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Ltd

Australia Post's Aggregate and Reserved Service Productivity – 2009 Update

Report prepared for
Australia Post

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EXECUTIVE SUMMARY

Australia Post requested Economic Insights to update the Lawrence (2007) report which examined Australia Post's aggregate and reserved service total factor productivity (TFP). This study analyses Australia Post's aggregate and reserved service productivity performance up to 2009 and forecast productivity performance through to 2012. We also undertake a number of sensitivity analyses on the specification and parameters used in Lawrence (2007).

Australia Post as a whole has exhibited strong TFP growth since 1990 with a trend TFP increase of 1.8 per cent per annum between 1990 and 2009. This resulted from strong output growth up to 2000. After stalling in 2001 and 2002, output growth continued up to 2008 but at a slower rate of growth than before 2000. Output fell markedly in 2009 and is forecast to continue to decline over the next three years with a negative impact on TFP growth. Combined with a levelling off in the quantity of total inputs after 2002, this has resulted in TFP growth of 1.2 per cent per annum over the last 7 years but this is forecast to reverse to -1 per cent per annum over the next three years. A reduction in the volume of letters is the main contributor to this recent and forecast fall in productivity.

A similar picture emerges for Australia Post's reserved services. Australia Post's reserved service output quantity grew strongly between 1997 and 2000, increasing by 12 per cent before flattening out and fluctuating around this level through to 2008. It then fell markedly in 2009 and is forecast to continue falling over the next three years. The trend growth rate of reserved letter output is a modest 0.6 per cent per annum between 1997 and 2009 and only 0.2 per cent per annum for the last 7 years. Reserved service input quantity, on the other hand, has declined over the last 13 years with a trend growth rate of -1.1 per cent per annum.

Reserved service TFP grew by a trend rate of 1.7 per cent per annum over the 13 year period from 1997 to 2009. TFP trend growth in the 6 years to 2002 was somewhat higher at 3.1 per cent per annum. This strong TFP performance then reduces to a trend growth rate of 0.8 per cent per annum for the last seven years due to virtually unchanged output levels. However, reserved service TFP fell markedly in 2009 and is forecast to fall further with a growth rate of -1.3 per cent per annum forecast over the next three years as output continues to fall.

Both Australia Post TFP indexes have outperformed the market sector MFP index over both the last 13 years and the last 7 years. Given that Australia Post's reserved service output was essentially flat between 2001 and 2008, being able to outperform the productivity performance of the economy as a whole has been an impressive achievement. However, the recent and forecast continuing fall in demand for letters may make this difficult to achieve going forward.

1 INTRODUCTION

In 2002 the Australian Competition and Consumer Commission (ACCC) engaged Denis Lawrence (then with Meyrick and Associates) to provide a report quantifying Australia Post's total factor productivity (TFP) performance over the preceding five years and the following five year regulatory period. The Lawrence (2002) report was 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. Services reserved to Australia Post under the *Australia Postal Corporation 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 Lawrence (2002) TFP study updated and expanded earlier work on Australia Post's productivity by Swan Consultants (Canberra) (1992a,b).

In 2007 Australia Post requested Denis Lawrence to update the Lawrence (2002) report to include Australia Post's actual aggregate and reserved service productivity performance up to 2007 and predicted productivity performance through to 2011 based on forecasts of output and input quantities provided by Australia Post. Improvements to Australia Post's information systems over the intervening period meant that it was then possible to include considerably more detail on the outputs provided by Australia Post and to better allocate inputs between reserved and non-reserved services.

Australia Post has requested Denis Lawrence (now with Economic Insights) to update the Lawrence (2007) report to include actual data up to and including the 2008 financial year, near finalised data for the 2009 financial year and forecast data provided by Australia Post for the financial years 2010 to 2012.

We commence by briefly reviewing the Lawrence (2002, 2007) reports and the methodological enhancements and data improvements that have been made in the current study in the remainder of this section. We then review the TFP methodology in section 2 before examining the specification of outputs and inputs and productivity results for Australia Post as a whole in section 3. In section 4 we review the TFP performance of providing the reserved services before drawing conclusions in section 5.

1.1 The Lawrence (2002) TFP study of Australia Post

Lawrence (2002) examined Australia Post's overall TFP performance using 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. The study used the Swan Consultants (Canberra) (1992a) database as a starting point but included new output detail provided by Australia Post for the period 1976 to 1991.

Australia Post's aggregate output quantity was found to have 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, was found to have 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 following 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 from 1976 to 2002. 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 decade to 2002. However, in line with the flattening out in both outputs and inputs at the end of the decade, TFP flattened after 2000 and declined marginally in 2002.

Lawrence (2002) also examined the estimated TFP performance of Australia Post's reserved letter service over the six years 1997 to 2002 and the forecast performance for the following five years, 2003 to 2007. Although more limited data were available for Australia Post's reserved service operations and its use and interpretation was subject to important caveats, a similar picture emerged for reserved services. Reserved service TFP growth fell from 3.8 per cent per annum between 1997 and 2002 to a forecast 1.2 per cent per annum over the following five years to 2007. This was brought about by a levelling off in reserved service outputs after 2001 and ongoing modest reductions in total input use.

1.2 The Lawrence (2007) TFP study of Australia Post

Significant improvements in Australia Post's information systems enabled some significant enhancements to be incorporated in the Lawrence (2007) study compared to earlier studies. These included:

- increased number of output categories – from 7 to 25 for the aggregate analysis and from one to five for the reserved services analysis;
- better allocation of revenue to output components reducing the size of the residual other revenue component;
- direct information on the number of full-time equivalent employees removing the need to make assumptions regarding part-time and casual staff utilisation;
- use of depreciation rates more closely linked to actual asset life experience;
- more consistent investment and retirements data available to form capital stock series; and,
- improved information on allocation of costs to reserved services which also allowed inclusion of more input categories for the reserved services analysis.

Australia Post as a whole exhibited strong TFP growth from 1990 with a trend TFP increase of 2.4 per cent per annum between 1990 and 2007. This resulted from strong output growth up to 2000. After stalling in 2001 and 2002, output growth continued but at a slower rate of growth than before 2000. Combined with a levelling off in the quantity of total inputs after 2000, this resulted in TFP growth of 1.7 per cent per annum over the 5 years up to 2007.

A similar picture emerged for Australia Post's reserved services. Australia Post's reserved service output quantity grew strongly between 1997 and 2000, increasing by 12 per cent before flattening out and fluctuating around this level for the remainder of the period through to 2007. The trend growth rate of reserved service output was a modest 0.7 per cent per annum between 1997 and 2007 and only 0.3 per cent per annum for the last 5 years of this period. Reserved service input quantity, on the other hand, declined over the 11 years up to 2007 with a trend growth rate of -1.2 per cent per annum. TFP trend growth in the 6 years to 2002 was 2.9 per cent per annum. This strong TFP performance then reduced to a trend growth rate of 0.7 per cent per annum for the last five years to 2007 due to virtually unchanged output levels.

Ongoing improvements in Australia Post's cost allocation processes have allowed further data and specification refinements to be included in the current study. In its draft determination, the ACCC (2008) also made a number of comments on the Lawrence (2007) study. These mainly concerned the price indexes used to deflate residual outputs and the price indexes, depreciation rates and user cost methods used to form the capital input. These comments are addressed in this report and a number of sensitivity analyses undertaken.

2 TFP METHODOLOGY

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

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

where ΔQ is the proportional change in the quantity of total output provided by Australia Post between the current period and the base period and ΔI is the corresponding proportional 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 Törnqvist 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 Törnqvist 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 Törnqvist 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 Törnqvist index could also be used as it closely approximates Fisher's ideal index.

In this exercise the Fisher ideal index is again 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.

3 AUSTRALIA POST'S AGGREGATE OUTPUTS, INPUTS AND PRODUCTIVITY

This study uses the Lawrence (2007) database as a starting point but includes a number of enhancements based on ongoing improvements to Australia Post's information systems and cost allocation processes. Since our main interest is Australia Post's more recent performance, we use actual data for the years 1990 to 2009 and forecast data for the years 2010 to 2012. Price and quantity data were assembled for 25 outputs and 4 inputs which are described in the following sections.

3.1 Outputs

There are 25 separate output components across 9 broad output groups covering letters, parcels, express, international outwards, international inwards, money orders, agency services, accommodation and other outputs.

3.1.1 Letters

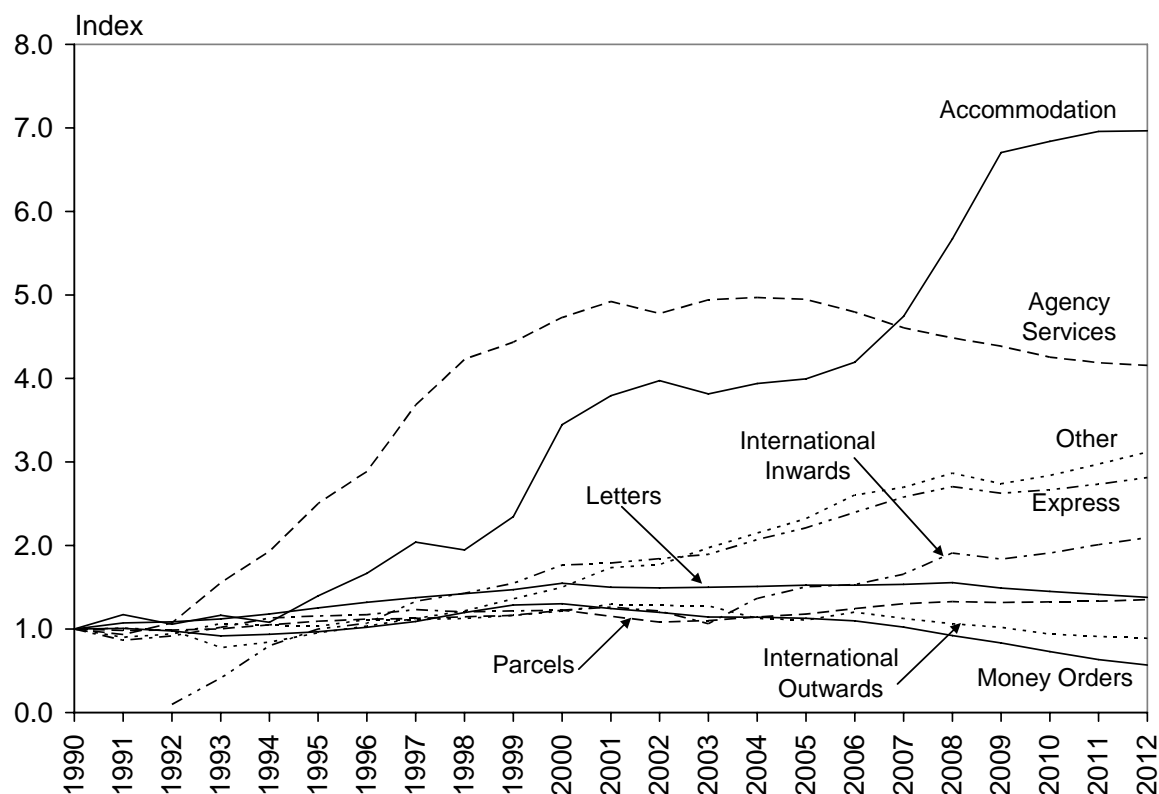
Six different letter output components are included in the letters group as follows:

- small fullrate
- small presort
- large fullrate
- large presort
- publications
- unaddressed

The price for each letters group component is derived by dividing the revenue for that component by the number of articles in that component. The letters group quantity index increased by 50 per cent between 1990 and 2000 before falling back slightly in the following two years and then increasing again to this level by 2008. Letter deliveries then fell markedly in 2009 and are forecast to continue declining through to 2012. Small and large fullrate letters and publications all follow a similar pattern to the letters group aggregate except that deliveries of small fullrate articles declines steadily from 1999 onwards. Deliveries of small and large presort articles and unaddressed letters showed stronger growth up to 2008 before also levelling off or falling. The share of the letters output group in Australia Post's total consolidated revenue has fallen from 61 per cent in 1990 to 45 per cent in 2009.

Movements in the quantity indexes for the letters group and the other 8 output groups are presented in figure 1.

Figure 1: Australia Post's aggregate output group quantity indexes, 1990–2012



3.1.2 Parcels

Four different parcels output components are included in the parcels group as follows:

- small card rate
- small contract
- large card rate
- large contract

The parcels group quantity index increased by 23 per cent between 1990 and 2000 before falling back somewhat in the following two years and then increasing again to this level by 2006. Parcels deliveries are forecast to increase modestly over the next three years, partly because of the increased use of internet shopping. The increase in the quantity index for this group has been driven by large contract parcels which have increased steadily over the period. Deliveries of the other three types of parcels have fallen back or remained flat since 1990 and all are expected to remain flat over the next three years. The share of the parcels output group in Australia Post's total revenue has increased from around 11 per cent in 1990 and to around 13 per cent in 2009. The share of the group's revenue contributed by large contract parcels has doubled from 23 per cent in 1990 to 47 per cent in 2009.

3.1.3 *Express*

Three different express output components are included in the express group as follows:

- letters
- packets
- parcels

The express group quantity index has grown steadily since it first appeared in 1992. It increased by more than 160 per cent between 1995 and 2009 and is forecast to increase by a further 7 per cent by 2012. Express packets and parcels are forecast to be subject to the strongest growth over the next four years. The share of the express output group in Australia Post's total revenue has doubled between 1995 and 2009 to just over 5 per cent. This is forecast to increase to 5.7 per cent by 2012.

3.1.4 *International Outwards*

Four different international outwards output components are included in the international outwards group as follows:

- letters
- packets
- parcels
- express

The international outwards group quantity index grew by around 30 per cent between 1990 and 2001 before falling by 15 per cent over the next 4 years. It then increased in 2006 before again falling and is forecast to continue to falling through to 2012. The share of the international outwards output group in Australia Post's total revenue was just over 9 per cent in 1990 but had fallen to just over 7 per cent in 2009 and is forecast to continue falling through to 2012.

3.1.5 *International Inwards*

Four different international inwards output components are included in the international inwards group as follows:

- letters
- packets
- parcels
- express

The international inwards group quantity index has increased by over 80 per cent between 1990 and 2009 and is forecast to increase by a further 14 per cent by 2012. The share of the

international inwards output group in Australia Post's total revenue has increased from around 3 per cent in 1995 to over 3.5 per cent in 2009 and is forecast to increase to over 4 per cent over the next three years.

3.1.6 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 increased by 30 per cent between 1990 and 2000 before decreasing steadily through to 2009 to be end up 17 per cent below their 1990 level. Their number is forecast to fall by a further 32 per cent over the next three years. The share of money orders in Australia Post's total revenue has moved little from one per cent over the last 20 years.

3.1.7 Agency services

The quantity of agency services is measured by the number of services while the price is derived by dividing the commission revenue obtained from these services by their number. The quantity of agency services increased by nearly 400 per cent between 1990 and 2001. This rapid increase reflected Australia Post's success at becoming a centre for financial transactions. Between 2001 and 2005 the quantity of agency services levelled out before starting to fall. It is forecast to fall by 5 per cent over the next three years. The share of agency services in Australia Post's total revenue initially increased from around 4 per cent in 1990 to around 7 per cent in 2001. It has fluctuated around this level since and is forecast to remain around this level till 2012.

3.1.8 Accommodation

The quantity of accommodation provided to organisations outside Australia Post was measured in Lawrence (2007) by deflating the amount of rent revenue received by the overall consumer price index. The ACCC (2008) argued that the consumer price index excluding volatile items would be a more appropriate price index for this output. This change has been made in the current study. The implied quantity of accommodation provided increased by nearly six fold between 1990 and 2009, starting from a small base. It is forecast to flatten out over the next three years. The share of accommodation in Australia Post's total revenue has remained low and accounted for only 0.5 per cent in 2009.

3.1.9 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 and redirection fees. The quantity of other outputs was also measured in Lawrence (2007) by deflating the relevant revenue received by the overall consumer price index. The ACCC (2008) argued that the

consumer price index excluding volatile items would also be a more appropriate price index for this output. This change has been made in the current study. The quantity of other outputs has grown strongly, increasing by 170 per cent between 1990 and 2009. It is forecast to increase by a further 14 per cent by 2012. The share of other outputs in Australia Post's total revenue has also increased strongly from around 9.5 per cent in 1990 to around 17 per cent in 2009 and is forecast to make up 19 per cent of total revenue by 2012.

3.2 Inputs

3.2.1 Labour

The quantity of labour inputs is measured as the number of full-time equivalent (FTE) staff employed directly by Australia Post and employed by post office agents. The number of FTE staff employed directly by Australia Post was provided by Australia Post for the years from 2002 onwards. These data are now available as a result of Australia Post's improved information systems. Compared to the Lawrence (2007) study, Australia Post has now been able to also supply FTE data for the owner drivers and other (non-mail delivery) contractors it uses. This means the number of directly measured labour inputs has increased compared to the earlier studies.

For the years prior to 2002 data were only available on the number of staff employed on a full-time, part-time and casual basis. By assuming that each full-time employee represents one FTE, we derived a conversion factor for part-time and casual staff to FTEs based on the Australia Post data for total FTEs in 2002. This produced a FTE conversion factor of 0.83 for part-time and casual staff. Lawrence (2002) and the earlier Swan Consultants (Canberra) (1992a) studies assumed, in the absence of other information available at the time, that the FTE conversion factor for part-time and casual staff was 0.5. This difference has a material impact as it means the earlier TFP studies underweighted the increased use of part-time staff by Australia Post through the 1990s and hence overestimated TFP growth, all else equal.

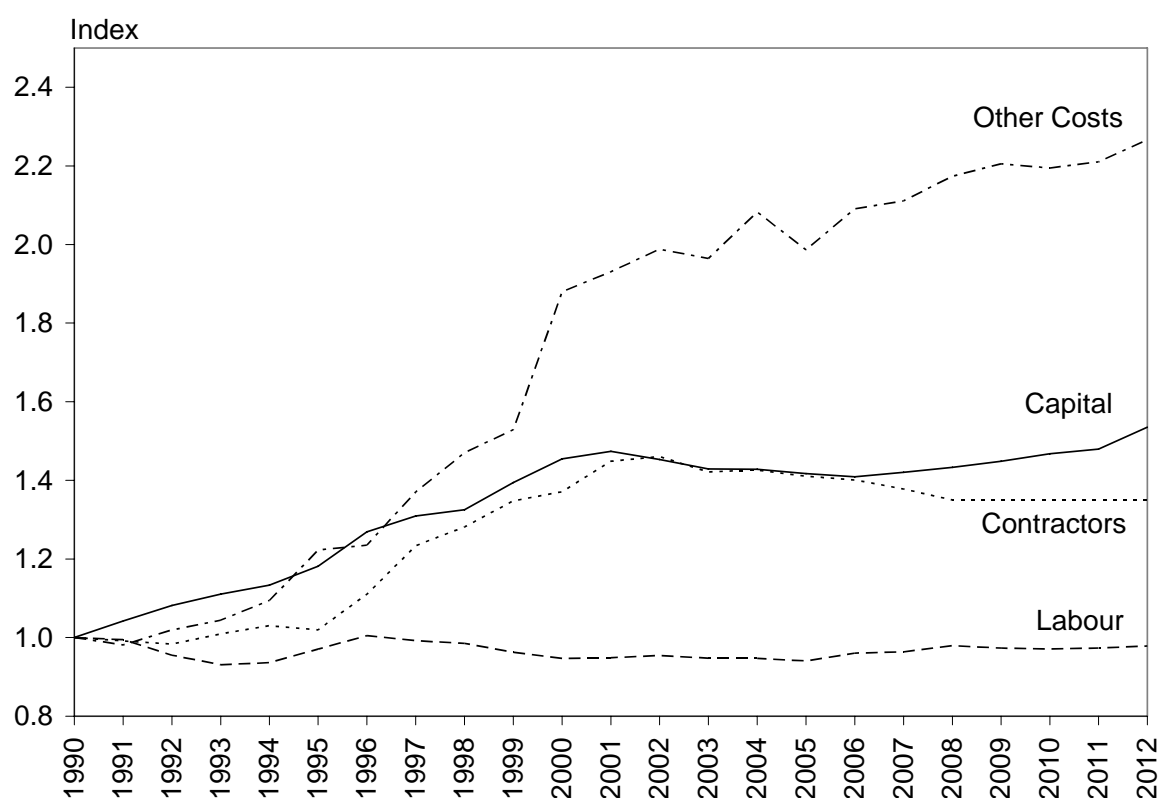
The price of labour is taken to be Australia Post's wages and salary costs excluding abnormals divided by the number of FTE Australia Post staff. Whereas Lawrence (2007) made an adjustment to reflect normal actuarial superannuation payments of \$84 million per annum from 2000 onwards, it was judged the return to more normal superannuation payments in recent years has rendered this adjustment unnecessary in the current study.

The estimated number of post office agency and licensed post office FTEs is derived by dividing post office agency and licensed post office costs by the implied price per FTE for Australia Post.

Total labour FTEs for 2002 onwards are now the sum of Australia Post's FTEs, those of its owner drivers and other (non-mail delivery) contractors, and the estimated FTEs for post office agencies and licensed post offices while total labour costs are the sum of Australia Post's wages and salaries excluding abnormals, owner driver and non-mail delivery contractor payments and post office agency and licensed post office costs. For the years prior to 2002 the relevant labour quantity series from Lawrence (2007) is spliced onto the current series.

The quantity of labour inputs fluctuated within a 10 per cent band below its 1990 level between 1990 and 1996. Since 1996 labour inputs declined to end up around 7 per cent below their 1990 level in 2005. They have since increased by around 3.5 per cent and are forecast to remain around this level for the next three years. 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 68 per cent in 1990 to 52 per cent in 2000 and has remained at around 56 per cent since 2005.

Figure 2: **Australia Post's aggregate input quantity indexes, 1990–2011**



3.2.2 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 contracts while the price of

contractors is derived by dividing the resource cost of delivery contracts by their number. This differs from Lawrence (2007) where the total cost of all delivery and cartage contracts was used instead of the resource cost of delivery contracts. The number of contracts used increased by 46 per cent between 1990 and 2002 but has since decreased to finish 35 per cent above its 1990 level in 2009. The number of contracts is forecast to remain constant over the next three years. The share of contractors in total costs has increased from just over 5 per cent to 8 per cent over the last 20 years and is forecast to remain the same through to 2012. The price of contracts was tightly held in check up to 2004 but has increased more rapidly since as Australia Post has had to pay more to retain contractor services.

3.2.3 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 were the same as those used in Lawrence (2002) 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:

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

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_{jt} 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 net capital stocks of non-dwelling construction for land and buildings and by that for plant and equipment for the other two asset classes (ABS 2009, Table 56). The investment series used was on an assets commissioned basis (rather than an annual expenditure basis). 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.

Significant revisions were made to the depreciation rates used in Lawrence (2007) compared to the earlier studies. Lawrence (2002) used the depreciation rates used by Swan Consultants (Canberra) (1992a,b) of 4 per cent for buildings, 10 per cent for motor vehicles and 5 per cent for plant and equipment. These depreciation rates for plant and equipment are considerably lower than those used in more recent studies such as Diewert and Lawrence (2006) and those currently used by the ABS (2009, Table 13). After reviewing Australia Post's actual asset lives for key capital components Lawrence (2007) revised the depreciation rates used to 6 per cent for buildings, 14 per cent for motor vehicles and 15 per cent for plant and equipment. All else equal, the use of higher depreciation rates to update and backdate fixed point capital stock estimates will lead to a faster decline in the capital stock and, hence, higher TFP growth.

The ACCC (2008) suggested that higher declining balance depreciation rates again should have been used as the depreciation rates used in Lawrence (2007) were similar to Australia Post's straight-line depreciation rates. However, the depreciation rates used in Lawrence (2007) are generally higher than the corresponding declining balance rates used by the ABS in constructing its multifactor productivity series. This study retains the depreciation rates used in Lawrence (2007). A sensitivity analysis of the effects of using different parameters in constructing the capital input, including different depreciation rates, is presented in section 4.3.

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 (including Lawrence 2002, 2007) 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. Following Lawrence (2002, 2007) 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.

A sensitivity analysis of the effects of using the endogenous versus the exogenous approach to calculating annual capital user costs is presented in section 4.3.

The quantity of capital employed by Australia Post increased by 47 per cent between 1990 and 2001, then declined to 41 per cent of its 1990 level by 2006 before again increasing to 45 per cent of its 1990 level in 2009. It is forecast to increase by around 4 per cent in 2012 when a major information technology and buildings investment program is completed and commissioned. The share of ex-post capital costs in total costs started at 10 per cent in 1990 before increasing to peak at 24 per cent in 1999. It has since fallen back to around 10 per cent of total costs and is forecast to remain at this until 2012.

3.2.4 Other inputs

Other inputs cover a wide range of materials and services used by Australia Post. The quantity of other inputs is formed by deflating their cost by the overall consumer price index (excluding the impact of the GST). The quantity of other inputs has increased faster than the other three input categories with an increase of around 120 per cent between 1990 and 2009. It is forecast to increase only marginally over the next three years. The share of other inputs in total costs has also increased from 17 per cent in 1990 to 25 per cent in 2009 and is forecast to remain at around this level through to 2012.

3.3 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 20 year period from 1990 to 2009 and for the periods up to and after 2002 are presented in table 2. Output quantity grew strongly up to 2008 apart from a temporary levelling out in 2001 and 2002. However, output fell markedly in 2009 and is forecast to continue to fall over the next three years. The trend growth rate of aggregate output was a relatively high 3.3 per cent per annum between 1990 and 2009. The growth rate for the first 13 years up to 2002 was higher at 4.5 per cent per annum but then decelerated to 1.7 per cent per annum for the last seven years. This is forecast to be a decrease in output of -0.5 per cent per annum over the next three years.

Aggregate input quantity, on the other hand, has grown far less strongly with a trend growth rate of 1.4 per cent per annum for the 20 year period to 2009. The growth rate for the first 13 years up to 2002 was higher at 2 per cent per annum but then fell to 0.5 per cent per annum for the last seven years. Total input quantity is also forecast to increase by 0.5 per cent per annum over the next three years.

TFP (which is the ratio of the aggregate output and aggregate input quantity indexes) grew by a trend 1.8 per cent per annum over the last 20 years. TFP trend growth in the 13 years to 2002 was somewhat higher at 2.6 per cent per annum and three subperiods within this are visible with stronger growth from 1990 to 1994, then a period of good TFP performance from

Table 1: Australia Post's aggregate output, input, TFP and partial productivity indexes, 1990–2012

	<i>Output</i>	<i>Input</i>	<i>TFP</i>	<i>Partial productivity index of:</i>			
	<i>Quantity</i>	<i>Quantity</i>		<i>Labour</i>	<i>Contract</i>	<i>Capital</i>	<i>Other cost</i>
	<i>Index</i>	<i>Index</i>	<i>Index</i>				
1990	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1991	1.028	0.998	1.030	1.033	1.036	0.986	1.047
1992	1.045	0.983	1.063	1.094	1.063	0.966	1.025
1993	1.087	0.978	1.112	1.168	1.077	0.979	1.041
1994	1.159	0.993	1.167	1.238	1.125	1.023	1.059
1995	1.242	1.041	1.193	1.280	1.218	1.051	1.015
1996	1.316	1.085	1.213	1.310	1.186	1.037	1.065
1997	1.389	1.109	1.253	1.401	1.126	1.061	1.014
1998	1.447	1.124	1.288	1.469	1.130	1.092	0.984
1999	1.508	1.134	1.330	1.566	1.119	1.082	0.987
2000	1.597	1.183	1.350	1.687	1.165	1.098	0.850
2001	1.598	1.198	1.334	1.685	1.103	1.084	0.828
2002	1.584	1.208	1.311	1.659	1.084	1.090	0.797
2003	1.611	1.195	1.348	1.700	1.133	1.127	0.820
2004	1.644	1.211	1.357	1.736	1.153	1.151	0.789
2005	1.683	1.191	1.413	1.790	1.193	1.188	0.847
2006	1.740	1.218	1.429	1.812	1.242	1.235	0.832
2007	1.762	1.223	1.441	1.829	1.279	1.241	0.835
2008	1.796	1.242	1.446	1.835	1.330	1.253	0.826
2009	1.732	1.244	1.392	1.780	1.283	1.196	0.785
2010	1.711	1.243	1.377	1.761	1.267	1.166	0.779
2011	1.707	1.247	1.368	1.754	1.264	1.154	0.772
2012	1.706	1.264	1.350	1.743	1.264	1.112	0.753

Source: Economic Insights estimates

Table 2: Australia Post's aggregate output, input and TFP growth rates, 1990–2012

<i>Period</i>	<i>Output</i>	<i>Input</i>	<i>TFP</i>
	<i>% pa</i>	<i>% pa</i>	<i>% pa</i>
1990–2009	3.23	1.41	1.82
1990–2002	4.51	1.95	2.56
2002–2009	1.68	0.53	1.15
2009–2012	–0.47	0.51	–0.99

Source: Economic Insights estimates

1994 to 2000 and then small falls in TFP in 2001 and 2002 when output growth temporarily levelled off. Between 2002 and 2009 the trend TFP growth rate was 1.2 per cent. This was

Figure 3: Australia Post's aggregate output, input and TFP indexes, 1990–2012

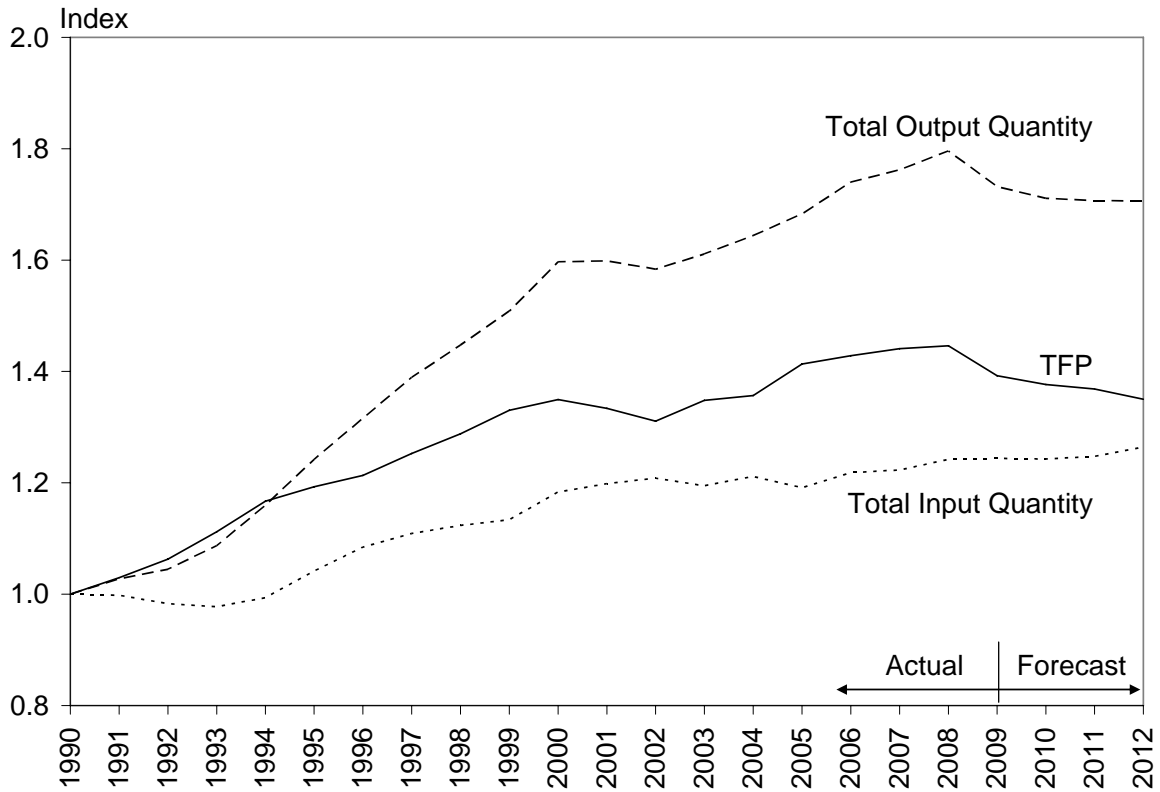
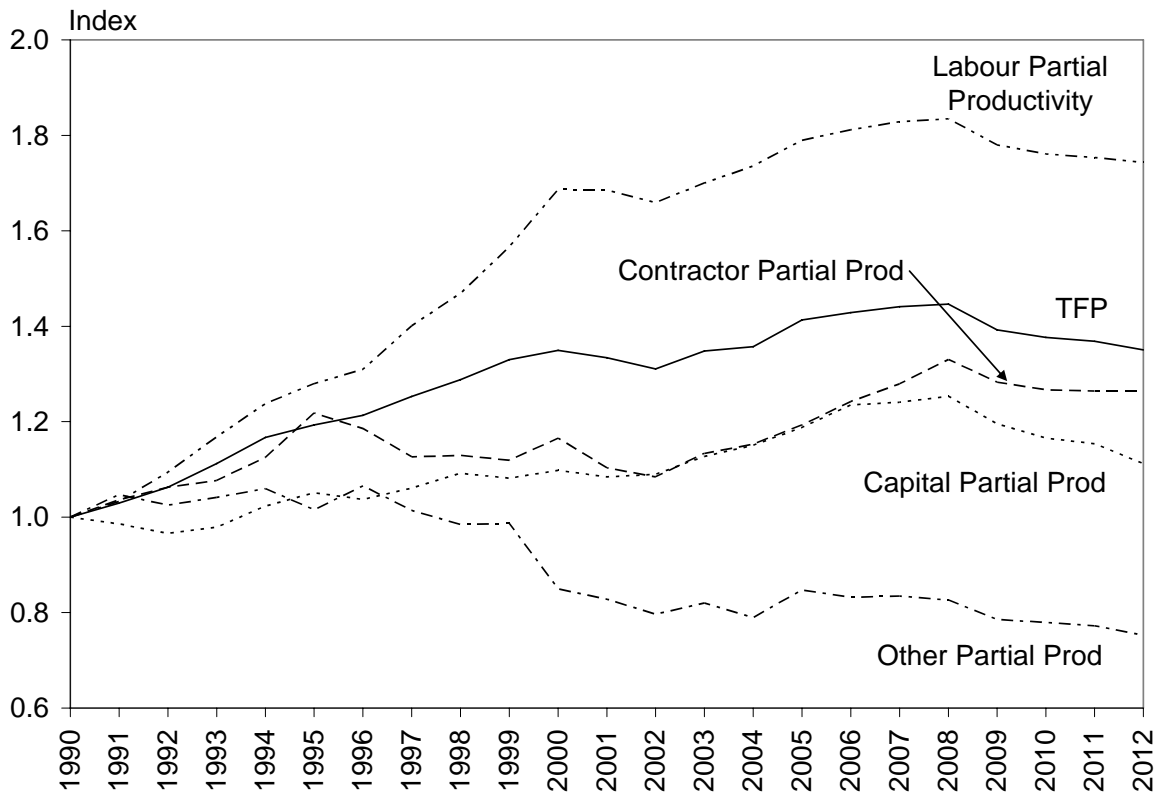


Figure 4: Australia Post's aggregate partial productivity and TFP indexes, 1990–2012



achieved despite the reduced rate of output growth after 2002. TFP fell markedly in 2009 with the reduction in output and TFP trend growth is forecast to continue at –1 per cent per annum for the next three years.

The partial productivities of the four inputs are presented in figure 4 along with the TFP index and they are also reported in table 1. 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 partial productivity has increased faster than TFP which has in turn increased faster than the contractor, capital and other inputs partial productivities. This reflects a substitution of capital and other inputs for labour and, to a lesser extent, contractors over the period. Indeed, as noted in the preceding sections, labour usage fell by 3 per cent between 1990 and 2009, contractor usage increased by 35 per cent, capital usage increased by 45 per cent and other input usage increased by 120 per cent. This compares with a 24 per cent increase in total input usage.

3.4 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) and Lawrence (2002, 2007) 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 could be expected to significantly reduce Australia Post's output growth in the future although greater use of internet based shopping and associated home deliveries could also open up some opportunities for parcel delivery services.

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. Three periods of technological change are specified in the current model which covers the period since 1990:

- 1990 to 1997 – a period when technical improvements were enhanced through better industrial relations and the corporatisation of Australia Post in 1989;
- 1998 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; and
- 2003 to 2009 – a period of lower output growth up to 2008 and then falling output but a recovery in productivity growth up to 2008 due to little change in input use before a fall in 2009 due to the reduction in output.

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

$$(3) \quad \ln I = \sum_{i=1}^3 \alpha_{0i} \cdot D_i + \sum_{i=1}^3 \beta_{0i} \cdot D_i \cdot T + \varepsilon_y \cdot \ln Y + \varepsilon_{NS} \cdot \ln NS + \varepsilon$$

where D_i are dummy variables corresponding to the three hypothesised periods of differential technological growth and the parameters ε_y and ε_{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>
α_{01}	0.001	0.013
α_{02}	-0.071	0.066
α_{03}	-0.069	0.053
β_{01}	-0.017	0.005
β_{02}	-0.007	0.004
β_{03}	-0.010	0.002
ε_y	0.380	0.184
ε_{NS}	0.620	0.184
R-squared	0.98	
Number of observations	20	

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 0.98. The elasticity of cost with respect to output is estimated at 0.38. It follows that the elasticity of cost with respect to network size is 0.62.

Some features of this model warrant comment. First, the rate of growth in technological development slowed markedly between the first and second periods but then partially recovered in the latest period. This is indicated by the changes in the values of the β 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 second period following the take-off in internet usage was less than half the level in the early to mid 1990s. The second feature of the results is that the elasticity of cost with respect to output is much smaller than in Lawrence (2007) but is similar to that obtained by Lawrence (2002).

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

$$(4) \quad T\dot{F}P = T\dot{G}R + (1 - \varepsilon_y)\dot{Y} - \varepsilon_{NS}\dot{N}S$$

where: $T\dot{F}P$ is growth in unadjusted TFP;

$T\dot{G}R$ is technological growth;

\dot{Y} is growth in aggregate output;

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

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

Figure 5: Australia Post's aggregate TFP and technological growth

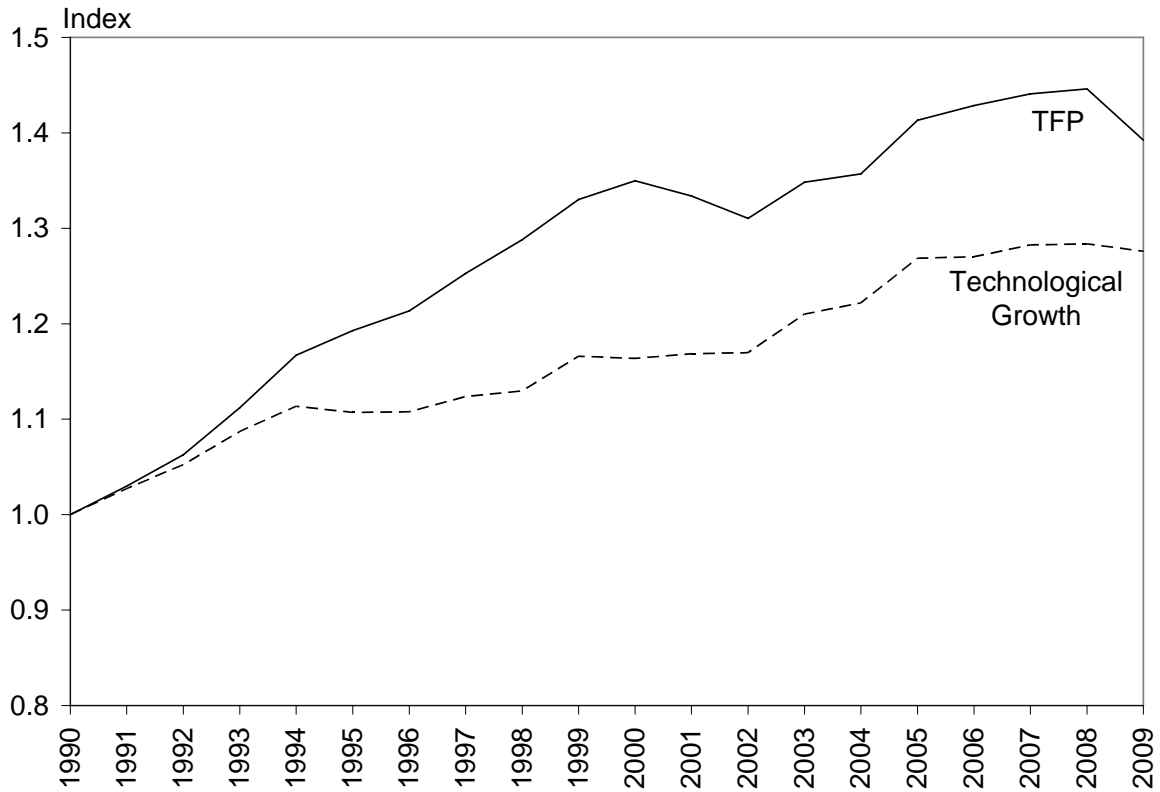
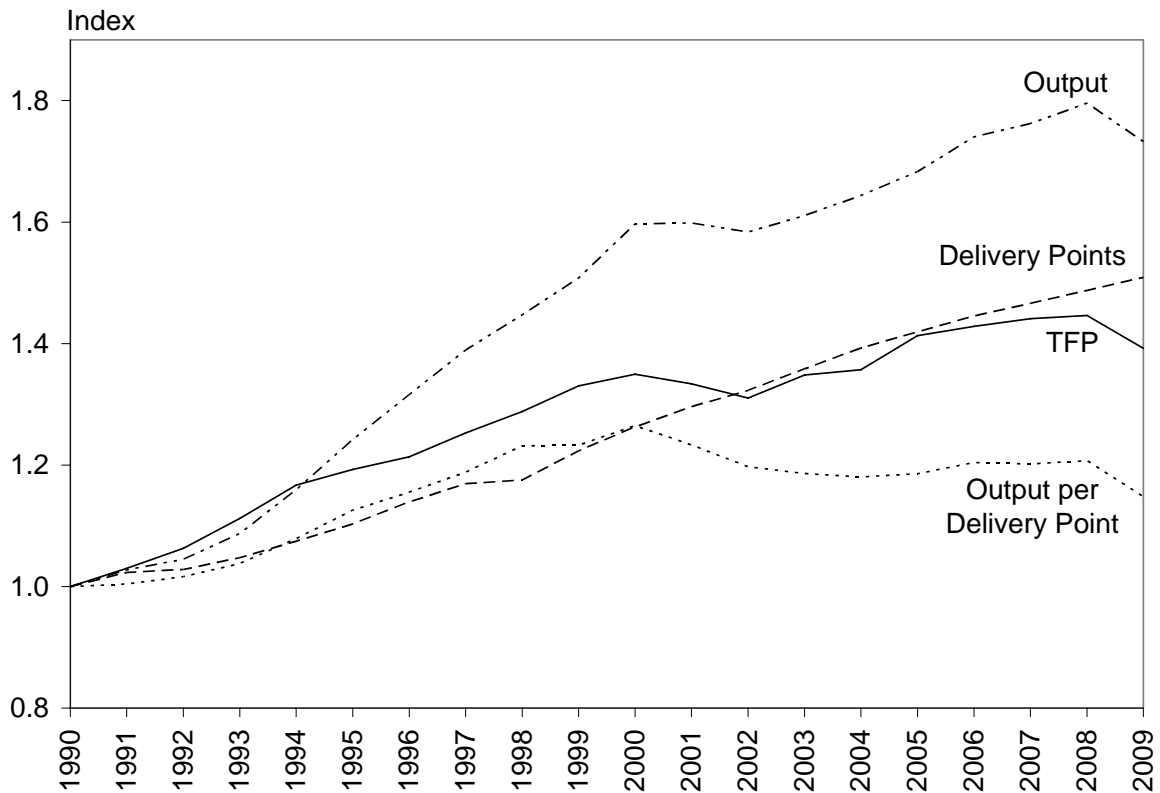


Figure 6: Growth in output, productivity and network size (index: 1990 = 1)



ε_{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 20 year period although it levelled off after 2005.

To understand why TFP faltered temporarily after 2000, 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 whole 20 year period, Australia Post's output rose much faster up to 2000. Output per delivery point increased by 27 per cent between 1990 and 2000. However, since 2000 output per delivery point has consistently declined and fell by 9 per cent between 2000 and 2009. After adjusting to this apparently fundamental change in its market, Australia Post went on to achieve good productivity growth from 2002 to 2008 after which it was again subjected to another significant fall in output and associated sizable reduction in output per delivery point.

4 RESERVED SERVICE OUTPUTS, INPUTS AND PRODUCTIVITY

The preceding section examined the TFP performance of Australia Post as a whole over the last 20 years and as forecast for the next three years. In this section we examine the TFP performance of Australia Post's reserved letter service over the last 13 years, 1997 to 2009, and the forecast performance for the next three years, 2010 to 2012. The analysis updates the earlier Lawrence (2002, 2007) reserved services TFP studies. Since the original Lawrence (2002) study Australia Post has made significant advances with its information systems and Lawrence (2007) included improved information on the allocation of costs to reserved services which also allowed inclusion of more input and output categories for the reserved services analysis. This study uses the same framework as Lawrence (2007) but with ongoing improvements in the accuracy of both input and output allocations to reserved services.

4.1 Reserved service outputs and inputs

4.1.1 Reserved service output

Australia Post's reserved services cover most, but not all of, 5 of the 25 individual output components included in the aggregate level TFP analysis discussed in section 3. Australia Post provided data on the reserved service parts of the following 5 letters output components:

- small fullrate
- small presort
- large fullrate
- large presort
- international inwards

The quantity of reserved services is measured by forming an index of the quantities of the five components. Prices for each of the 5 components are derived by dividing the revenue obtained for each component by the relevant number of articles. The quantity of reserved services output increased by nearly 14 per cent between 1997 and 2008 but fell by 4 per cent in 2009 and is forecast to fall another 7 per cent by 2012. The movements in the 5 output component quantities have, however, been quite different over the last 13 years. The quantity of small fullrate reserved letters has fallen by 30 per cent while the quantities of small presort and large presort reserved letters have increased by 93 per cent and 140 per cent, respectively. The quantities of large fullrate reserved letters have fluctuated but remained at the around the same levels in 2009 as they were in 1997 while the quantity of international inwards reserved letters fell by 5 per cent. Movements in the quantity indexes for reserved services outputs are presented in figure 7 and for the four input categories are presented in figure 8.

Figure 7: Australia Post's reserved service output quantity indexes, 1990–2012

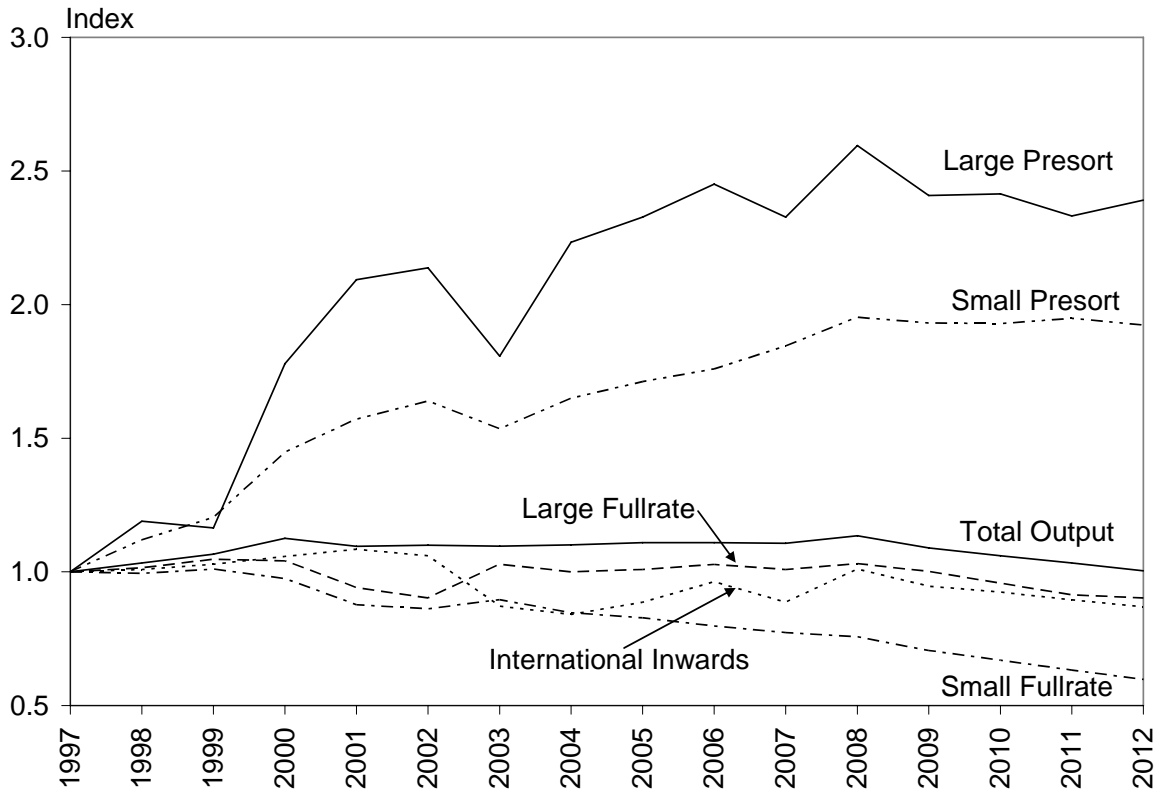
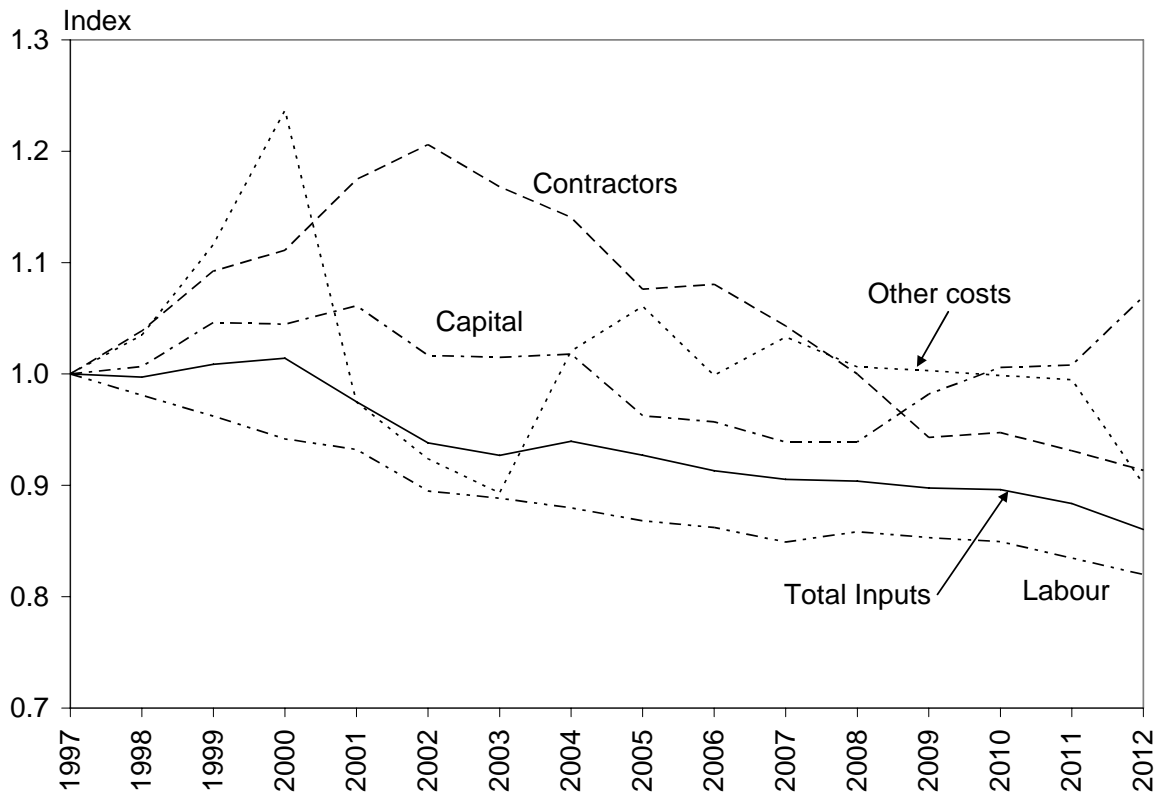


Figure 8: Australia Post's reserved service input quantity indexes, 1990–2012



4.1.2 Labour

Australia Post provided data on the FTE labour allocated to reserved services for the period from 2007 and forecast out to 2012. The FTE labour input to reserved services from Lawrence (2007) for the period 1997 to 2006 was spliced onto the latest data to provide a consistent time series from 1997 to 2012. A similar process was followed for labour costs for reserved services.

The quantity of labour used in reserved services operations fell by 15 per cent between 1997 and 2009 and is forecast to fall by a further 4 per cent by 2012. Labour costs as a share of total costs (as calculated in this study) have varied between around 58 and 69 per cent over the last 13 years.

4.1.3 Contractors

Given improvements in its information systems since the Lawrence (2002) study, Australia Post was able to provide the cost of contractors used in the delivery of reserved services for the years from 2001 to 2009 and forecast out to 2012. For the years from 1997 to 2001, reserved services contractor costs were assumed to move in line with aggregate Australia Post contractor costs. The price (resource cost) per contract was assumed to be the same for reserved services as for Australia Post as a whole.

The quantity of contract input used in reserved services operations increased by 20 per cent between 1997 and 2002 but then fell back to be 6 per cent below its 1997 level by 2009. It is forecast to fall by a further 3 per cent by 2012. Contractor costs as a share of total costs (as calculated in this study) have increased from around 5 per cent in 1997 to 9.5 per cent in 2009. They are forecast to increase to around 10 per cent by 2012 with the increase in the contract price more than offsetting the reduction in the forecast quantity of contracts.

4.1.4 Capital

Australia Post provided detailed data on its reserved service asset purchases and retirements from 2001 to 2009 and forecasts out to 2012. We work at the same level of aggregation as in the aggregate Australia Post analysis reported in section 3 and have four asset groups: land, buildings, plant and equipment, and motor vehicles. To obtain estimates of reserved service asset purchases and retirements for 1997 to 2000 we multiply the corresponding aggregate Australia Post asset purchases and retirements for those years by the average proportion of those variables reserved service assets account for from 2001 onwards. Real investment and retirement series were obtained by deflating the current price series by the National Accounts Implicit Price Deflator for net capital stocks of non-dwelling construction for land and buildings and by that for plant and equipment for the other two asset classes (ABS 2009, Tables 56). The point estimates of reserved service asset stocks are taken to be those

developed by the ACCC for the year 2001 during its 2002 pricing review. These point estimates are updated and backdated using equation (1) and the real asset purchases and retirements series. An index of the total quantity of capital inputs was then formed from the four separate capital stock estimates using the Fisher ideal index and current price stock values as weights.

The quantity of capital used in the provision of the reserved letters service increased by 6 per cent between 1997 and 2001 before declining to finish up in 2009 just below its 1997 level. It is forecast to increase marginally over the next two years before increasing by around 6 per cent in 2012 as major new information technology and buildings investment programs are completed and commissioned. The share of capital in total costs varies between 15 and 21 per cent between 1997 and 2004 before falling to 7 per cent in 2009.

4.1.5 Other costs

Materials and services costs are derived by subtracting labour costs, contractor costs and depreciation from total reserved letter costs. The size of other costs in this study is smaller than the corresponding input category in Lawrence (2002) because more inputs are now accounted for explicitly in other input groups. The price of materials and services is taken to be the overall consumer price index excluding the impact of the GST. For the years from 2009 onwards, the CPI is assumed to increase by 2.5 per cent per annum. The quantity of materials and services is derived by deflating the estimated cost by the CPI.

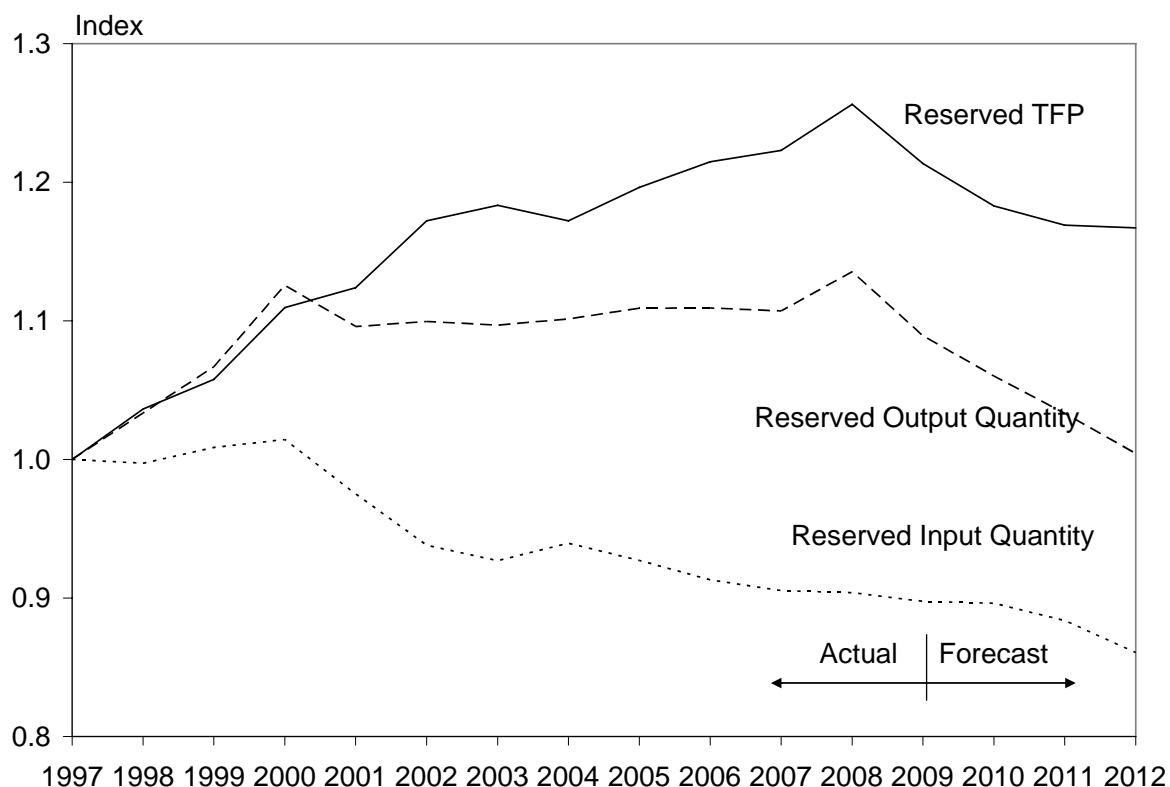
The quantity of materials and services increased by 24 per cent between 1997 and 2000 and then declined substantially over the following 3 years before increasing modestly to end up at around its 1997 level in 2009. It is forecast to fall by 10 per cent over the next three years. The share of materials and services in total costs varied between 15 and 18 per cent between 1997 and 2009 and is forecast to remain within this range through to 2012.

4.2 Reserved service productivity

Australia Post's reserved service output quantity, input quantity and TFP indexes are presented in figure 9 and table 4. Trend growth rates in these indexes for the 13 year period 1997 to 2009 and for the periods up to and after 2002 are presented in table 5 along with the forecast growth rate to 2012. Reserved letter output quantity grows strongly between 1997 and 2000, increasing by 12 per cent before flattening out and fluctuating around this level for through to 2008 and then falling through to 2012. The trend growth rate of reserved letter output is a modest 0.6 per cent per annum between 1997 and 2009. The growth rate for the first 6 years up to 2002 is considerably higher at 2 per cent per annum but then falls to only

0.2 per cent per annum for the last 7 years. It is forecast to decline by 2.7 per cent per annum for the next three years.

Figure 9: **Australia Post's reserved service output and input quantity and TFP indexes, 1997–2012**



Reserved service input quantity, on the other hand, has declined over the last 13 years with a trend growth rate of -1.1 per cent per annum. The trend growth rate in input use for the 6 years up to 2002 was also -1.1 per cent per annum and the trend rate of decline has been -0.7 per cent per annum for the last seven years. It is forecast to decline more rapidly at -1.4 per cent per annum for the next three years.

Reserved service TFP grows by a trend of 1.7 per cent per annum over the 13 year period from 1997 to 2009. TFP trend growth in the 6 years to 2002 was somewhat higher at 3.1 per cent per annum. This strong TFP performance then reduces to a trend growth rate of 0.8 per cent per annum for the last seven years. This lower growth in TFP performance is attributable to virtually unchanged output levels before a fall in output from 2009 onwards. TFP trend growth is forecast to be negative at -1.3 per cent per annum over the next three years as the rate of output reduction increases.

The partial productivities of the four inputs are presented in figure 10 along with the reserved service TFP index and are also reported in table 4. Again labour partial productivity has

increased faster than TFP which has in turn increased faster than the capital, other costs and contractor partial productivities. This reflects a substitution of contractors, materials and services, and capital for labour over the period. As noted above, labour usage fell by 15 per cent over the 13 years to 2009, other costs usage remained virtually unchanged, contractor usage decreased by 6 per cent and capital usage decreased by 2 per cent. This compares with a 10 per cent decline in total input usage.

Table 4: Australia Post's reserved service output, input, TFP and partial productivity indexes, 1997–2012

	<i>Output</i>	<i>Input</i>	<i>TFP</i>	<i>Partial productivity index of:</i>			
	<i>Quantity</i>	<i>Quantity</i>		<i>Labour</i>	<i>Contract</i>	<i>Capital</i>	<i>Other cost</i>
	<i>Index</i>	<i>Index</i>	<i>Index</i>				
1997	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1998	1.034	0.997	1.036	1.054	0.995	1.027	0.999
1999	1.067	1.009	1.058	1.109	0.977	1.020	0.956
2000	1.125	1.014	1.110	1.195	1.013	1.077	0.910
2001	1.096	0.975	1.124	1.176	0.933	1.033	1.124
2002	1.100	0.938	1.172	1.229	0.912	1.082	1.191
2003	1.097	0.927	1.183	1.235	0.939	1.081	1.228
2004	1.101	0.940	1.172	1.252	0.966	1.082	1.079
2005	1.109	0.927	1.196	1.278	1.031	1.152	1.046
2006	1.109	0.913	1.215	1.287	1.027	1.159	1.111
2007	1.107	0.905	1.223	1.304	1.062	1.179	1.072
2008	1.136	0.904	1.256	1.323	1.136	1.210	1.128
2009	1.089	0.897	1.214	1.277	1.155	1.109	1.086
2010	1.060	0.896	1.183	1.248	1.119	1.054	1.062
2011	1.033	0.884	1.169	1.238	1.110	1.025	1.039
2012	1.004	0.861	1.167	1.225	1.099	0.939	1.115

Source: Economic Insights estimates

Table 5: Australia Post's reserved service output, input and TFP growth rates, 1997–2012

<i>Period</i>	<i>Output</i>	<i>Input</i>	<i>TFP</i>
	<i>% pa</i>	<i>% pa</i>	<i>% pa</i>
1997–2009	0.61	–1.09	1.70
1997–2002	2.01	–1.09	3.10
2002–2009	0.15	–0.67	0.82
2009–2012	–2.69	–1.40	–1.29

Source: Economic Insights estimates

Figure 10: Australia Post's reserved service partial productivity and TFP indexes, 1997–2012

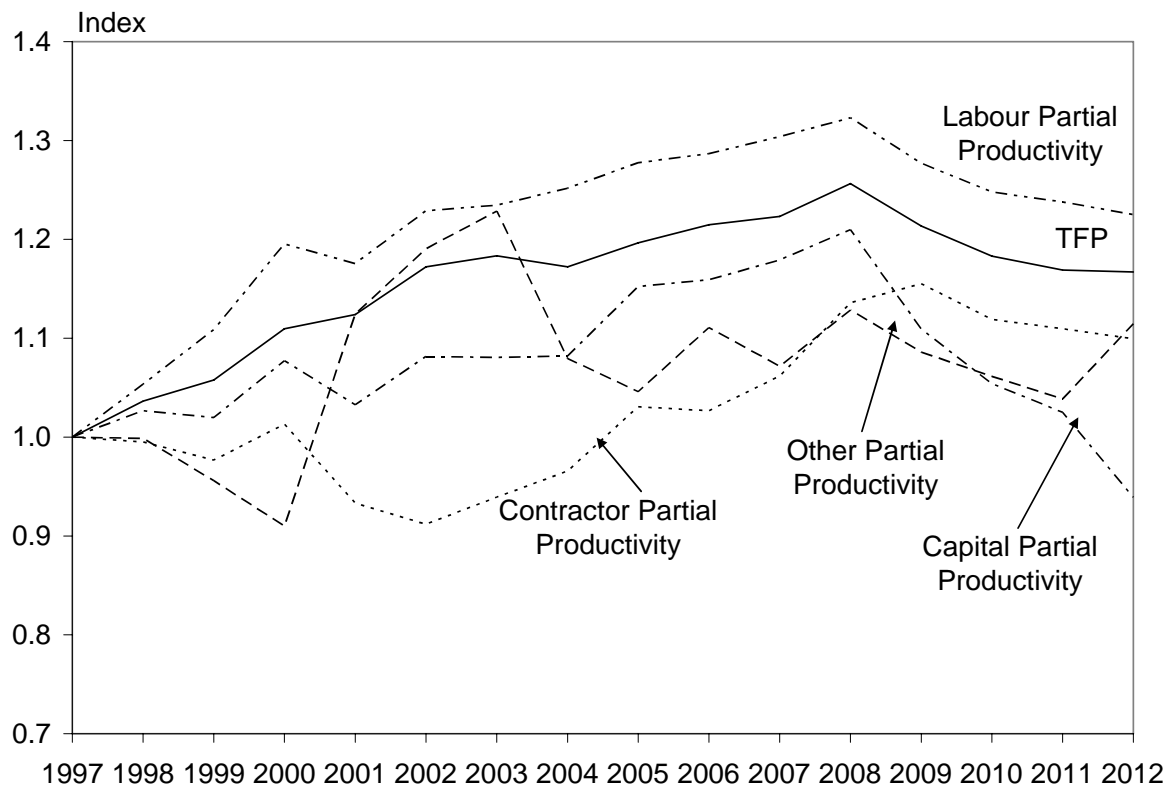
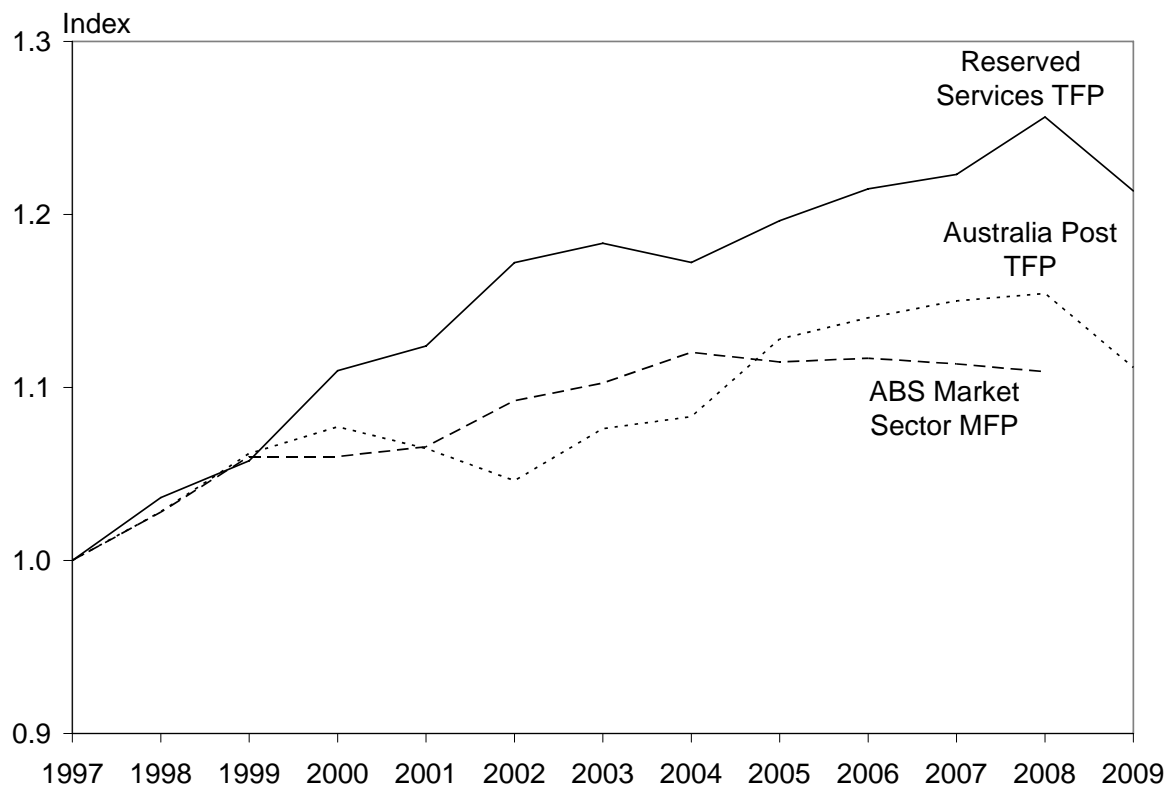


Figure 11: Australia Post's TFP indexes and ABS MFP indexes, 1997–2009



In figure 11 we compare Australia Post's reserved service and aggregate TFP indexes with the ABS's market sector 'multifactor' productivity (MFP) (ABS 2009, Table 13) for the period 1997 to 2009. The MFP index is the ratio of the constant price value added of the ABS's 12 market sectors divided by an index of labour and capital inputs. The MFP index is a 'net' productivity index in that intermediate inputs are deducted from the numerator and the denominator only includes the primary inputs of labour and capital. The TFP indexes, on the other hand, are 'gross' productivity indexes in that only outputs are included in the numerator and all inputs, including intermediate inputs, appear in the denominator. All else equal, a net productivity index such as the MFP index will report a higher productivity growth rate as it has a smaller denominator than the corresponding gross productivity measure.

Over the period 1997 to 2009 the reserved services TFP index has increased more than the aggregate Australia Post TFP index with a trend growth rate of 1.7 per cent per annum compared to 1.4 per cent. Both indexes have increased more than the ABS market sector MFP index over the period up to 2008 (the latest year the latter index is currently available for) which only had a trend growth rate of 0.9 per cent per annum. The aggregate Australia Post TFP index is, however, held back by its small declines in 2001 and 2002. If we look at the respective growth rates from 2002 to 2009, the aggregate Australia Post TFP index grows by a trend rate of 0.8 per cent per annum compared to the reserved services TFP index growth rate of 0.5 per cent and the ABS MFP growth rate of only 0.3 per cent (up to 2008). Both Australia Post TFP indexes have thus outperformed the market sector MFP index over both the last 13 years and the last 7 years. Given that Australia Post's reserved service output has essentially been flat between 2001 and 2008, being able to outperform the productivity performance of the economy as a whole has been an impressive achievement. It should also be noted that the net productivity MFP measure used by the ABS will give a higher growth rate, all else equal, than the equivalent gross TFP measure as used in the Australia Post series. However, the fall in Australia Post's output in 2009 and expected ongoing falls in output over the next three years will significantly reduce Australia Post's productivity performance going forward.

4.3 Sensitivity analyses

As noted in section 3.1, ACCC (2008) made a number of comments on the data and specification used in Lawrence (2007). These related to:

- suggested use of the consumer price index excluding volatile items as the deflator for the accommodation and other revenue outputs instead of the overall consumer price index;
- sensitivity analysis regarding capital goods price indexes used;

- possible use of higher depreciation rates in forming the capital stock; and
- the use of endogenous (or ex post) methods of constructing the user cost of capital versus exogenous (or ex ante) methods.

With regard to the first of these comments, we have no objection to using the consumer price index excluding volatile items as the deflator for the accommodation and other revenue outputs in the aggregate Australia Post TFP analysis and this change has been adopted in this study. As suggested by the ACCC, the overall consumer price index is retained as the deflator for other costs because this will include fuel and other volatile items.

To examine the impact of the ACCC (2008) suggestions regarding the specification and construction of capital inputs, we undertake a number of sensitivity analyses in this section. We do this using the reserved service database as the reserved service results are likely to be of most interest. We also examine another change which is using the earliest available estimate of Australia Post's fair value-based asset values as the starting point for constructing the capital stock series instead of the replacement cost proxy used in Lawrence (2002, 2007).

Capital goods price indexes

The capital goods price indexes used in Lawrence (2007) were the ABS (2009) market sector net capital stock deflators for Non-dwelling construction (used for land and buildings inputs) and for Plant and equipment (used for motor vehicles and plant and equipment inputs). These deflators are used to bring asset additions and sales series to constant prices before equation (1) is applied to produce a constant price capital stock series. The market sector capital price indexes are used in preference to the Communications sector indexes as the latter is dominated by telecommunications where technological changes could be expected to have led to more rapid declines in capital input prices.

An alternative to using the net capital stock capital goods price indexes would have been to use the corresponding gross fixed capital formation (GFCF) price deflators. In the case of Non-dwelling construction this would make no difference as the ABS net capital stock and GFCF price indexes are virtually identical. However, this is not the case for Plant and equipment where the market sector net capital stock price deflator decreases by 15 per cent between 1997 and 2008 while the corresponding GFCF price deflator decreases by 25 per cent over the same period.

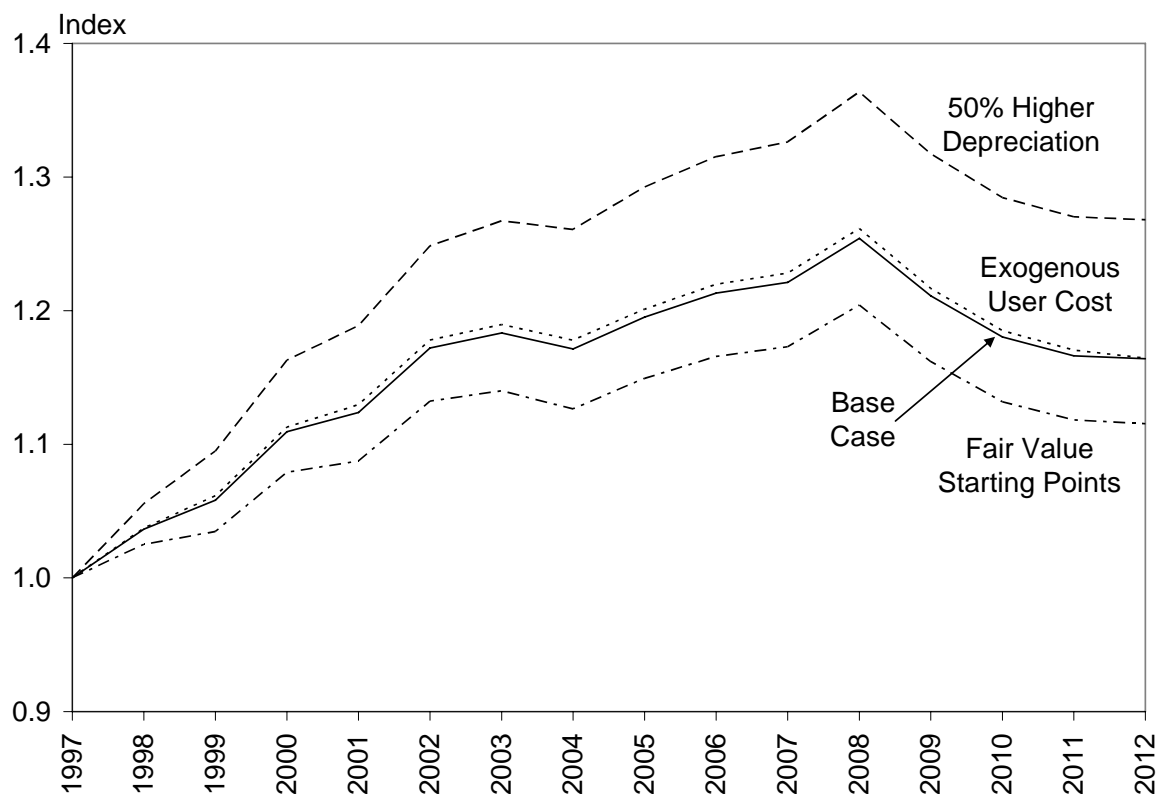
In table 6 we present the results of using the GFCF price deflators instead of the net capital stock price deflators in forming the reserved service TFP index. Comparing the base case Lawrence (2007) approach with the results using the GFCF deflators, the difference in TFP results is minimal with only third decimal place differences.

Table 6: Sensitivity analyses – Australia Post's reserved service TFP, 1997–2012

	<i>Base Case</i>	<i>GFCF deflators</i>	<i>50% higher depreciation</i>	<i>Fair value starting points</i>	<i>Exogenous user costs</i>
1997	1.000	1.000	1.000	1.000	1.000
1998	1.036	1.036	1.056	1.025	1.037
1999	1.058	1.058	1.095	1.035	1.061
2000	1.110	1.109	1.163	1.079	1.113
2001	1.124	1.124	1.189	1.088	1.130
2002	1.172	1.172	1.248	1.132	1.178
2003	1.183	1.183	1.267	1.140	1.190
2004	1.172	1.171	1.261	1.127	1.178
2005	1.196	1.195	1.292	1.149	1.201
2006	1.215	1.213	1.315	1.166	1.220
2007	1.223	1.221	1.326	1.173	1.228
2008	1.256	1.254	1.364	1.204	1.261
2009	1.214	1.211	1.317	1.162	1.217
2010	1.183	1.180	1.285	1.132	1.185
2011	1.169	1.166	1.270	1.118	1.171
2012	1.167	1.164	1.268	1.115	1.165

Source: Economic Insights estimates

Figure 12: Sensitivity analyses – Australia Post's reserved service TFP, 1997–2012



Depreciation rates

ACCC (2008) suggests that Lawrence (2007) could have used higher declining balance depreciation rates in forming the capital stock estimates as the rates used are similar in magnitude to the straight–line depreciation rates used by Australia Post. However, the declining balance rates used in Lawrence (2007) were a significant increase over those used by Lawrence (2002) and earlier studies and were based on a range of information, including the declining balance depreciation rates used by the ABS (2009) in forming its sectoral multifactor productivity series.

Lawrence (2002) and Swan Consultants (Canberra) (1992) used declining balance depreciation rates of 4 per cent for buildings, 10 per cent for motor vehicles and 5 per cent for plant and equipment. Lawrence (2007) revised the depreciation rates to 6 per cent for buildings, 14 per cent for motor vehicles and 15 per cent for plant and equipment. These rates were informed by information from Australia Post on actual asset lives and by the corresponding rates used by the ABS in forming its multifactor productivity series.

The ABS made information available to Diewert and Lawrence (2006) on the declining balance depreciation rates it uses in forming its sectoral productivity series. The ABS uses separate depreciation rates for 10 capital stock components for all sectors. Using the manufacturing sector rates as an example, the weighted average ABS depreciation rate for Buildings is 4.9 per cent, for Motor vehicles is 10.6 per cent and for Plant and equipment is 16.6 per cent. The Lawrence (2007) depreciation rates are higher than the ABS rates for Buildings and Motor vehicles and slightly lower for Plant and equipment.

While we are confident that the depreciation rates used in Lawrence (2007) are reasonable and are consistent with rates used by the ABS and in other infrastructure industry TFP studies, we nonetheless undertook a sensitivity analysis as suggested by the ACCC (2007) of using substantially higher rates again. We have used rates 50 per cent above those used by Lawrence (2007) as an example, ie 9 per cent for buildings, 21 per cent for motor vehicles and 22.5 per cent for plant and equipment. It should be noted that these rates are approximately equal to those obtained using the formula in Steering Committee on National Performance Monitoring of GTEs (1992, p.17) to convert between straight–line and declining balance rates if the Lawrence (2007) rates were taken to be the straight–line rates.

From table 6 and figure 12 we see that using these higher rates leads to a significantly higher rate of TFP growth for reserved services. In fact, the TFP growth rate for 1997 to 2012 increases from 1.6 per cent to 2.2 per cent. However, it is important to look at the plausibility of the implied capital stock estimates that result from using this substantially higher depreciation rate. Using the Lawrence (2007) depreciation rates the Australia Post reserved service capital stock decreases by 2 per cent between 1997 and 2012 in constant prices.

However, using the 50 per cent higher depreciation rates leads to a reduction in the constant price capital stock of 40 per cent over the same period. Such a large reduction in the capital stock over this period is considered implausible and thus using substantially higher depreciation rates fails a basic ‘sanity check’.

Given that the Lawrence (2007) declining balance depreciation rates are close to those used by the ABS in forming its multifactor productivity series and the use of higher rates produces implausible movements in the capital stock, we continue to use the Lawrence (2007) depreciation rates in this study.

Fair value starting points

The market price proxy starting points used in Lawrence (2002, 2007) for reserved service assets were values estimated by the ACCC in its modelling work for its 2002 review of postal charges. Since it is desirable for asset values to be transparent and reproducible, we consider using the Australia Post fair value asset values for 2001 as an alternative starting point in forming the capital stock series. Accounting-based series have previously been less preferred in productivity studies compared to depreciated replacement cost based estimates. However, most regulators now favour the use of historic cost-based series for regulatory purposes, particularly where assets are sunk costs (see ACCC 2004 and Economic Insights 2009).

Fair value series are an attempt to estimate market values based on a range of available information including acquisition costs and replacement costs. The 2001 Australia Post fair values are smaller than the corresponding ACCC estimates – \$195 million versus \$260 million for reserved service land, \$333 million versus \$398 million for buildings, \$68 million versus \$74 million for motor vehicles and \$393 million versus \$502 million for plant and equipment.

Using the Australia Post 2001 fair values as starting points for the capital stock leads to a larger increase in the capital stock over time (as the same additions and sales are applied to a smaller starting point). The capital stock now increases by 26 per cent in constant price terms between 1997 and 2009. This leads to a lower rate of TFP growth as shown in table 6 and figure 12. The TFP growth rate for 1997 to 2012 falls to 1.3 per cent per annum from 1.6 per cent per annum in the base case.

Endogenous versus exogenous user costs

The final sensitivity analysis undertaken is using the exogenous approach to forming the capital user cost instead of the endogenous approach used in Lawrence (2002, 2007). The exogenous approach was used in Swan Consultants (Canberra) (1992a) and involves setting the user cost of capital based on exogenous opportunity cost rates and rates of observed capital gain. The simpler endogenous approach has been favoured by some regulators and

involves allocating the difference between total revenue and non-capital costs as the gross user cost of capital. This gross user cost includes both depreciation and the actual rate of return realised at the end of the year.

To form an exogenous (or ex ante) user cost we use the formula in Swan Consultants (Canberra) (1992a, p.116). The opportunity cost of capital is taken to be the 10 year government bond rate plus a 6 per cent market risk premium. The rate of capital gains is taken to be the observed change in the capital goods price index. The depreciation rates used in Lawrence (2007) are also used.

From table 6 and figure 12 we see that moving to an exogenous or ex ante user cost of capital has negligible impact on the reserved service TFP index compared to using the endogenous approach.

Conclusions

Based on the sensitivity analyses reported above, we conclude that the capital specification used in Lawrence (2007) is both reasonable and robust. Using GFCF price deflators instead of net capital stock deflators has negligible impact on the TFP estimates. The declining balance depreciation rates used in Lawrence (2007) are generally higher than but close to those used by the ABS in forming its multifactor productivity series. Using substantially higher depreciation rates leads to implausible falls in the capital stock. Using fair value starting points instead of the ACCC estimates from 2002 would lead to more of an increase in the capital stock and correspondingly lower TFP growth. While the fair value estimates have the advantage of transparency, we adopt the conservative approach of retaining the 2002 ACCC starting points in this study. Finally, the use of endogenous versus exogenous capital annual user costs has negligible impact on estimated TFP growth in this instance.

5 CONCLUSIONS

Australia Post as a whole has exhibited strong TFP growth since 1990 with a trend TFP increase of 1.8 per cent per annum between 1990 and 2009. This resulted from strong output growth up to 2000. After stalling in 2001 and 2002, output growth continued up to 2008 but at a slower rate of growth than before 2000. Output fell markedly in 2009 and is forecast to continue to decline over the next three years with a negative impact on TFP growth. Combined with a levelling off in the quantity of total inputs after 2002, this has resulted in TFP growth of 1.2 per cent per annum over the last 7 years but this is forecast to reverse to –1 per cent per annum over the next three years. A reduction in the volume of letters is the main contributor to this recent and forecast fall in productivity. Falls in non-postal items such as money orders and agency services are also observed in recent years and forecast to continue. Parcels output has levelled off in recent years while other components such as express mail has continued to grow but at a reduced rate.

A similar picture emerges for Australia Post's reserved services. Australia Post's reserved service output quantity grew strongly between 1997 and 2000, increasing by 12 per cent before flattening out and fluctuating around this level through to 2008. It then fell markedly in 2009 and is forecast to continue falling over the next three years. The trend growth rate of reserved letter output is a modest 0.6 per cent per annum between 1997 and 2009 and only 0.2 per cent per annum for the last 7 years. Reserved service input quantity, on the other hand, has declined over the last 13 years with a trend growth rate of –1.1 per cent per annum. Reserved service TFP grew by a trend rate of 1.7 per cent per annum over the 13 year period from 1997 to 2009. TFP trend growth in the 6 years to 2002 was somewhat higher at 3.1 per cent per annum. This strong TFP performance then reduces to a trend growth rate of 0.8 per cent per annum for the last seven years due to virtually unchanged output levels. However, reserved service TFP fell markedly in 2009 and is forecast to fall further with a growth rate of –1.3 per cent per annum forecast over the next three years as output continues to fall.

Both Australia Post TFP indexes have outperformed the market sector MFP index over both the last 13 years and the last 7 years. Given that Australia Post's reserved service output was essentially flat between 2001 and 2008, being able to outperform the productivity performance of the economy as a whole has been an impressive achievement. However, the recent and forecast continuing fall in demand for letters may make this difficult to achieve going forward.

APPENDIX A: THE FISHER IDEAL TFP INDEX

Mathematically, the Fisher ideal output index is given by:

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

where:

- Q_F^t is the Fisher ideal output index for observation t;
- P_i^B is the price of the ith output for the base observation;
- Y_i^t is the quantity of the ith output for observation t;
- P_i^t is the price of the ith output for observation t; and,
- Y_j^B is the quantity of the jth output for the base observation.

Similarly, the Fisher ideal input index is given by:

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

where:

- I_F^t is the Fisher ideal input index for observation t;
- W_i^B is the price of the ith input for the base observation;
- X_i^t is the quantity of the ith input for observation t;
- W_i^t is the price of the ith input for observation t; and,
- X_j^B is the quantity of the jth input for the base observation.

The Fisher ideal TFP index is then given by:

$$(3) \quad TFP_F^t = Q_F^t / I_F^t.$$

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:

$$(4) \quad Q_F^{1,t} = 1 \times Q_F^{1,2} \times Q_F^{2,3} \times \dots \times Q_F^{t-1,t}.$$

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