundancies are excluded from the analysis as are abnormal labour items associated with changes in the bond rate during the 1990s which affect the discount rate used to calculate future liabilities.

The quantity of labour inputs fluctuated within a 5 per cent band around its 1976 level through until 1998. Since 1999 labour inputs have been around 10 per cent below their 1976 level. Movements in the quantity indexes for labour and the other input categories are presented in figure 2. The share of labour costs in total costs (as measured in this study) has fallen from around three quarters in 1976 to half in 2002.

Figure 2: Australia Post's aggregate input indexes, 1976–2002



Contractors

The delivery and cartage of mail by contractors is an important part of postal operations. The quantity of contractor input is measured by the number of contractors used while the price of contractors is derived by dividing the cost of contractors by their number. The number of contractors used initially fell by 18 per cent between 1976 and 1982 but has since increased to finish 26 per cent above its 1976 level. The share of contractors in total costs has increased from 6.5 per cent to 8.5 per cent over the 27 year period.

Capital

Capital inputs are different to other inputs in that they are not fully consumed in the year of purchase. Rather, they provide a flow of services over their lives. The quantity and cost of using capital must take this phenomenon into account. The flow of services provided by capital employed by Australia Post was assumed to be a fixed proportion of the capital stock. The capital stock used by Australia Post was estimated using data on yearly investment, asset retirements, assumed depreciation rates and a point estimate of the market value of the capital stock.

The point estimates of market value used as starting points and the depreciation rates used for building up the capital stock estimates were the same as those used by Swan Consultants (Canberra) (1992a) for 1990. The real stock of capital employed by Australia Post in years other than 1990 was calculated using the declining balance method summarised in the following relationship:

$$(1) \quad S_{jt} = S_{jt-1}(1 - d_j) + I_{jt} - R_{jt}$$

where: S_{jt} is the end of period real capital stock of asset class j in period t ;

d_j is the declining balance rate of economic depreciation on asset class j ;

I_{jt} is real investment in asset class j in period t ; and

R_t is real retirements in asset class j in period t .

Capital stock estimates were formed for four asset classes: land, buildings, plant and equipment, and motor vehicles. Real investment and retirement series were obtained by deflating the current price series by the National Accounts Implicit Price Deflator for private capital expenditure on non-dwelling construction for land and buildings and by that for plant and equipment for the other two asset classes. An index of the total quantity of capital inputs was formed from the four separate capital stock estimates using the Fisher ideal index and current price stock values as weights.

Earlier TFP studies typically calculated an explicit user cost as the cost of using capital in a particular year. User cost formulae usually take account of the cost of depreciation, the opportunity cost of the funds tied up in the asset and the rate of capital gain (or loss) on the asset. Swan Consultants (Canberra) (1992a) used a relatively sophisticated user cost formula which took account of interactions between the inflation rate, the depreciation rate and the opportunity cost rate. However, recent practice in TFP studies has been to use an *ex-post* approach to calculating the user cost of capital which allocates the difference between total revenue and variable costs to be the cost of capital. This approach was preferred by the US Federal Communications Commission (1997) and accurately measures the return capital actually earns. A problem with the *ex-ante* or shadow price approach of using an explicit user cost formula is that a systematic divergence can occur between the predicted or expected rate of return on capital and that actually realised. This study defines the residual between total revenue and total variable costs to be the gross return to capital or the full cost of using capital in that year. The gross return has to cover depreciation costs and a residual return on capital.

The quantity of capital employed by Australia Post has increased steadily over the period to a peak of 162 per cent above its 1976 level in 2001. The quantity of capital employed declined marginally in 2002. The share of capital costs in total costs started at 8.5 per cent in 1976 before declining to a small negative value in 1981 (ie total revenues were not covering variable costs let alone capital costs) and then increasing progressively to peak at 21 per cent in 1999 before finishing at around 18 per cent in 2002.

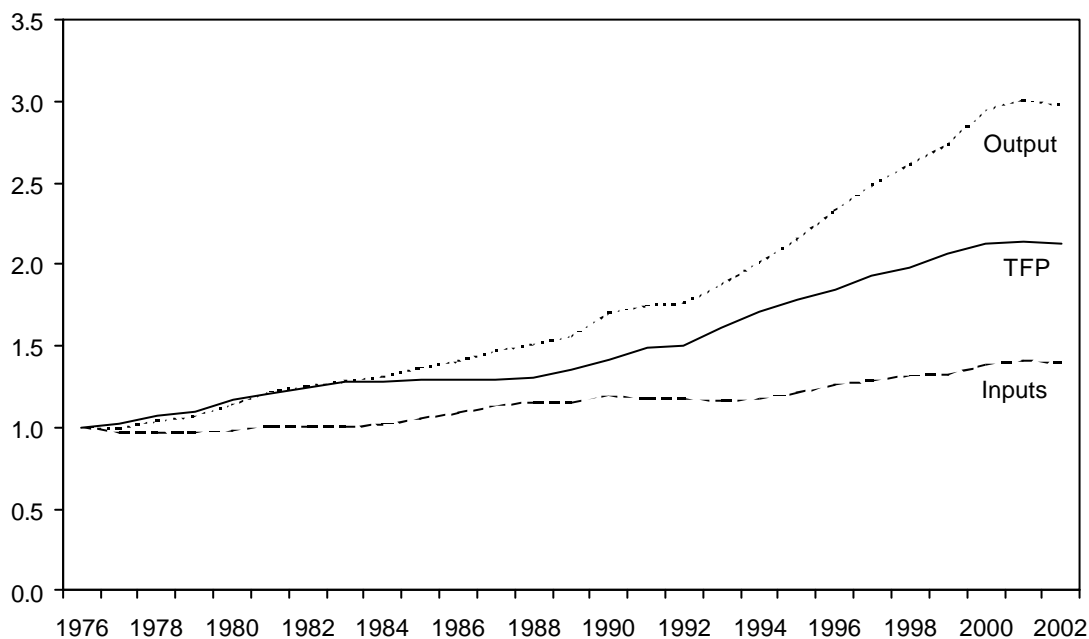
Other inputs

Other inputs covers a wide range of materials and services used by Australia Post. The quantity of other inputs is formed by deflating their cost by the consumer price index (excluding the impact of the GST). The quantity of other inputs has increased faster than the other three input categories with a steady increase of 410 per cent between 1976 and 2001 before a marginal fall in 2002. The share of other inputs in total costs has also increased steadily from 8 per cent in 1976 to 24 per cent in 2002. The increasing importance of other inputs reflects the increasing use of contracting out and outsourcing of a wide range of functions found in most large organisations.

4.3 Productivity

Australia Post's aggregate output quantity, input quantity and TFP indexes are presented in figure 3 and table 1. Trend growth rates in these indexes for the whole 27 year period and for the periods up to and after 1991 are presented in table 2. Output quantity has grown strongly over the period but levelled out in 2001 and declined marginally in 2002. The trend growth rate of aggregate output was a very high 4.5 per cent per annum between 1976 and 2002. The growth rate for the first 16 years up to 1991 was somewhat lower at 3.8 per cent per annum but then accelerated to 5.7 per cent per annum for the last decade, the flattening out and reduction of output in the last few years notwithstanding.

Figure 3: Australia Post's aggregate output and input quantity and TFP indexes, 1976–2002



Aggregate input quantity, on the other hand, has grown far less strongly with a trend growth rate of 1.5 per cent per annum for the entire period. This was also the trend growth rate for the 16 years up to 1991 but the growth rate then increased to 2.2 per cent per annum for the last decade. The increase in input use also flattened out in 2001 and declined marginally in 2002.

TFP (which is the ratio of the aggregate output and aggregate input quantity indexes) grew by a trend 3 per cent per annum over the whole period. TFP trend growth in the 16 years to 1991 was somewhat lower at 2.3 per cent per annum and the three subperiods within this are still clearly visible with good growth in the first few years after 1976, then a period of flat TFP performance during the first half of the 1980s and improving performance towards the end of this period up to 1991. This strong TFP performance then continued through the 1990s with a trend TFP growth rate of 3.5 per cent per annum for the last decade. However, in line with the

flattening out in both outputs and inputs at the end of the decade, TFP growth has flattened after 2000 and declined marginally in 2002.

Table 1: Australia Post's aggregate output and input quantity and TFP indexes, 1976–2002

<i>Year</i>	<i>Output quantity index</i>	<i>Input quantity index</i>	<i>Total factor productivity</i>
1976	1.000	1.000	1.000
1977	0.993	0.971	1.022
1978	1.038	0.968	1.072
1979	1.069	0.970	1.102
1980	1.139	0.977	1.166
1981	1.219	1.009	1.209
1982	1.253	1.002	1.251
1983	1.282	1.003	1.278
1984	1.308	1.018	1.285
1985	1.365	1.054	1.294
1986	1.405	1.090	1.289
1987	1.468	1.133	1.295
1988	1.507	1.155	1.305
1989	1.557	1.153	1.350
1990	1.701	1.197	1.422
1991	1.747	1.176	1.486
1992	1.762	1.174	1.501
1993	1.880	1.164	1.616
1994	2.014	1.174	1.716
1995	2.154	1.209	1.782
1996	2.333	1.260	1.852
1997	2.486	1.288	1.930
1998	2.613	1.316	1.985
1999	2.736	1.327	2.062
2000	2.945	1.384	2.128
2001	3.005	1.408	2.135
2002	2.976	1.399	2.128

Source: M&A estimates

Table 2: Australia Post's aggregate output and input quantity and TFP trend growth rates, 1976–2002

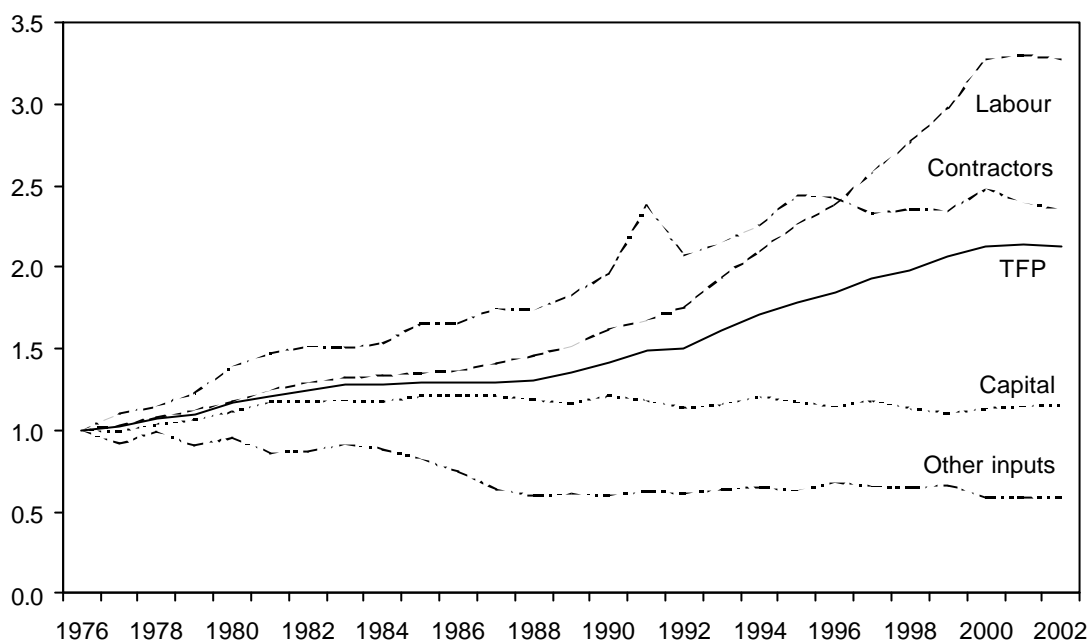
<i>Variable</i>	<i>1976–2002</i>	<i>1976–1991</i>	<i>1992–2002</i>
	<i>% pa</i>	<i>% pa</i>	<i>% pa</i>
Output quantity	4.49	3.78	5.66
Input quantity	1.51	1.51	2.15
Total factor productivity	2.98	2.27	3.51

Source: M&A estimates

The partial productivities of the four inputs are presented in figure 4 along with the TFP index. Partial productivity indexes are derived by dividing the aggregate output quantity index by the quantity index for the relevant input category. In simplified terms, the TFP index is effectively a weighted average of the partial productivity indexes where the weights are complex terms involving the cost shares of the four inputs. From figure 4 we see that labour and contractor partial productivities have increased faster than TFP which has in turn increased faster than the capital and other inputs partial productivities. This reflects a substitution of capital and other inputs for labour and contractors over the period. Indeed, as noted in the preceding sections, labour usage fell by 10 per cent over the period, contractor

usage increased by 30 per cent, capital usage increased by 160 per cent and other input usage increased by 400 per cent. This compares with a 40 per cent increase in total input usage.

Figure 4: **Australia Post's aggregate partial productivity and TFP indexes, 1976–2002**



4.4 Econometric decomposition of TFP growth

Productivity improvements as measured by TFP can result from a number of factors including; technological improvements in the way mail is handled, management-induced improvements in the way operations are carried out, and changes in the market serviced. A more densely settled geographical area, for example, would be cheaper to deliver mail to on a per unit basis than a sparsely settled area. If the market being serviced by Australia Post is changing through time, measured productivity could be affected even if there has been no underlying technical improvement in postal operations.

Swan Consultants (Canberra) (1992a) attempted to estimate the underlying rate of technological improvement in postal operations by decomposing TFP using an econometric model. The model indicated that Australia Post's productivity growth was influenced by the growth in its network. In this section we update the earlier econometric work and look at the effects of two recent technological developments which can be expected to impact on Australia Post.

The first of these concerns changes in Australia Post's outputs and methods of service delivery. Since 1991 Australia Post has continued to enhance its productivity through the establishment of agencies and expansion in its range of activities to include shopfronts and the development of specialised services.

The second recent technological development concerns the growth in the use of the internet, and more recently broadband services, which have introduced a low-cost alternative to traditional forms of communications such as letters. These technological advances have not fully impacted on Australia Post at this point in time but could be expected to significantly reduce Australia Post's output growth in the future. At June 2002, broadband services were used by less than 5 per cent of Australian households and only 40 per cent of households were connected to the Internet. By 2010 around 70 per cent and 60 per cent of households are expected to be connected to the internet and broadband services, respectively (Gilmour and Brown 2001).

In Swan Consultants (Canberra) (1992a) the factor requirements function proposed by Diewert (1974) was used to derive the underlying rate of technological change. The factor requirements function is given by:

$$(2) \quad I = C / W = f(Y, NS, T)$$

where I is a measure of aggregate input use, C is total cost, W is a measure of unit input prices, Y is a measure of aggregate output, NS is the number of delivery points serviced by Australia Post, and T is time.

When estimating this model, account needs to be taken of the possibility that technological improvement in Australia Post has changed through time. Four periods of technological change are specified in the current model:

- 1976 to 1980 – a period of strong technological growth when poor work practices inherited from the Postmaster General's Department were removed;
- 1981 to 1985 – a period of stronger growth fostered through better industrial relations and corporatisation of Australia Post;
- 1986 to 1993 – a period when technical improvements were enhanced through better industrial relations and the corporatisation of Australia Post in 1989; and
- 1994 to 2002 – a period of possible lower technological growth caused, in part, by reduced output growth emanating from the introduction of the internet and broadband services.

As in the previous study, a logarithmic form of equation (2) was specified to account for the above technological changes. Specifically, the model estimated is given by:

$$(3) \quad \ln I = \sum_{i=1}^4 a_{0i} \cdot D_i + \sum_{i=1}^4 b_{0i} \cdot D_i \cdot T + e_y \cdot \ln Y + e_{NS} \cdot \ln NS + e$$

where D_i are dummy variables corresponding to the four hypothesized periods of differential technological growth and the parameters e_y and e_{NS} measure the cost elasticities of output and delivery points, respectively. This specification of changes in the structure of cost is very flexible in that both the average levels of technology and the rate of technological growth can differ between periods.

Table 3: Estimated parameters of Australia Post's factor requirements function with constant returns to scale imposed

<i>Parameter</i>	<i>Parameter estimate</i>	<i>Standard error</i>
a_{01}	-10.334	1.820
a_{02}	-10.379	1.803
a_{03}	-10.300	1.838
a_{04}	-10.499	1.832
b_{01}	-0.030	0.004
b_{02}	-0.021	0.004
b_{03}	-0.022	0.003
b_{04}	-0.012	0.003
e_y	0.326	0.118
e_{NS}	0.674	0.118
<i>R</i> -squared	0.99	
Durbin Watson Statistic	2.11	
Number of observations	27	

The model was estimated with constant returns to scale imposed and the results are given in table 3. The estimated model fits the data well as indicated by the *R*-squared figure of 0.99. No evidence of first-order auto-correlation is evident. The elasticity of cost with respect to output is estimated at 0.33. It follows that the elasticity of cost with respect to network size is 0.67.

Several features of this model require comment. First, the rate of growth in technological development has been slowing significantly through time. This is indicated by the fall in the value of the *b* coefficients in the equation. These coefficients are the growth in input use holding output and network size constant. Examining these coefficients it can be seen that technological change in the period following the introduction of the internet was about one third levels in the mid-seventies. The second feature of the results is that the elasticity of cost with respect to output is much smaller than in the previous Swan study. This elasticity may be capturing the effects on input use of factors other than network size. It may, thus, provide an unreliable estimate of this elasticity.

The model results can be used to decompose Australia Post's productivity performance. Specifically, it can be shown that:

$$(4) \dot{TFP} = \dot{TGR} + (1 - e_y) \dot{Y} - e_{NS} \dot{NS}$$

where \dot{TFP} is growth in unadjusted TFP;

\dot{TGR} is technological growth;

\dot{Y} is growth in aggregate output;

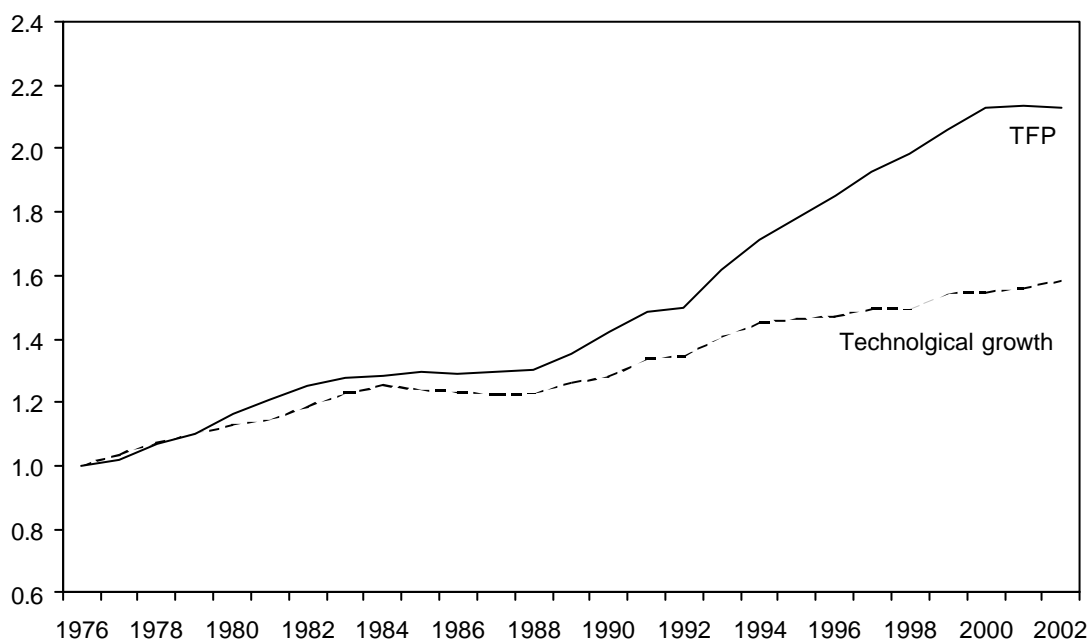
\dot{NS} is growth in the size of Australia Post's network;

e_y is the elasticity of input use with respect to aggregate output; and

e_{NS} is the elasticity of input use with respect to the size of the network serviced.

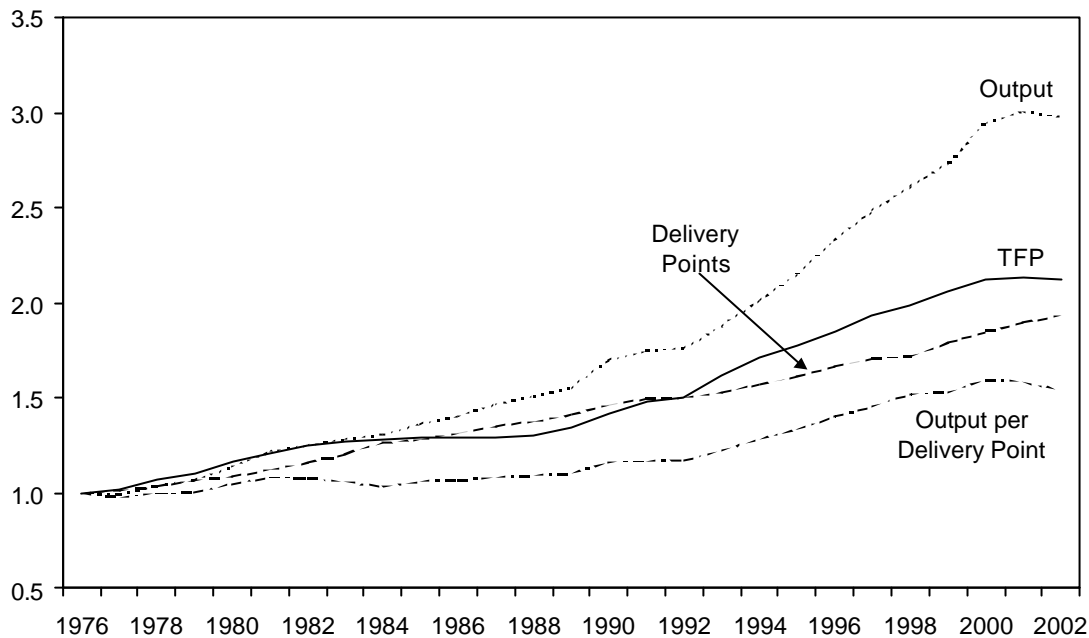
The results of implementing this formula are given in figure 5 where it can be seen that after adjusting for output and network size, Australia Post recorded significant technological improvement over the study period.

Figure 5: Australia Post's total factor productivity and technological growth



To understand why TFP rose significantly after 1992 consider figure 6 in which TFP growth is compared to growth in the network and output. While delivery points have been rising steadily over the study period, Australia Post's output rose significantly after 1992. Consequently, output per delivery point serviced rose by about 50 per cent in the last 10 years of the study period.

Figure 6: **Growth in output, productivity and network size (index: 1976 = 1)**



The results of this analysis indicate that Australia Post's future productivity growth will be influenced by:

- expected output growth;
- growth in the network; and
- the underlying rate of technological progress.

Output growth may slow in the future partly due to the growth in the internet and broadband services. There is some evidence from the modelling that technological improvement is also slowing. However, these factors would need to be balanced against any anticipated growth in the network serviced by Australia Post which will enhance productivity growth. The growth prospects in these three areas would need to be assessed in more detail and the model developed further to determine Australia Post's likely future productivity improvements.

5 Reserved service outputs, inputs and productivity

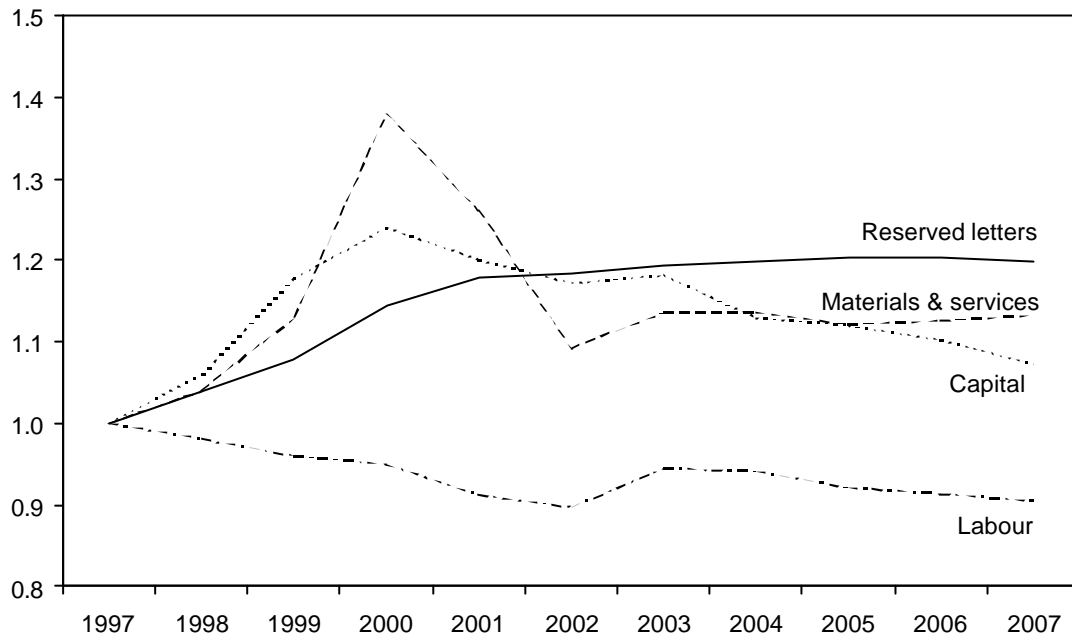
The preceding section examined the TFP performance of Australia Post as a whole over the last 27 years. In this section we examine the estimated TFP performance of Australia Post's reserved letter service over the last six years, 1997 to 2002, and the forecast performance for the next five years, 2003 to 2007. The analysis is based entirely on data supplied by Australia Post to correspond with the coverage of the reserved letter business currently being examined by the ACCC, ie it is limited to the domestic reserved letter operations. Australia Post has had to make a number of assumptions about the allocation of joint and common costs in providing the data for this part of the study and we have, in turn, had to make a number of assumptions in getting the data into a format that can be used for TFP analysis. The latter particularly applies to capital stock estimates. Consequently, the results of the reserved service TFP analysis should be interpreted with some caution.

5.1 Reserved service outputs and inputs

Reserved letters

The output measure used in the reserved service TFP analysis is the same as that used for the reserved letter output component of the aggregate Australia Post TFP analysis. The quantity of reserved letters is measured by the number of relevant letters handled while the price is derived by dividing the revenue obtained from these letters by their number. The quantity of reserved letters increased by 18 per cent between 1997 and 2002 but is forecast to remain relatively constant for the next five years. Movements in the quantity indexes for reserved letters and the three input categories are presented in figure 7.

Figure 7: Australia Post's reserved service output and input indexes, 1976–2002



Labour

For the period from 1997 to 2002 Australia Post has estimated the cost of reserved letter labour as the direct (operating) labour component obtained from source data plus the non-operating labour component estimated by allocating total non-operating labour in the same ratio as total non-operating expense (of which total non-operating labour formed a part). For the forecast years Australia Post has indicated labour costs form 67 per cent of total forecast reserved letter costs. Australia Post has formed estimates of the reserved letter direct cost by allocating direct costs using process costing techniques which rely, among other things, on the time taken to perform various tasks. Indirect and allocated costs are assigned to reserved letters using activity based costing techniques. The quantity of labour is derived by dividing the labour cost by the estimated full-time equivalent wage rate. For the years from 2004 onwards the wage rate is assumed to increase by 3.5 per cent per annum.

The quantity of labour used in reserved letters operations fell by 10 per cent between 1997 and 2002. In the forecast period it initially increases by 5 per cent before falling back to finish in 2007 at the same level it was in 2002. Labour costs as a share of total costs (as calculated in this study) vary between around 60 and 65 per cent over the 11 year period.

Capital

Australia Post has provided an estimate of the split of its capital stock between reserved and non-reserved services in its Annual Reports since 1997. However, the early asset splits were based on evolving methodologies and it is only since 2001 that Australia Post has had a methodology for this split which meets full accounting standards. This methodology cannot

be extended back to earlier years due to changes in Australia Post's computing systems and accounting software. The definition of reserved services used in the Australia Post Annual Reports is also broader than that used in this report as it covers, among other things, reserved international services. To advance this exercise Australia Post was able to supply estimates of the asset values of the activities covered in the current report but using its old asset valuation methodologies for the years 1997 to 2001. From 2001 onwards more reliable asset value estimates for reserved services are available.

Estimates of the quantity of the capital stock from 2001 onwards are formed using a declining balance methodology similar to that outlined for the aggregate capital stock above and data from asset balance sheets supplied by Australia Post covering land, buildings, fitout, plant and equipment, vehicles, software and FuturePost processing assets. For the years 1997 to 2000, the adjusted reserved letter asset series provided by Australia Post is used but rescaled so that the 2001 estimate from this series coincides with that from the subsequent balance sheet series. The cost of capital inputs is again taken to be the residual between revenue and variable input costs.

The quantity of capital used in the provision of the reserved letters service increased by 24 per cent between 1997 and 2000 before declining to finish up in 2007 at around 7 per cent above its 1997 level. The share of capital in total costs varies between 14 and 16 per cent between 1997 and 2005 before falling to a forecast 8 per cent in 2007.

Materials and services

Materials and services costs are derived by subtracting estimated labour costs and depreciation from total reserved letter costs. Australia Post calculated depreciation for the first four years by allocating total depreciation in the same ratio as total non-operating expense of which depreciation formed a part. For 2001 and 2002, operational depreciation was obtained from source data. The non-operating depreciation component was estimated by allocating the balance of depreciation in the same ratio as total non-operating expense of which non-operating depreciation formed a part. For the years from 2003 onwards, depreciation was taken from the asset balance sheets supplied by Australia Post. The price of materials and services is taken to be the consumer price index excluding the impact of the GST. For the years from 2003 onwards, the CPI is assumed to increase by 3 per cent per annum. The quantity of materials and services is derived by deflating the estimated cost by the CPI.

The quantity of materials and services increased by 13 per cent between 1997 and 1999 and then stayed at this level for the remainder of the period through to 2007 with the exception of a pronounced spike in 2000 and 2001. Australia Post explain this peak by the use of contract labour in lieu of staffed labour in the delivery area which impacted predominantly on the letters business. This expense declined markedly in the following year. Australia Post also reported significant increases in a number of other non-labour cost items in 2000. The share of materials and services in total costs varies between 20 and 26 per cent between 1997 and 2007.

5.2 Reserved service productivity

Australia Post's reserved service output quantity, input quantity and TFP indexes are presented in figure 8 and table 4. Separate results for the period 2003 to 2007 are presented in table 5. Trend growth rates in these indexes for the whole 11 year period and for the periods up to and after 2002 are presented in table 6. Reserved letter output quantity grows strongly between 1997 and 2001, increasing by 18 per cent before levelling out and remaining virtually unchanged for the remainder of the period right through to 2007. The trend growth rate of reserved letter output is a modest 1.8 per cent per annum between 1997 and 2007. The growth rate for the first 6 years up to 2002 is considerably higher at 3.7 per cent per annum but then falls to only 0.1 per cent per annum for the forecast next 5 years.

Figure 8: Australia Post's reserved service output and input quantity and TFP indexes, 1997–2007

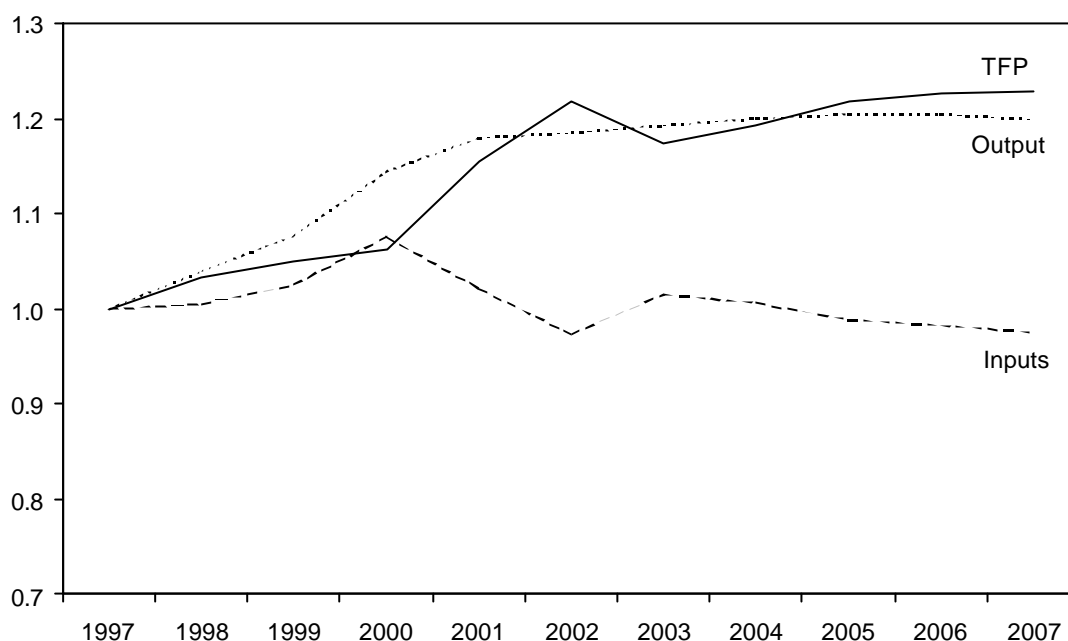


Table 4: Australia Post's reserved service output and input quantity and TFP indexes, 1997–2007

Year	Output quantity index	Input quantity index	Total factor productivity
1997	1.000	1.000	1.000
1998	1.040	1.005	1.034
1999	1.077	1.025	1.051
2000	1.144	1.076	1.063
2001	1.180	1.022	1.155
2002	1.185	0.973	1.217
2003	1.193	1.016	1.174
2004	1.200	1.006	1.192
2005	1.205	0.989	1.219
2006	1.205	0.983	1.226
2007	1.199	0.975	1.229

Source: M&A estimates

Table 5: Australia Post's reserved service output and input quantity and TFP indexes, 2003–2007

Year	Output quantity index	Input quantity index	Total factor productivity
2003	1.000	1.000	1.000
2004	1.006	0.991	1.015
2005	1.010	0.974	1.038
2006	1.010	0.968	1.044
2007	1.005	0.960	1.046

Source: M&A estimates

Reserved service input quantity, on the other hand, remains relatively flat over the 11 year period with a trend growth rate of –0.4 per cent per annum. There is a small upwards spike in input use in 2000 corresponding with the increased use of materials and services in that year. The trend growth rate in input use for the 6 years up to 2002 was –0.1 per cent per annum but the trend rate of decline is higher at –1.1 per cent per annum for the next five years.

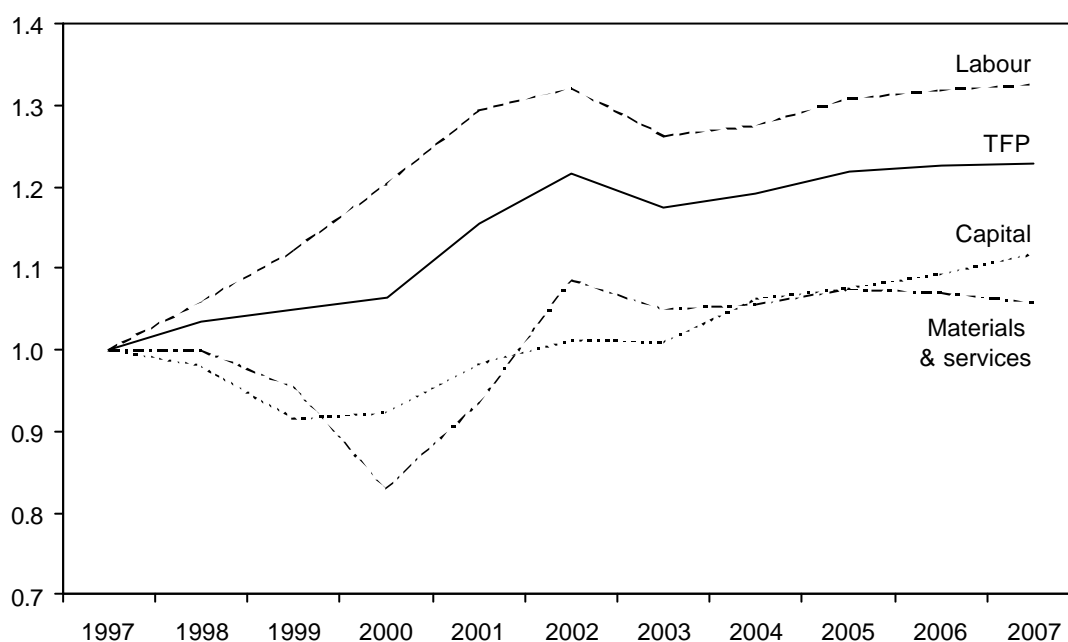
Table 6: Australia Post's reserved service output and input quantity and TFP trend growth rates, 1997–2007

<i>Variable</i>	<i>1997–2007</i>	<i>1997–2002</i>	<i>2003–2007</i>
	<i>% pa</i>	<i>% pa</i>	<i>% pa</i>
Output quantity	1.76	3.68	0.14
Input quantity	-0.42	-0.11	-1.05
Total factor productivity	2.18	3.79	1.19

Source: M&A estimates

Reserved service TFP grows by a trend 2.2 per cent per annum over the whole 11 year period. TFP trend growth in the 6 years to 2002 was somewhat higher at 3.8 per cent per annum. This strong TFP performance then falls away with a trend TFP growth rate of only 1.2 per cent per annum for the next five years to 2007. This flattening out in forecast future TFP performance is attributable to virtually unchanged output levels and only small reductions in input use.

Figure 9: Australia Post's reserved service partial productivity and TFP indexes, 1997–2007



The partial productivities of the three inputs are presented in figure 9 along with the reserved service TFP index. Again the labour partial productivity has increased faster than TFP which has in turn increased faster than the capital and materials and services partial productivities. This reflects a substitution of capital and materials and services for labour over the period. As noted above, labour usage fell by 10 per cent over the period, capital usage increased by 7 per cent and materials and services usage increased by 13 per cent. This compares with a 3 per cent decline in total input usage.

6 Conclusions

Australia Post as a whole has exhibited strong TFP growth during the 1990s with a trend TFP increase of 3.5 per cent per annum between 1992 and 2002. This resulted from strong output growth, particularly in the non-reserved output categories of other revenue, other addressed mail, agency services and unaddressed mail, combined with modest increases in the quantity of total inputs. However, in 2001 and 2002 output growth stalled and then declined marginally while input use also levelled out. This resulted in TFP growth also levelling out and then declining marginally in 2002.



Although more limited data is available for Australia Post's reserved service operations and its use and interpretation is subject to important caveats, a similar picture emerges for reserved services. Reserved service TFP growth falls from 3.8 per cent per annum between 1997 and 2002 to a forecast 1.2 per cent per annum over the next five years to 2007. A levelling off in reserved service outputs after 2001 and ongoing modest reductions in total input use bring this about. As in the case of Australia Post as a whole, there is ongoing substitution of capital and materials and services for labour.

Appendix A: The Fisher ideal TFP index

Mathematically, the Fisher ideal output index is given by:

$$(1) Q_F^t = [(\sum_{i=1}^m P_i^B Y_i^t / \sum_{j=1}^m P_j^B Y_j^B)(\sum_{i=1}^m P_i^t Y_i^t / \sum_{j=1}^m P_j^t Y_j^B)]^{0.5}$$

where: Q_F^t is the Fisher ideal output index for observation t ;

P_i^B is the price of the i th output for the base observation;

Y_i^t is the quantity of the i th output for observation t ;

P_i^t is the price of the i th output for observation t ; and

Y_j^B is the quantity of the j th output for the base observation.

Similarly, the Fisher ideal input index is given by:

$$(2) I_F^t = [(\sum_{i=1}^n W_i^B X_i^t / \sum_{j=1}^n W_j^B X_j^B)(\sum_{i=1}^n W_i^t X_i^t / \sum_{j=1}^n W_j^t X_j^B)]^{0.5}$$

where: I_F^t is the Fisher ideal input index for observation t ;

W_i^B is the price of the i th input for the base observation;

X_i^t is the quantity of the i th input for observation t ;

W_i^t is the price of the i th input for observation t ; and

X_j^B is the quantity of the j th input for the base observation.

The Fisher ideal TFP index is then given by:

$$TFP_F^t = Q_F^t / I_F^t .$$

The Fisher index can be used in either the unchained form denoted above or in the chained form used in this study where weights are more closely matched to pair-wise comparisons of observations. Denoting the Fisher output index between observations i and j by $Q_F^{i,j}$, the chained Fisher index between observations 1 and t is given by:

$$Q_F^{1,t} = 1 \times Q_F^{1,2} \times Q_F^{2,3} \times \dots \times Q_F^{t-1,t} .$$

Appendix B: Australia Post's aggregate output and input data

Table B1: Australia Post's aggregate output data, 1976–2002

Year	<i>Reserved letters</i>			<i>Other addressed mail</i>		
	<i>Price</i> \$/article	<i>Quantity</i> million	<i>Value</i> \$m	<i>Price</i> \$/article	<i>Quantity</i> million	<i>Value</i> \$m
1976	0.182	1,543.3	280.9	0.472	219.1	103.4
1977	0.192	1,557.6	299.7	0.505	220.3	111.3
1978	0.192	1,633.6	313.2	0.490	214.3	105.0
1979	0.215	1,667.0	358.0	0.570	215.8	122.9
1980	0.217	1,737.0	376.4	0.596	243.8	145.4
1981	0.232	1,828.3	424.3	0.618	273.7	169.1
1982	0.257	1,895.3	486.8	0.688	283.0	194.7
1983	0.284	1,952.4	554.7	0.770	297.2	228.7
1984	0.308	2,016.1	621.6	0.831	309.2	256.9
1985	0.326	2,090.7	681.9	0.890	319.2	284.1
1986	0.351	2,153.4	755.3	0.955	312.4	298.2
1987	0.379	2,264.4	858.4	1.118	312.1	348.8
1988	0.389	2,399.2	933.4	1.270	349.4	443.6
1989	0.409	2,496.8	1,021.3	1.357	365.6	496.0
1990	0.415	2,595.5	1,077.6	1.330	405.9	539.9
1991	0.441	2,713.8	1,196.5	1.483	380.6	564.5
1992	0.456	2,770.3	1,263.6	1.689	368.7	622.7
1993	0.466	2,850.2	1,328.6	1.593	421.6	671.8
1994	0.465	3,000.2	1,395.3	1.563	469.6	734.2
1995	0.460	3,160.7	1,452.8	1.652	520.0	859.1
1996	0.450	3,323.0	1,494.5	1.550	575.7	892.5
1997	0.452	3,459.9	1,562.5	1.593	590.6	940.9
1998	0.449	3,596.9	1,614.4	1.598	619.7	990.3
1999	0.446	3,726.5	1,661.4	1.612	645.5	1,040.3
2000	0.445	3,959.4	1,762.2	1.632	705.9	1,151.7
2001	0.416	4,081.8	1,697.0	1.624	664.0	1,078.0
2002	0.410	4,099.8	1,681.7	1.723	629.1	1,083.8

Table B1: Australia Post's aggregate output data, 1976–2002 (cont'd)

<i>Year</i>	<i>Unaddressed mail</i>			<i>Money orders</i>		
	<i>Price \$/article</i>	<i>Quantity million</i>	<i>Value \$m</i>	<i>Price \$/order</i>	<i>Quantity million</i>	<i>Value \$m</i>
1976	0.056	32.1	1.8	0.549	13.6	7.5
1977	0.050	40.0	2.0	0.631	10.9	6.9
1978	0.042	76.8	3.2	0.677	9.2	6.2
1979	0.050	122.0	6.1	0.556	9.8	5.4
1980	0.046	113.1	5.2	0.601	10.6	6.4
1981	0.054	115.5	6.2	0.703	11.0	7.8
1982	0.064	113.5	7.3	0.960	10.5	10.1
1983	0.075	98.4	7.4	1.052	10.0	10.6
1984	0.075	106.0	7.9	1.149	10.1	11.6
1985	0.074	119.1	8.8	1.141	10.5	11.9
1986	0.077	141.2	10.9	1.111	10.7	11.9
1987	0.080	175.3	14.1	1.102	11.2	12.4
1988	0.080	212.9	17.0	1.096	12.1	13.2
1989	0.083	236.7	19.7	1.310	12.8	16.8
1990	0.087	242.4	21.0	1.487	12.8	19.0
1991	0.084	247.1	20.8	1.679	12.9	21.6
1992	0.085	270.2	22.9	2.059	12.5	25.8
1993	0.089	287.6	25.7	2.112	11.7	24.8
1994	0.077	268.8	20.7	2.109	12.0	25.3
1995	0.078	280.4	21.8	2.117	12.4	26.2
1996	0.077	322.1	24.8	2.121	13.0	27.7
1997	0.076	327.1	25.0	2.112	14.0	29.5
1998	0.083	344.3	28.5	2.090	15.3	32.0
1999	0.084	381.7	32.0	2.244	16.5	37.0
2000	0.089	381.1	34.0	2.579	16.7	43.0
2001	0.091	370.1	33.8	2.611	15.9	41.6
2002	0.096	402.7	38.7	2.605	15.6	40.8

Table B1: Australia Post's aggregate output data, 1976–2002 (cont'd)

<i>Year</i>	<i>Agency services</i>			<i>Accommodation</i>		
	<i>Price \$/service</i>	<i>Quantity million</i>	<i>Value \$m</i>	<i>Price Index</i>	<i>Rent \$1976m</i>	<i>Value \$m</i>
1976	2.272	37.2	84.6	1.000	5.4	5.4
1977	3.056	33.6	102.7	1.116	4.2	4.7
1978	2.746	34.4	94.5	1.230	4.1	5.1
1979	2.526	36.4	92.0	1.331	3.3	4.4
1980	2.152	37.6	81.0	1.466	2.7	4.0
1981	2.193	37.9	83.1	1.604	2.7	4.4
1982	2.284	37.7	86.1	1.771	2.5	4.5
1983	2.490	36.7	91.3	1.975	2.0	4.0
1984	2.467	36.9	90.9	2.111	2.5	5.2
1985	2.583	36.0	93.0	2.201	2.7	6.0
1986	2.093	41.2	86.2	2.386	2.3	5.4
1987	2.010	42.0	84.5	2.609	2.2	5.7
1988	2.299	38.8	89.1	2.799	1.6	4.6
1989	2.308	38.1	87.9	3.004	1.3	3.9
1990	1.965	40.7	79.9	3.245	1.1	3.5
1991	2.366	38.0	89.9	3.415	1.3	4.3
1992	2.098	43.6	91.5	3.480	1.1	4.0
1993	1.581	63.1	99.8	3.516	1.3	4.5
1994	1.471	78.5	115.5	3.580	1.2	4.3
1995	1.402	101.8	142.7	3.695	1.5	5.7
1996	1.305	117.4	153.2	3.851	1.8	7.0
1997	1.300	149.7	194.5	3.902	2.2	8.7
1998	1.297	172.0	223.1	3.901	2.2	8.5
1999	1.308	180.3	235.8	3.952	2.6	10.4
2000	1.322	192.3	254.2	4.046	3.8	15.6
2001	1.327	200.1	265.6	4.174	4.2	17.6
2002	1.335	201.2	268.7	4.294	4.4	19.1

Table B1: Australia Post's aggregate output data, 1976–2002 (cont'd)

<i>Year</i>	<i>Other revenue</i>			<i>Total output</i>		
	<i>Price Index</i>	<i>Quantity \$1976m</i>	<i>Value \$m</i>	<i>Price Index</i>	<i>Quantity \$1976m</i>	<i>Value \$m</i>
1976	1.000	18.3	18.3	1.000	501.8	501.8
1977	1.116	22.8	25.5	1.110	498.1	552.8
1978	1.230	31.7	39.0	1.087	520.7	566.2
1979	1.331	34.7	46.3	1.183	536.7	635.1
1980	1.466	40.5	59.4	1.185	571.8	677.7
1981	1.604	46.5	74.7	1.258	611.8	769.5
1982	1.771	47.3	83.7	1.389	628.7	873.3
1983	1.975	47.6	94.1	1.540	643.4	990.8
1984	2.111	42.9	90.6	1.652	656.5	1,084.7
1985	2.201	50.4	110.9	1.747	684.9	1,196.7
1986	2.386	54.1	129.1	1.839	705.2	1,297.0
1987	2.609	60.3	157.4	2.011	736.6	1,481.3
1988	2.799	41.6	116.4	2.138	756.4	1,617.4
1989	3.004	39.6	118.9	2.259	781.3	1,764.6
1990	3.245	60.0	194.6	2.267	853.7	1,935.6
1991	3.415	73.0	249.3	2.449	876.6	2,147.0
1992	3.480	73.0	253.9	2.583	884.4	2,284.4
1993	3.516	70.7	248.5	2.548	943.5	2,403.6
1994	3.580	71.5	255.8	2.524	1,010.8	2,551.1
1995	3.695	67.8	250.3	2.552	1,081.0	2,758.7
1996	3.851	77.4	298.2	2.475	1,171.0	2,897.8
1997	3.902	92.9	362.4	2.503	1,247.7	3,123.5
1998	3.901	97.4	379.9	2.499	1,311.2	3,276.7
1999	3.952	106.8	422.3	2.505	1,373.0	3,439.1
2000	4.046	117.0	473.5	2.527	1,477.7	3,734.2
2001	4.174	137.0	571.9	2.457	1,508.1	3,705.5
2002	4.294	139.5	599.0	2.498	1,493.7	3,731.7

Table B2: Australia Post's aggregate input data, 1976–2002

Year	Labour (FTEs)			Capital		
	Price \$000/yr	Quantity no. '000	Value \$m	Price Index	Quantity Index	Value \$m
1976	9.773	39.283	383.9	42.580	1.000	42.6
1977	11.374	37.796	429.9	36.323	1.000	36.3
1978	12.305	37.798	465.1	7.415	1.001	7.4
1979	13.205	37.456	494.6	29.012	1.007	29.2
1980	14.155	37.943	537.1	13.725	1.022	14.0
1981	16.157	38.455	621.3	-8.382	1.036	-8.7
1982	18.285	38.032	695.4	0.158	1.061	0.2
1983	20.325	38.113	774.6	14.022	1.084	15.2
1984	21.591	38.516	831.6	25.513	1.114	28.4
1985	22.946	39.736	911.8	24.627	1.128	27.8
1986	24.090	40.402	973.3	21.405	1.157	24.8
1987	25.707	40.814	1,049.2	48.467	1.213	58.8
1988	27.834	40.641	1,131.2	42.897	1.267	54.4
1989	30.542	40.454	1,235.5	40.875	1.338	54.7
1990	32.126	41.221	1,324.3	45.175	1.403	63.4
1991	33.743	41.010	1,383.8	128.712	1.476	189.9
1992	35.580	39.455	1,403.8	183.812	1.550	284.9
1993	37.215	38.036	1,415.5	235.530	1.622	382.0
1994	39.391	37.709	1,485.4	252.546	1.667	421.0
1995	41.744	37.383	1,560.5	258.761	1.834	474.5
1996	42.470	38.472	1,633.9	243.841	2.039	497.2
1997	45.660	37.816	1,726.7	262.065	2.101	550.6
1998	47.990	37.068	1,778.9	259.736	2.302	598.0
1999	48.514	36.076	1,750.2	297.729	2.479	738.0
2000	50.599	35.338	1,788.1	306.016	2.595	794.1
2001	49.051	35.747	1,753.4	280.840	2.618	735.2
2002	51.734	35.704	1,847.1	254.613	2.586	658.4

Table B2: Australia Post's aggregate input data, 1976–2002 (cont'd)

<i>Year</i>	<i>Contractors</i>			<i>Other costs</i>		
	<i>Price</i> \$000/yr	<i>Quantity</i> no. '000	<i>Value</i> \$m	<i>Price</i> Index	<i>Quantity</i> \$1976m	<i>Value</i> \$m
1976	7.449	4.441	33.1	1.000	42.250	42.2
1977	8.853	4.001	35.4	1.116	45.849	51.2
1978	9.826	4.017	39.5	1.230	44.066	54.2
1979	11.614	3.861	44.8	1.331	49.911	66.5
1980	14.493	3.639	52.7	1.466	50.373	73.9
1981	16.622	3.671	61.0	1.604	59.753	95.8
1982	19.066	3.671	70.0	1.771	60.793	107.7
1983	22.094	3.787	83.7	1.975	59.370	117.3
1984	24.533	3.790	93.0	2.111	62.384	131.7
1985	28.331	3.655	103.5	2.201	69.782	153.6
1986	29.093	3.761	109.4	2.386	79.447	189.5
1987	32.497	3.729	121.2	2.609	96.638	252.1
1988	34.430	3.858	132.8	2.799	106.805	299.0
1989	40.056	3.773	151.1	3.004	107.573	323.2
1990	41.194	3.843	158.3	3.245	120.076	389.6
1991	52.677	3.269	172.2	3.415	117.449	401.1
1992	45.594	3.779	172.3	3.480	121.668	423.4
1993	43.130	3.879	167.3	3.516	124.813	438.8
1994	44.899	3.960	177.8	3.580	130.429	466.9
1995	48.724	3.918	190.9	3.695	144.199	532.8
1996	48.851	4.266	208.4	3.851	144.960	558.3
1997	46.952	4.741	222.6	3.902	159.828	623.6
1998	47.604	4.924	234.4	3.901	170.577	665.4
1999	50.628	5.179	262.2	3.952	174.268	688.7
2000	56.644	5.268	298.4	4.046	210.971	853.6
2001	57.004	5.568	317.4	4.174	215.513	899.5
2002	56.423	5.613	316.7	4.294	211.821	909.5

Table B2: Australia Post's aggregate input data, 1976–2002 (cont'd)

<i>Year</i>	<i>Price Index</i>	<i>Total inputs</i>	
		<i>Quantity \$1976m</i>	<i>Value \$m</i>
1976	1.000	501.8	501.8
1977	1.134	487.3	552.8
1978	1.166	485.7	566.2
1979	1.304	486.9	635.1
1980	1.382	490.5	677.7
1981	1.520	506.1	769.5
1982	1.737	502.6	873.3
1983	1.968	503.4	990.8
1984	2.123	510.9	1,084.7
1985	2.262	529.1	1,196.7
1986	2.371	547.0	1,297.0
1987	2.604	568.8	1,481.3
1988	2.790	579.8	1,617.4
1989	3.050	578.6	1,764.6
1990	3.223	600.5	1,935.6
1991	3.640	589.9	2,147.0
1992	3.877	589.2	2,284.4
1993	4.116	583.9	2,403.6
1994	4.330	589.1	2,551.1
1995	4.548	606.6	2,758.7
1996	4.583	632.3	2,897.8
1997	4.831	646.5	3,123.5
1998	4.961	660.4	3,276.7
1999	5.164	666.0	3,439.1
2000	5.377	694.5	3,734.2
2001	5.246	706.3	3,705.5
2002	5.317	701.8	3,731.7

Appendix C: Australia Post's reserved service output and input data

Table C1: Australia Post's reserved service data, 1997–2007

Year	Reserved letters			Labour (FTEs)		
	Price \$/article	Quantity million	Value \$m	Price \$000/yr	Quantity no. '000	Value \$m
1997	0.452	3,459.9	1,562.5	37.952	26.200	994.4
1998	0.449	3,596.9	1,614.4	39.891	25.700	1,025.2
1999	0.446	3,726.5	1,661.4	42.069	25.150	1,058.0
2000	0.445	3,959.4	1,762.2	42.298	24.900	1,053.2
2001	0.416	4,081.8	1,697.0	42.542	23.900	1,016.7
2002	0.410	4,099.8	1,681.7	43.267	23.500	1,016.8
2003	0.421	4,126.5	1,735.4	43.267	24.756	1,071.1
2004	0.432	4,151.4	1,795.2	44.781	24.657	1,104.2
2005	0.431	4,167.9	1,796.6	46.349	24.132	1,118.5
2006	0.430	4,168.0	1,791.1	47.971	23.937	1,148.3
2007	0.428	4,147.1	1,776.6	49.650	23.702	1,176.8

Table C1: Australia Post's reserved service data, 1997–2007 (cont'd)

Year	Materials & services			Capital		
	Price Index	Quantity \$1997m	Value \$m	Price Index	Quantity \$1997m	Value \$m
1997	1.000	317.4	317.4	0.244	1,027.2	250.7
1998	1.000	330.0	330.0	0.238	1,089.1	259.2
1999	1.013	358.7	363.3	0.199	1,209.1	240.1
2000	1.037	437.6	453.8	0.200	1,273.8	255.1
2001	1.070	400.1	428.0	0.204	1,233.4	252.2
2002	1.100	346.5	381.3	0.236	1,203.3	283.7
2003	1.133	360.6	408.7	0.210	1,214.0	255.5
2004	1.167	360.7	421.2	0.233	1,159.8	269.9
2005	1.203	355.9	427.9	0.217	1,150.6	250.2
2006	1.239	357.3	442.6	0.177	1,132.0	200.2
2007	1.276	359.6	458.8	0.128	1,101.6	141.1

Table C1: Australia Post's reserved service data, 1997–2007 (cont'd)

Year	Total inputs		
	Price Index	Quantity \$1997m	Value \$m
1997	1.000	1,562.5	1,562.5
1998	1.028	1,570.5	1,614.4
1999	1.037	1,601.9	1,661.4
2000	1.048	1,681.8	1,762.2
2001	1.063	1,596.4	1,697.0
2002	1.106	1,520.8	1,681.7
2003	1.094	1,586.7	1,735.4
2004	1.142	1,572.3	1,795.2
2005	1.163	1,544.7	1,796.6
2006	1.167	1,535.2	1,791.1
2007	1.166	1,523.8	1,776.6

References

- Abbott, M. (2000), 'An economic evaluation of the Australian Postal Corporation Act 1989', *Economic Papers* 19(3), 1–15.
- Diewert, W.E. (1974), 'Functional forms for revenue and factor requirements functions', *International Economic Review* 15(1), 119–150.
- Diewert, W.E. (1993), *The Measurement of Productivity: A Survey*, Swan Consultants (Canberra) conference on *Measuring the Economic Performance of Government Enterprises*, Sydney.
- Federal Communications Commission (1997), *Price Cap Performance Review for Local Exchange Carriers and Access Charge Reform*, CC Dockets No. 97–159, Washington.
- Gilmour, G. and B. Brown (2001), 'An economic model for the Australian broadband communications industry', Communications Research Unit, Canberra.
- Industry Commission (1990), *Measuring the Performance of Selected Government Business Enterprises*, Information Paper, Canberra.
- Swan Consultants (Canberra) (1992a), 'Performance measures for Australia Post: 1975–76 to 1990–91', in Steering Committee on National Performance Monitoring of Government Trading Enterprises, *Measuring the Total Factor Productivity of Government Trading Enterprises*, Canberra.
- Swan Consultants (Canberra) (1992b), *A Disaggregated Analysis of Australia Post's Total Factor Productivity*, Report prepared for Australia Post, Canberra.
- Swan Consultants (Canberra) (1992c), *An International Comparison of the Productivity of Australia Post and New Zealand Post*, Report prepared for Australia Post, Canberra.
- Zeitsch, J., D. Lawrence and J. Salerian (1994), 'Comparing like with like in productivity studies – apples, oranges and electricity', *Economic Record* 70(209), 162-70.