International Benchmarking of Postal Service Productivity

Report prepared for
Australia Post

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EXECUTIVE SUMMARY

This report benchmarks the productivity performance of postal services in seven countries – Australia, Canada, Denmark, Italy, Japan, New Zealand and the United States – using the total factor productivity (TFP) measure and partial productivity measures for four inputs. TFP measures the production of all outputs produced relative to all inputs used by each postal service. The TFP method used allows consistent comparisons of productivity levels and growth rates across postal services and over time.

The study has been sponsored by Australia Post and is based on confidential data collected by Economic Insights from each of the participating postal services. A condition of participation by the postal services was that data and results for each service remain confidential. To maintain this confidentiality each participating postal service is receiving a report that identifies its own performance only relative to the other services which are labelled as A, B, C, etc. This report presents the results for Australia Post.

The data used in this study were primarily provided by each of the postal services and supplemented by publicly available information on price deflators and other variables needed to form a price for capital services. Some adjustments were made to the data supplied to remove anomalies and enable more like–with–like comparisons of activities.

The data span the years 2002 to 2009 but some postal services were only able to provide data for part of this period.

The measure of output comprises three broad categories: letters; parcels; and other output. Four broad input categories were included: labour; other operating expenditure; land and buildings combined; and plant, equipment, software and other capital combined.

Like other network industries, postal service productivity performance will be influenced by the operating environment conditions that each service faces, many of which will be beyond the control of management. To allow meaningful comparisons of performance, it is necessary to adjust for the most important operating environment conditions to put the services on a relatively even footing.

For postal services two of the most important operating environment differences are mail density (mail items per delivery point) and customer density (delivery points per kilometre of route length). Those services that have high mail density (ie a relatively large number of items delivered to each customer) and/or high customer density (ie a relatively large number of customers or delivery points per kilometre of route length) will be an advantage relative to those services with lower network densities. The TFP results were adjusted for mail density

and customer density differences for those countries that provided relevant data. Both unadjusted and adjusted results are presented.

For the unadjusted results, Australia Post ranked third in terms of TFP. It showed steady, consistent improvement over the sample period. Three other postal services showed a deterioration in TFP over the period, while the others showed some improvement but only one of these showed steady improvement.

Australia Post also ranked third in terms of labour productivity reflecting the importance of the labour in total costs for postal service operations. The labour productivity results of other countries also tended to broadly mirror their results for TFP.

Australia Post ranked sixth in terms of the productivity of other operating expenditure but in level terms this measure was very similar for Australia Post and four other postal services. There was little change in Australia Post's other operating expenditure productivity, while two other postal services showed noticeable improvement over the period reviewed.

Australia Post ranked third in terms of the productivity of land and buildings, however the productivity level was similar to the second and fourth ranked postal services for this productivity measure. There was also little change in Australia Post's land and buildings productivity over the period reviewed.

Australia Post ranked fifth in terms of the productivity of other capital which comprises plant and equipment, motor vehicles and computer software. There was also a small decline in other capital productivity for Australia Post over the period 2002 to 2009. Most of the postal services experienced a decline in the productivity of other capital in the latter part of the time period reviewed.

As the cost shares for capital are relatively low, the productivity levels for land and buildings and other capital had little impact on the TFP rankings. For example the postal service that received the highest ranking in terms of TFP was ranked sixth in terms of both land and buildings productivity and other capital productivity.

We now turn to the TFP results with adjustments for mail density and customer density effects. Density effects were adjusted for by using a technique known as two stage regression analysis. In the first stage productivity indexes are calculated as described above. In the second stage of the analysis, these indexes are regressed against relevant variables that take account of key operating environment conditions – in this case mail density and customer density. The coefficients from the regression are then used to adjust for the differences in business environment variables and their impact on the productivity measure. This produces an adjusted TFP index that is based on all participants having the same mail density and customer density.

Five services provided data that enabled adjustment for mail density only and four services provided data that enabled adjustment for both mail density and customer density. The density effects were found to be highly statistically significant and important in terms of their impacts on the relative rankings.

When the TFP estimates were adjusted for mail density, Australia Post improved its relative position from third to second. The service with the highest TFP score also had a relatively high mail density figure and the other four services had below average mail density figures. This meant that all services with below average mail density improved their TFP scores while the service with the above average mail density figure experienced a decline in its TFP score as a result of the mail density adjustment.

Figure A: **TFP adjusted for mail density and customer density, 2008 or latest year**
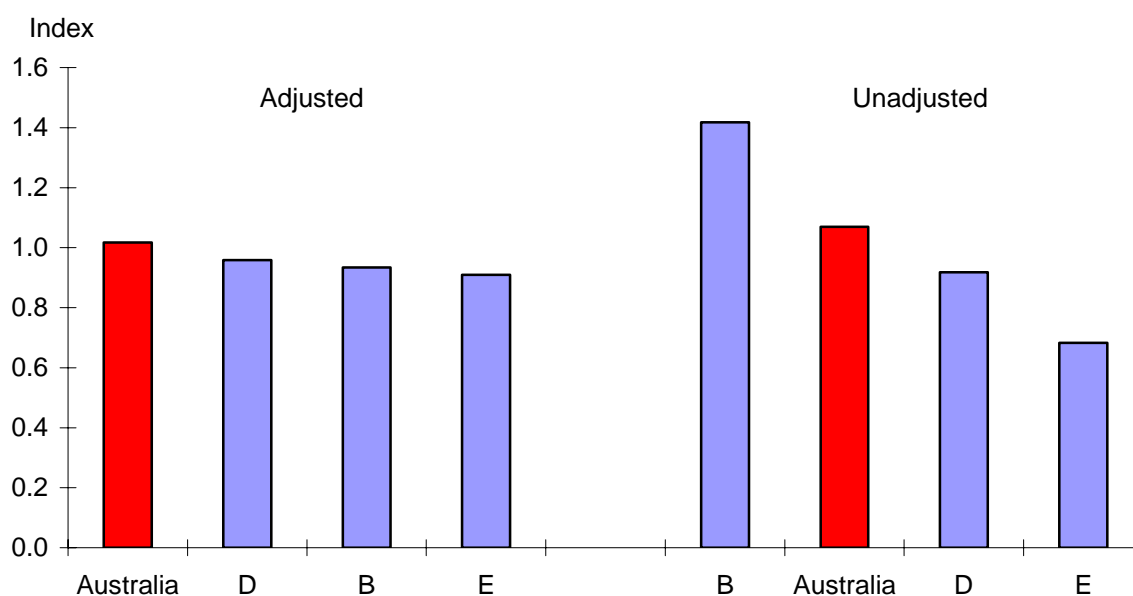
When the TFP estimates for the four postal services with relevant data were adjusted for both mail density and customer density (and also for customer density only), Australia Post improved its relative ranking amongst the four postal services from second to first (see figure A). In the smaller sample of four postal services, the customer density influence was more important than the mail density influence on TFP. The service with the highest TFP in the smaller sample of four postal services also had the highest customer density measure. As a result there was a significant impact on TFP for this service when the adjustment was undertaken for customer and mail density or customer density alone.

To conclude, Australia Post has shown the most consistent improvement in TFP of the seven postal services reviewed. Importantly, Australia Post improved its ranking when formal, statistically based adjustments were made for differences in mail and customer density with its TFP level being ranked either first or second after the adjustments were made.

1 INTRODUCTION

Australia Post has engaged Economic Insights Pty Ltd ('Economic Insights') to benchmark the productivity performance of postal services in seven countries – Australia, Canada, Denmark, Italy, Japan, New Zealand and the United States – using the total factor productivity (TFP) measure and partial productivity measures for four inputs. TFP measures the production of all outputs produced relative to all inputs used by each postal service. The TFP method used allows consistent comparisons of productivity levels and growth rates across postal services and over time.

The study is based on confidential data collected by Economic Insights from each of the participating postal services. A condition of participation by the postal services was that data and results for each service remain confidential. To maintain this confidentiality each participating postal service is receiving a report that identifies its own performance only relative to the other services which are labelled as A, B, C, etc. This report presents the results for Australia Post.

'Benchmarking' is the term given to measuring the performance of one entity relative to another. Benchmarking studies provide an important source of information on the performance of a business relative to its peers and the associated potential for further efficiency improvements. In this report, Economic Insights benchmarks the performance of the seven postal services based on TFP as well as measures of partial factor productivity (PFP) for four inputs: labour; other operating expenditure; land and buildings combined; and plant, equipment, software and other capital combined. The data generally span the years 2002 to 2009 although some postal services were only able to provide data for part of this period. The productivity measures have been constructed using an indexing method that allows consistent comparisons of productivity growth over time and of productivity levels across postal services.

Like other network industries, postal service productivity performance will be influenced by the operating environment conditions that each service faces, many of which will be beyond the control of management. To allow meaningful comparisons of performance, it is necessary to adjust for the most important operating environment conditions to put the services on a relatively even footing. For postal services two of the most important operating environment differences are mail density (mail items per delivery point) and customer density (delivery points per kilometre of route length). Those services that have high mail density (ie a relatively large number of items delivered to each customer) and/or high customer density (ie a relatively large number of customers or delivery points per kilometre of route length) will be an advantage relative to those services with lower network densities.

Other operating environment differences include the extent to which the postal service is a statutory monopoly for parts of its business; whether and to what extent the postal service is restricted in the types and quality of services it is mandated to deliver, or the types and quantities of inputs it uses or from expanding into other business services. Although these factors are recognised as potentially important, data availability limited the scope to make statistically validated adjustments for all these factors. However, some adjustments have been made for density factors for five of the countries that provided relevant data to support the adjustments.

The rest of this report is structured as follows. Section 2 outlines the benchmarking methodology that was used. Section 3 describes the data and key characteristics of the 7 postal services. Section 4 presents the results for TFP and for the four partial productivity measures without adjustments for business environment differences. Section 5 presents the TFP results after adjustments for mail density and customer density effects based on econometric methods have been made.

2 BENCHMARKING METHODOLOGY

2.1 Measuring productivity

Productivity is a measure of the quantity of output produced from the use of a given quantity of inputs. TFP measures total output quantity relative to the quantity of all inputs used while partial productivity measures the quantity of one or more outputs relative to one particular input quantity. Partial productivity measures that relate a specific output to a specific input are not a complete representation of overall efficiency and can be misleading when considered in isolation. It is possible, for example, to improve the partial productivity of one input (eg labour productivity) by investing in more capital but at the expense of capital productivity. TFP measures provide a more holistic measure of performance by looking at all outputs and all inputs combined. Productivity studies can be used to measure either TFP levels between organisations or TFP growth over time for a given organisation or industry.

To operationalise the TFP concept we use index number theory to combine changes in diverse outputs and inputs into measures of change in total outputs and total inputs relative to a base observation. Changes for individual outputs and inputs are weighted together using revenue shares and input cost shares, respectively.

Index number methods need to satisfy a number of basic statistical and economic consistency properties. When there are panel data (for a number of firms over a number of time periods) the index also needs to be constructed so that consistent comparisons can be made both over time and across firms so that comparisons of both productivity growth rates and productivity levels can be made. The methodology adopted in this study satisfies these properties.

TFP measures the productive or cost efficiency of a firm or industry. Productive efficiency combines technical efficiency (producing as much output as feasible given current engineering knowledge from a given quantity of inputs) and allocative efficiency (ensuring inputs are used in cost minimising combinations).

TFP indexes have a number of advantages compared to alternative techniques for measuring cost efficiency including:

- they provide a complete picture of how an entity is performing because they use comprehensive measures of outputs and inputs;

- indexing procedures are simple and robust;

- they can be implemented when there are only a small number of observations;

- the results are readily reproducible;

- they have a rigorous grounding in economic and statistical theory; and

- the procedure for estimating TFP imposes good disciplines regarding data consistency.

For benchmarking purposes where panel data are used, multilateral TFP indexing methods are required. These indexes allow the comparison of productivity levels across firms as well as productivity growth rates over time. Traditional measures of TFP (such as the Tornqvist index) have enabled comparisons to be made of rates of change of productivity between organisations but have not enabled comparisons to be made of differences in the absolute levels of productivity in either cross–section or combined time–series, cross–section data. This is due to the failure of conventional TFP measures to satisfy the important technical property of transitivity. This property states that direct comparisons between observations m and n should be the same as indirect comparisons of m and n via the intermediate observation k. In practical terms, this means that with cross–sectional data the same relative result between two firms should be obtained regardless of the ordering of the data or the path used to make the comparisons.

Caves, Christensen and Diewert (1982) developed the multilateral translog TFP (MTFP) index measure to allow comparisons of the absolute levels as well as growth rates of productivity. It satisfies the technical properties of transitivity and characteristicity which are required to accurately compare TFP levels for panel data. Lawrence, Swan and Zeitsch (1991) and the Bureau of Industry Economics (BIE 1996) used this index to compare the productivity levels and growth rates of the five major Australian state electricity systems and the United States investor–owned electricity system. The Australian component of these studies was updated by Lawrence (2002b). Zeitsch and Lawrence (1996) used the method to compare the efficiency of coal–fired electricity generation plants in the United States, Canada and Australia. Lawrence (2003) applied the method to derive X factors for New Zealand's electricity lines businesses. Swan Consultants (1992a,b) used the method to compare the total factor productivity of Australia Post and New Zealand Post and Australia Post and the United States Postal System, respectively. This study builds on those approaches using more recent and more comprehensive data covering seven postal services.

The Caves, Christensen and Diewert multilateral TFP index used in this study is given by:

$$
\begin{aligned}
(1) \quad \log (TFP_m/TFP_n) = {} & \sum_i (R_{im}+R_i^{\,*})\,(\log Y_{im} - \log Y_i^{\,*})/2 - \\
& \sum_i (R_{in}+R_i^{\,*})\,(\log Y_{in} - \log Y_i^{\,*})/2 - \\
& \sum_j (S_{jm}+S_j^{\,*})\,(\log X_{jm} - \log X_j^{\,*})/2 + \\
& \sum_j (S_{jn}+S_j^{\,*})\,(\log X_{jn} - \log X_j^{\,*})/2
\end{aligned}
$$

where *m* and *n* are two observations in the sample, Y_i are output quantities, X_j are input quantities, R_{im} is the revenue share of output *i* for observation *m*, S_{jm} is the cost share of input *j* for observation *m*, R_i^* (S_j^*) is the revenue (cost) share averaged over all businesses and time periods and $logY_i^*$ ($log\ X_j^*$) is the average of the log of output *i* (input *j*). Using equation (1), comparisons between any two observations *m* and *n* will be both base–business and base–year independent. Transitivity is satisfied since comparisons between the businesses A and B will be the same regardless of whether they are compared directly or via, say, business C. An alternative interpretation of this index is that it compares each observation to a hypothetical business with output vector $logY_i^*$, input vector $log\ X_j^*$, revenue shares R_i^* and cost shares S_j^*, ie the geometric mean of the sample.

Like any quantitative method, TFP indexes have limitations as well as advantages. These include the fact that they are a non–parametric technique and, hence, cannot produce confidence intervals and other statistical information.

2.2 Measuring outputs and inputs

To measure productivity performance, data are required on the price and quantity of each output and input and ideally on key operating environment conditions. Quantity data are required because productivity is essentially a weighted average of the change in output quantities divided by a weighted average of the change in input quantities. Although the weights are complex and vary depending on the technique used, they are derived from the share of each output in total revenue and the share of each input in total costs. To derive the revenue and cost shares, information on the value of each output and input is required, ie its price times its quantity. Hence, either the price and quantity of each output and input or, alternatively, their values and quantities, or their values and prices are required.

The quantity data are the primary drivers of productivity results while the value or price data are secondary drivers in that they are used to determine the weights for aggregation. Quantity information can be obtained either directly or indirectly. Direct quantity data are physical measures of a particular output or input, eg numbers of letters or parcels or full–time equivalent employees. Indirect quantity data are obtained by deflating the revenue or cost of a particular output or input by an average price or a price index, eg other services revenue could be deflated by an appropriate service price index or other operating expenditure could be deflated by an appropriate cost index. Price and cost indexes should ideally reflect the change in unit prices for the revenue and cost components that are deflated. The deflated revenue and cost components are simply expressed in constant price terms based on a benchmark year.

There are arguments in favour of both direct and indirect methods for measuring quantities. Some argue that the indirect method allows greater differences in the quality of outputs or inputs to be captured and for a greater range of items to be captured within the one measure. However, the indirect method places more onus on having both the value and the price data completely accurate. Since price data are generally harder to match to the specific circumstances of a particular firm, there is more scope for error with the indirect method. Hence, it is a good policy to rely on direct quantity data wherever possible and to only use indirect quantity data in those cases where the category is too diverse to be accurately represented by a single quantity (eg materials and services inputs).

In benchmarking the productivity of firms relative to other firms, it is important to take account of major operating environment differences over which firms have no control. Some differences in the operating environment can be taken account of in TFP measures by defining additional outputs or inputs but this approach requires additional data that are often not readily available as well as agreement on how to best incorporate the relevant factors into output and input measures. In some cases it may not be clear as to how operating environment factors should be represented in output and input measures and economies of scale and scope variables cannot be taken account of with this approach. An alternative approach, which is used in this report, is to use econometric methods to identify the extent to which a specific operating environment variable influences the measure of productivity.

Some of the postal services in this study have important non-postal businesses, in particular banking services. Data limitations made it difficult to separate out banking services from the total business services of one service, particularly on the cost side. The outputs and inputs relate to the total postal business for 6 postal services and the total business, including banking for the other postal service.

2.3   The output quantity and revenue share measures

Outputs were aggregated into three broad categories:

- letters;

- parcels and packets; and

- other.

The outputs of letters, parcels and packets were measured by the respective numbers of items while the other output category was measured in constant prices using the national consumer price index (CPI) as the deflator. The constant price measure of output in national currency was converted to US dollars by using the GDP purchasing power parity (PPP) exchange rate estimated by the OECD (2008). Purchasing power parities are the rates of currency

conversion that eliminate differences in international price levels and are commonly used to make comparisons of real variables between countries. Volume indices based on PPP converted data reflect only differences in the volume of goods and services produced and remove influences such as speculative effects that may be present in ordinary exchange rates.

Revenues were provided by the postal services for each category and used to form revenue shares which did not need adjustment to a common currency (since they are used in ratio form only).

2.4   The input quantity and cost share measures

Inputs were aggregated into four categories:

- labour;

- other operating expenditure;

- land and buildings capital;

- plant, equipment, motor vehicles, software and other capital.

Input quantities for labour were measured in terms of the number of full time equivalent employees. Input quantities for other operating expenditure were measured in terms of national currency constant prices using the CPI deflator. The constant dollar measure of other operating expenditure in national currency terms was converted to US dollars by using a GDP purchasing power parity exchange rate estimated by the OECD (2008).

The national currency costs of labour and other operating expenditure were combined with the estimates of the national currency costs of capital (explained below) to form cost shares which did not need adjustment to a common currency.

Capital inputs are different from other inputs in that they are not all used in the year in which they are purchased but instead provide a flow of services over their useful lifetime. This implies a need to measure the time profile of the capital stock with adjustments for depreciation, disposals and new investment and a measure of the flow of services provided by the capital stock. In this case the flow of the quantity of capital services was assumed to be proportional to the measure of the constant price capital stock which was estimated using the perpetual inventory formula:

(2) $K_{jt} = S_{jt-1}(1-d_j) + I_{jt} - R_{jt}$

Where

K_{jt} = capital stock of type j in period t;

d_j = depreciation rate for capital of type j;

I_{jt} = gross investment of capital of type j in period t;

R_{jt} = gross retirement of capital of type j in period t.

Capital stock estimates were calculated in constant price local currency terms in 2003 units using the most representative investment deflator for each country. A base period estimate of the capital stock was calculated for 2003 and then investment in nominal terms was converted to real terms so the capital stock for each year was in 2003 local currency terms.

The annual price of capital services input is measured by the user price of capital (also known as the rental price of capital services). The user price of capital services was estimated using the following formula:

(3) $P^r_{jt} = P^i_{jt} (r_{jt} + d_j - capital\ gains_{jt})$

where:

P^r_{jt} =user price of capital of type j in period t;

P^i_{jt} =price of investment of capital of type j in period t;

r_{jt} = opportunity cost (expected return) of capital of type j in period t;

d_j = depreciation rate for capital of type j;

capital gains$_{jt}$ = capital gains (or losses if negative) of capital of type j in period t.

P^i_{jt} was taken to be the most representative investment deflator available. r_{jt} was the nominal long term bond rate in each country plus a common risk premium of 6 percentage points. d_j was 0 for land, 0.06 for buildings, 0.14 for motor vehicles, 0.28 for software and 0.15 for plant, equipment and other capital. Capital gains were assumed to be equal to the percentage changes in the CPI so that the opportunity cost of capital was effectively a real opportunity cost of capital measure.

The user price of capital services was multiplied by the volume of capital measure to obtain the total annual cost of capital services input which was combined with other cost data to form a total cost measure from which relevant input cost shares were derived.

Starting point capital estimates were the initial period asset values provided by each postal service. These were combined with the investment and retirements data in constant local currency terms using the perpetual inventory formula in (2) above. Where investment data were not provided for capital (other than land), investment estimates were imputed using the perpetual inventory method applied to reported book depreciated asset values. Where investment data were not provided for land the historic cost book values of land were used.

Some countries provided data at a more disaggregated level with, for example, separate asset values and investment data for land, buildings, plant, equipment, software, motor vehicles and other. Where disaggregated information was provided, separate estimates of the capital stocks in volume terms and user costs in local currency terms were made at the disaggregated level and then aggregated to the two categories used in the TFP calculation.

The constant dollar measures of the capital stock were converted to US dollars by using the OECD's construction and machinery and equipment purchasing power parity exchange rates. The TFP estimates were not sensitive to whether the GDP or construction and machinery and equipment PPP exchange rates were used to form the common currency capital stocks.

2.5   Adjusting for business environment differences

There are likely to be significant economies of scale and scope in the delivery of postal services. Two important sources of these economies relate to mail density and customer density. Mail density is defined as the number of units of mail per delivery point and customer density is defined as the number of delivery points per kilometre of route length. Postal systems with higher mail density and higher customer density are likely to have higher TFP levels than postal systems with lower density on these measures. This is because the postal services with higher densities can deliver a given amount of mail using less input than postal services with low network densities.

Five postal services provided data that enabled the construction of a mail density variable and four postal services provided data that enabled the construction of a customer density variable. The econometric technique known as two stage regression analysis was used to investigate the relationship between TFP and mail density and customer density. An overview of the technique is presented below and the results are presented in more detail in section 5.

The sample size for testing the significance of both the customer density variable and the mail density variable was limited to 10 observations covering 4 postal systems. However, the sample size for testing the significance of the mail density variable alone was 27 observations covering 5 postal systems. Despite the limited sample sizes, the density variables were found to be statistically significant and important in terms of their impact on the relative rankings of the TFP scores. Customer density was found to be more important than mail density in terms of its impact on TFP rankings.

The limited number of observations precluded the exploration of a cost function approach to estimating the impact of other operating environment influences.

2.6   Overview of the two stage regression technique

Two stage regression analysis has the advantage of combining the strengths of both the standard index number based approach to calculating productivity and the econometric cost function approach to adjusting for operating environment effects. In the first stage, the standard total or partial factor productivity index is calculated and then in the second stage the index is regressed against a range of operating environment variables. The main advantage of second stage regression analysis of productivity scores over the cost function approach is that it has the potential to adjust measured efficiency for a greater number of operating environment factors.

Coelli, Rao and Battese (1998, p.170) describe the second stage process in the following terms:

> 'In the second stage, the efficiency scores from the first stage are regressed upon the environmental variables. The sign of the coefficients of the environmental variables indicate the direction of the influence, and standard hypothesis tests can be used to assess the strength of the relationship. The second–stage regression can be used to "correct" the efficiency scores for environmental factors by using the estimated regression coefficients to adjust all efficiency scores to correspond to a common level of environment (e.g. the sample means).'

Either ordinary least squares (OLS) or Tobit regression methods can be used in the second stage analysis. Tobit analysis is a statistical technique that is used when it is known that the values the dependent variable can take must lie within a particular range or above some particular value. In the current case, for example, the calculated TFP estimates can never be negative. If the predicted dependent variables from OLS are positive (which they were) then the estimates will coincide with those from Tobit analysis, as there are no binding constraints on the estimation process. If, however, OLS regressions produce negative predicted values then it would be necessary to move to Tobit analysis.

Coelli, Rao and Battese (1998, p.171) assessed the alternative approaches available for adjusting for operating environment differences and concluded the following:

> 'We have considered a number of possible approaches to the consideration of environmental variables. We recommend the two–stage approach in most cases. It has the advantages that:
>
> * it can accommodate more than one variable;
>
> * it can accommodate both continuous and categorical variables;

- it does not make prior assumptions regarding the direction of the influence of the categorical variable;

- one can conduct hypothesis tests to see if the variables have a significant influence upon efficiencies;

- it is easy to calculate; and

- the method is simple and therefore transparent.'

3   DATA

3.1   Overview of data and sources

Spreadsheet questionnaire

Each of the postal services was provided with a questionnaire spreadsheet specifying the desired data format and a set of instructions aimed at ensuring data being provided using common definitions and coverage. Data were requested for the period 1997–2009 and at both the whole of business and reserved services levels. However, only two postal services were able to provide a complete data set for this period and for both the whole of business and reserves services levels. As a result, the benchmarking had to be undertaken at the whole of business postal services level and, for one postal service, the whole of business including banking services level.

For those postal services where banking or business activities other than postal activities were a major part of the business, requests were made for information to allow the benchmarking to focus on the postal business activities alone. Two of the postal services had significant banking activities. One provided the information required to disaggregate the postal and banking activities but the other could not provide this information and so for this postal service the results relate to the whole of business including both postal activities and banking activities.

The data were reviewed to identify apparent anomalies and extensive follow up questions were sent to each postal service seeking clarification. As a result of this process, some adjustments were made to the data to address anomalies as described further below.

The data generally span the years 2002 to 2009 although some postal services were only able to provide data for part of this period.

Outputs

On the output side data were requested in considerable detail for: seven letter types, five parcel types, three express mail types, four types of international outwards mail and four types of international inwards mail in volume terms. Revenues were requested for each of these categories as well as for three types of merchandise, four types of agency services and several types of other services. Price indexes were also requested for the categories where there were no volume quantity measures. Data were also requested on the number of delivery points, service area and length of postal routes.

Only a few postal services were able to provide the requested data at the desired specified level of disaggregation and some were unable to provide any data on delivery points, service

area or length of postal routes. As a result, in order to obtain results for all services, the benchmarking had to be undertaken for three output categories, namely: letters; parcels and packets; and other outputs. In most cases a constant price measure of other output was formed by using the all groups consumer price index or nearest equivalent. In some cases the number of years covered was restricted as a result of major accounting changes or structural changes in the postal service.

In some countries unaddressed or saturation-advertising type mail was a major category while in others it was minimal. These differences mainly resulted from differences in institutional arrangements with this type of mail being delivered by competitor organisations in some countries but with competition for this type of mail being restricted to varying degrees in other countries. Given the broad range of treatment of this type of mail and its potential to distort output measures, in undertaking benchmarking across the postal services, an adjustment was made to outputs, revenues and costs to remove unaddressed or saturation-type mail to allow more like–with–like comparisons.

Six services provided data on unaddressed or saturation-type mail and adjustments were made for these services to remove the impact of this mail on both outputs and inputs. Five of these services provided both revenue and volume data while one only provided revenue data for unaddressed or saturation-type mail – a unit price assumption was made for this latter service based on information provided by a similar service. The adjustment for this type of mail on the output side was the removal of relevant revenues and volumes from the respective totals for letters. The adjustment on the input side was to adjust labour costs and volumes on a proportional basis as described below.

In some cases where disaggregated data were limited, express, registered, international and other mail were allocated to letters and parcels on a pro-rata basis. Where possible, adjustments were made to other revenue to remove the impact of abnormal items such as gains on sale.

Given the limited information available on the operating environment variables it was not possible to make any adjustment for operating environment influences for two of the postal services. However, five postal services provided information to allow adjustment for mail density (mail per delivery point) and four postal services provided information to allow adjustment for both mail density and customer density (delivery points per kilometre of route length). The impacts of the adjustments on the TFP rankings are presented in Section 5.

Inputs

The adjustment to costs to take account of the removal of unaddressed or saturation-advertising type mail was to make a proportional adjustment to full time employees and to

the wage bill based on the unaddressed revenue as a proportion of the wage bill. Unaddressed mail was assumed to mainly affect labour costs in reality and there was insufficient information available to apportion other cost components.

The main data anomalies related to a few abnormal items on the input side. In one case a pension adjustment that had been removed was added back but amortized over the full data period. In another case large asset reclassifications that occurred in a particular year were reclassified and disaggregation undertaken to maintain consistency.

For one postal service full time equivalent employees had to be estimated based on conversion factors obtained from what was considered to be the most similar postal service.

Only a few postal services provided specific, relevant information on capital goods price indexes. Where suitable land and capital goods price indexes had not been provided, relevant indexes at the most suitable disaggregated level were obtained from national government statistics agency websites.

The components of the user cost of capital formula were described above in Section 2.4. Long term bond rates were obtained from the OECD Statistical Extracts Main Economic Indicators database. Purchasing Power Parities were obtained from the OECD.Stat database.

3.2 Postal service characteristics

Table 1: **Postal service basic characteristics, 2007**

Country	Australia	Canada	Denmark	Italy	Japan	New Zealand	United States
Domestic mail and parcel volume (millions)	5,493	11,498	3,232	6,620	24,602	n/a	211,401
Number of delivery points (millions)	10.5	14.5	n/a	n/a	n/a	n/a	148.0
Labour expenses/ operation expenses (per cent)	98	65	61	40	13	n/a	92
Operating expenses/revenue (per cent)	83	98	100	86	93	92	107
Full time and part time employees (number)	32,256	72,494	21,163[1]	149,999[1]	254,177[1]	n/a	684,762

[1] Full time equivalent numbers
Source: International Post Corporation Statistical Database

A summary of the basic characteristics of the seven postal services is provided in Table 1 which is based on publicly available information. The main features of note are:

- the large size of the United States Postal Service compared to the other countries; and

- the high share of operating expenses and labour costs in total revenue which implies a low share of capital costs.

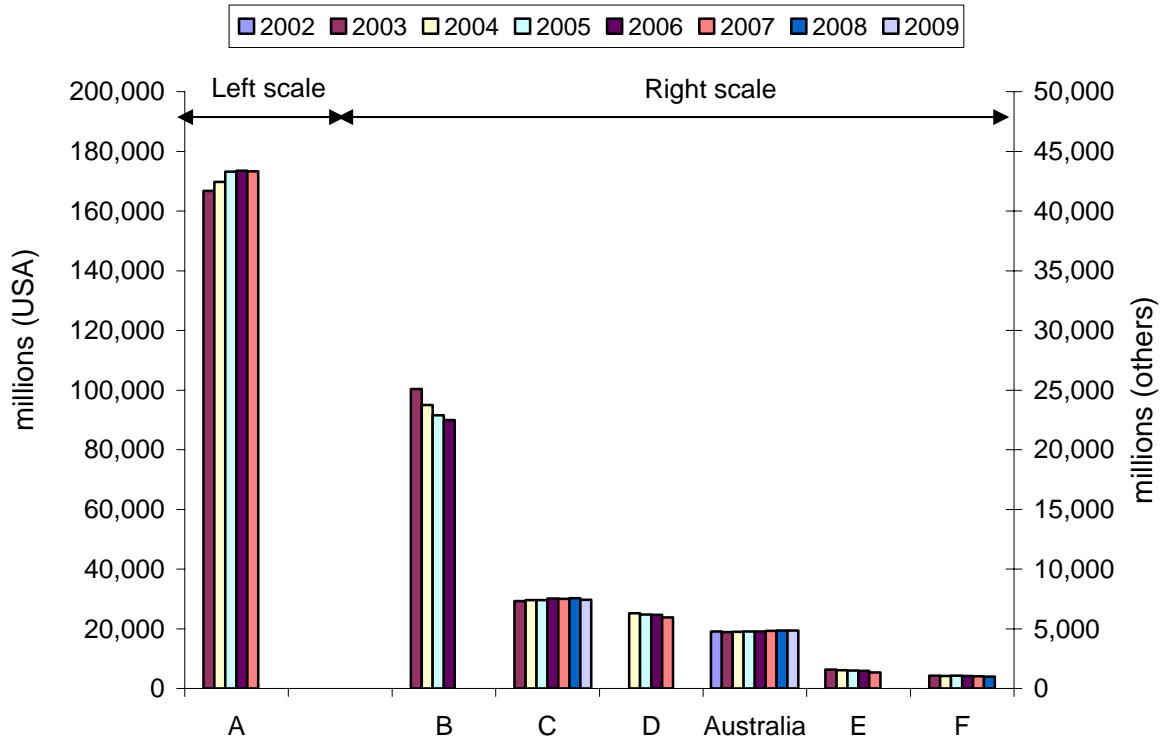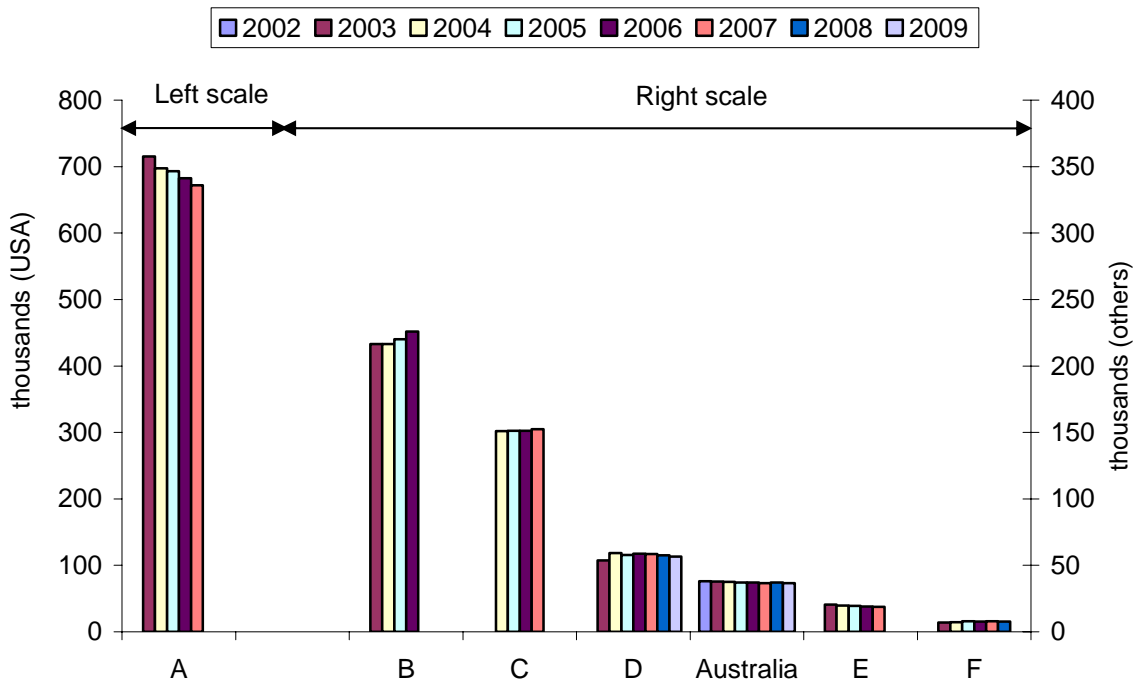Figure 1: **Addressed letters for 7 postal services, 2002 to 2009**

Figure 2: **Full time equivalent employees for 7 postal services, 2002 to 2009**

The relative sizes of the postal services are also highlighted in figures 1 and 2 which depict letters (less unaddressed and saturation-advertising type mail) and full time equivalent employees, respectively. Since this data comes from the confidential database, only Australia Post is identified. Note that for the first four figures the other countries are labelled from 'A' to 'F' according to the ranking in each graph. That is, postal service 'A' is not necessarily the same postal service across these four graphs.

Australia Post is the fifth largest of the seven postal services in terms of volume of addressed letters. It also has the fifth largest workforce in full–time equivalents although there is more dispersion of workforce size than for addressed letters.

Figure 3: **Mail density for 5 postal services**
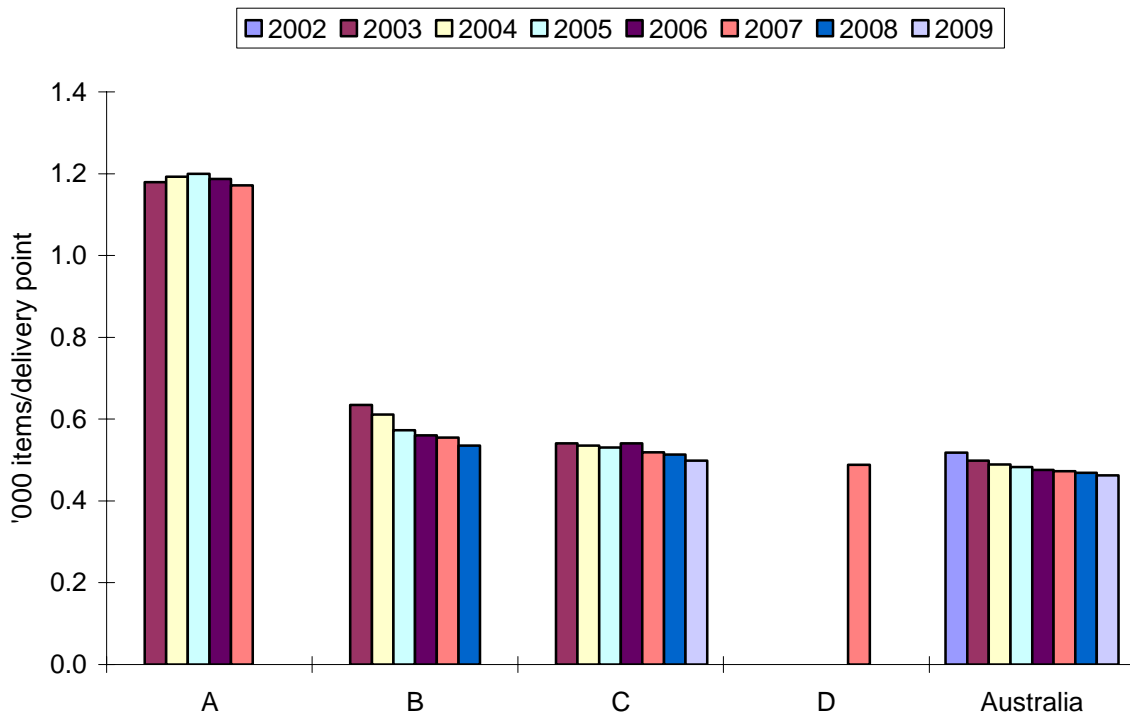
Data on mail density (letters per delivery point) and customer density (delivery points per kilometre of route length) are provided in figures 3 and 4, respectively.

Figure 3 shows that postal service 'A' has relatively high mail density while the mail densities for the other four postal services lie in a relatively narrow band. Australia Post has the lowest mail density of the included postal services. All else equal, this would tend to place Australia Post at a disadvantage in productivity comparisons as it will have to use more resources to deliver a given quantity of mail compared to its peers.

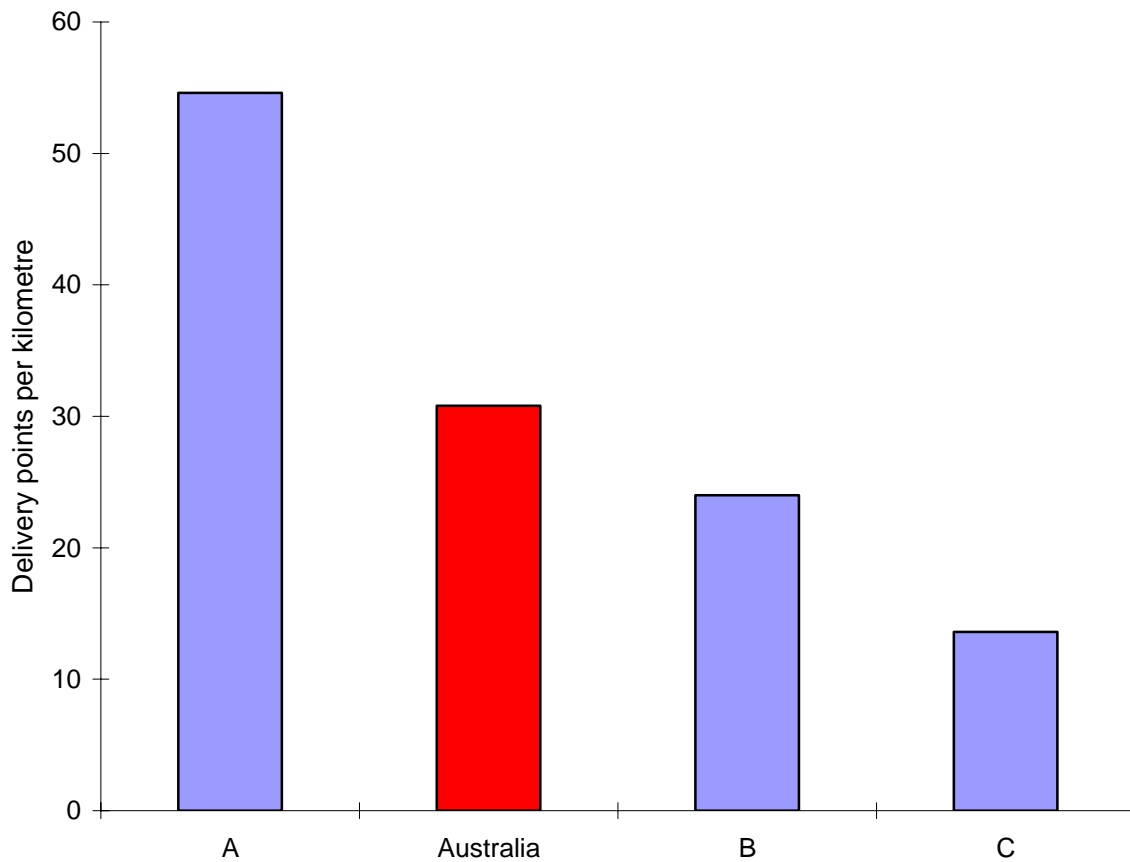Figure 4: **Customer density for 4 postal services, 2008 or latest year**

Figure 4 shows that Australia Post, based on the data supplied, has the second highest customer density of the four postal services where these data were available. However, it should be noted that Australia Post did not include route length associated with rural delivery by roadside mail contractors in the data supplied. If this length were included, Australia Post's customer density would be lower. Postal service 'A' has twice the customer density of that derived using Australia Post's supplied information.

We turn now to the results of the productivity benchmarking.

4 PRODUCTIVITY RESULTS

4.1 Total factor productivity

The total factor productivity measures, before adjusting for differences in mail and customer density are shown in figure 5. The relative rankings are ordered on the latest year that is common to all countries which is 2006. In subsequent figures each postal service retains the label it is given in figure 5.

Australia Post ranks third for all of the years in the sample but shows noticeable improvement in every year from 2002 to 2009. In contrast, postal service A which has the highest productivity level shows no improvement over the period for which data were available, ie 2003 to 2007. Postal service B, with the second highest productivity level, also shows improvement over the period 2003 to 2008, although the improvement is not as steady as for Australia Post. Postal service C also shows noticeable improvement over the period 2003 to 2006. Postal services D and E experienced some deterioration in total factor productivity over the periods for which data were available. There was only a small improvement for postal service F over the period 2004 to 2007.

Figure 5: **Total factor productivity for 7 postal services, 2002 to 2009**
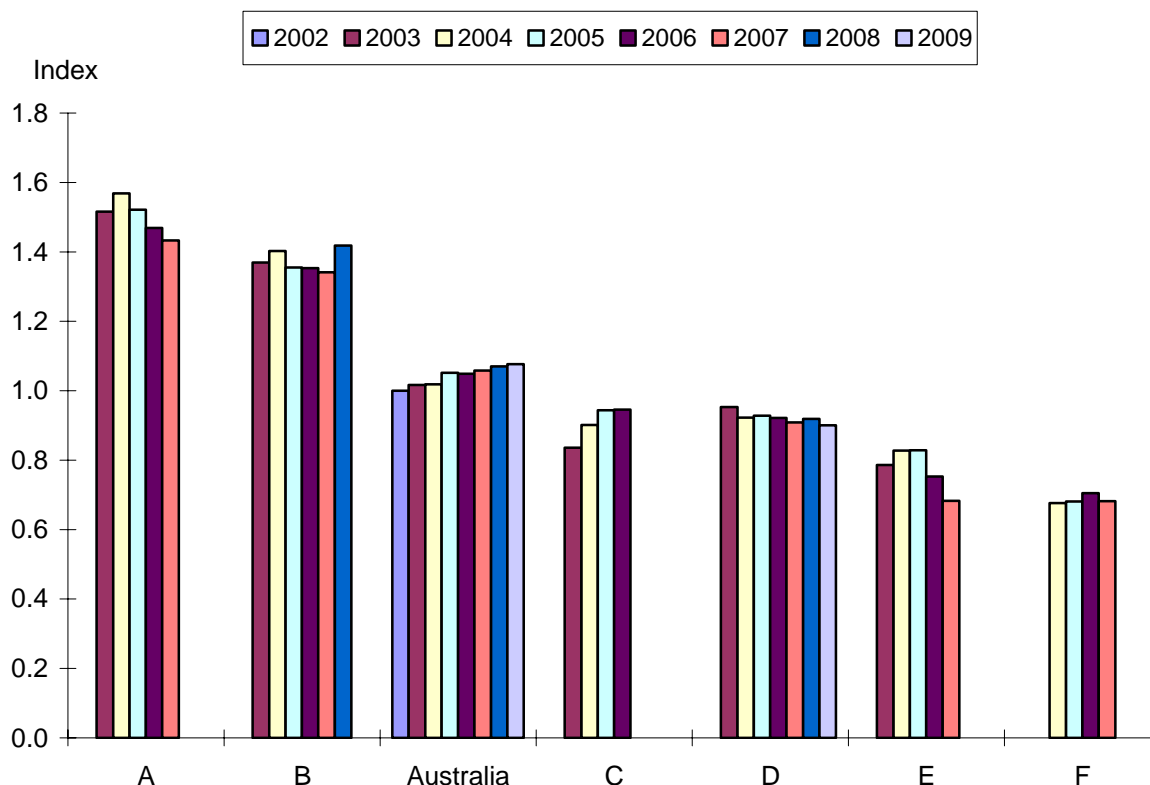
## 4.2   Partial factor productivity

Measures of the partial factor productivity of labour, other operating expenditure, land and buildings capital, and other capital are shown in figures 6 to 9. The term 'partial factor productivity' is used to distinguish it from 'total factor productivity'.

The relative rankings are ordered on the latest year that is common to all countries which is 2006. As noted, the labelling of postal services based on the TFP rankings is retained for the partial factor productivity rankings.

Labour productivity

Australia Post ranks third in terms of labour productivity (figure 6) but again shows steady improvement over time, mirroring the results for TFP which can be explained by the importance of labour in the total cost structure of postal services. The labour productivity results for other services also tend to broadly mirror the results for TFP. The main exceptions were that the postal service that was ranked first for TFP was ranked second for labour productivity and, conversely, the service that was ranked second for TFP was ranked first for labour productivity.

Figure 6: **Labour productivity for 7 postal services, 2002 to 2009**
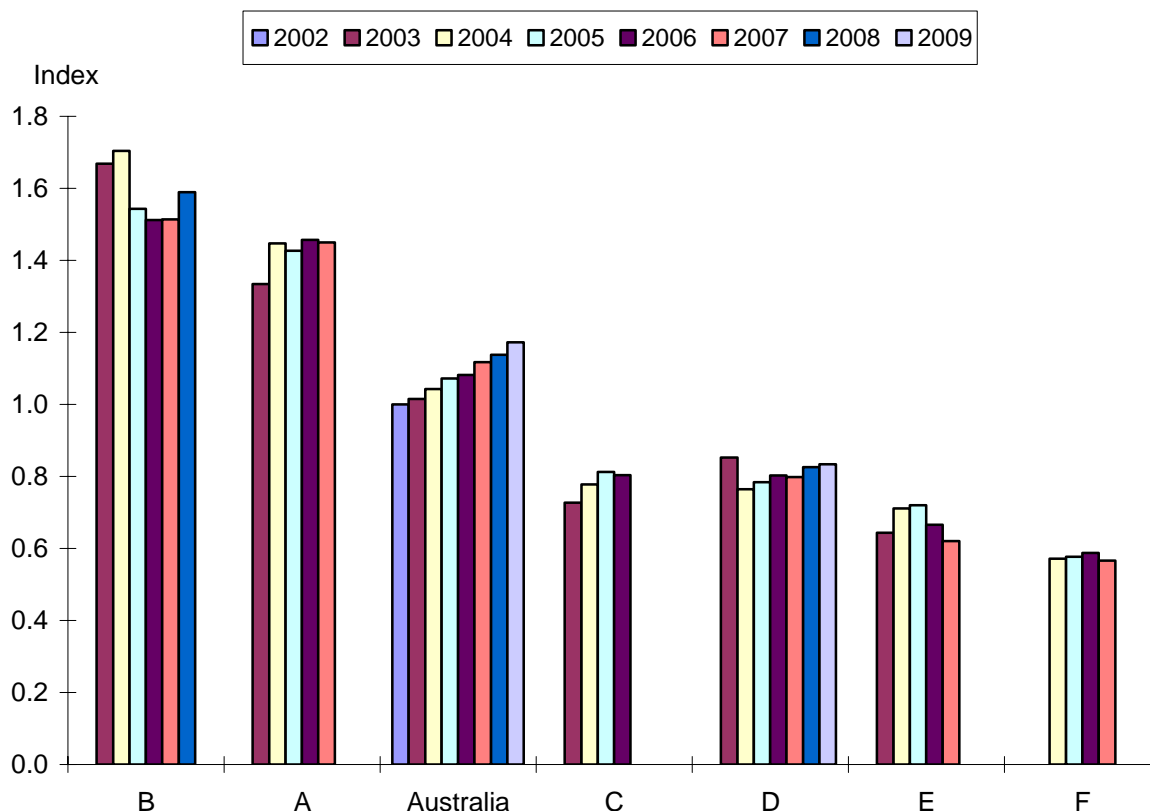
Other operating expenditure productivity

Australia Post is ranked sixth in terms of its other operating expenditure productivity but this measure of productivity is very similar in level terms for Australia Post and postal services B, D, E and F (figure 7).

Postal service A which has the highest TFP also has the highest productivity for other operating expenditure. However, there is a marked deterioration in this measure of productivity for this postal service over the sample period. In contrast, postal services C and B show improvement in the productivity of other operating expenditure over the sample period, while Australia Post's other operating expenditure productivity shows little change over the period 2002 to 2009.

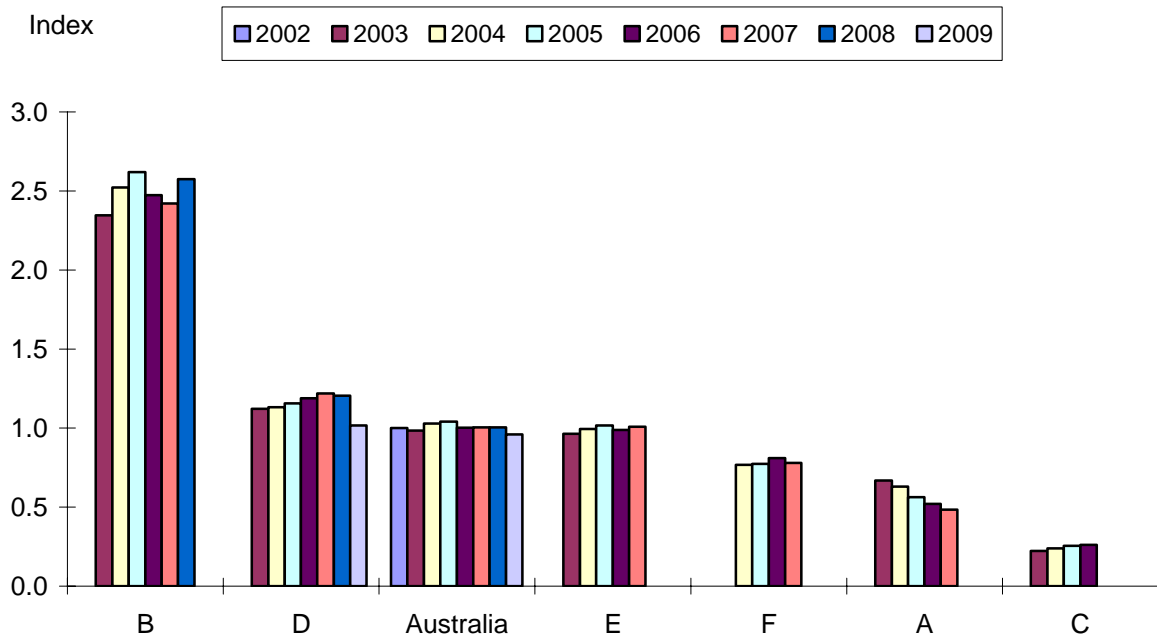Figure 7: **Other operating expenditure productivity for 7 postal services, 2002 to 2009**
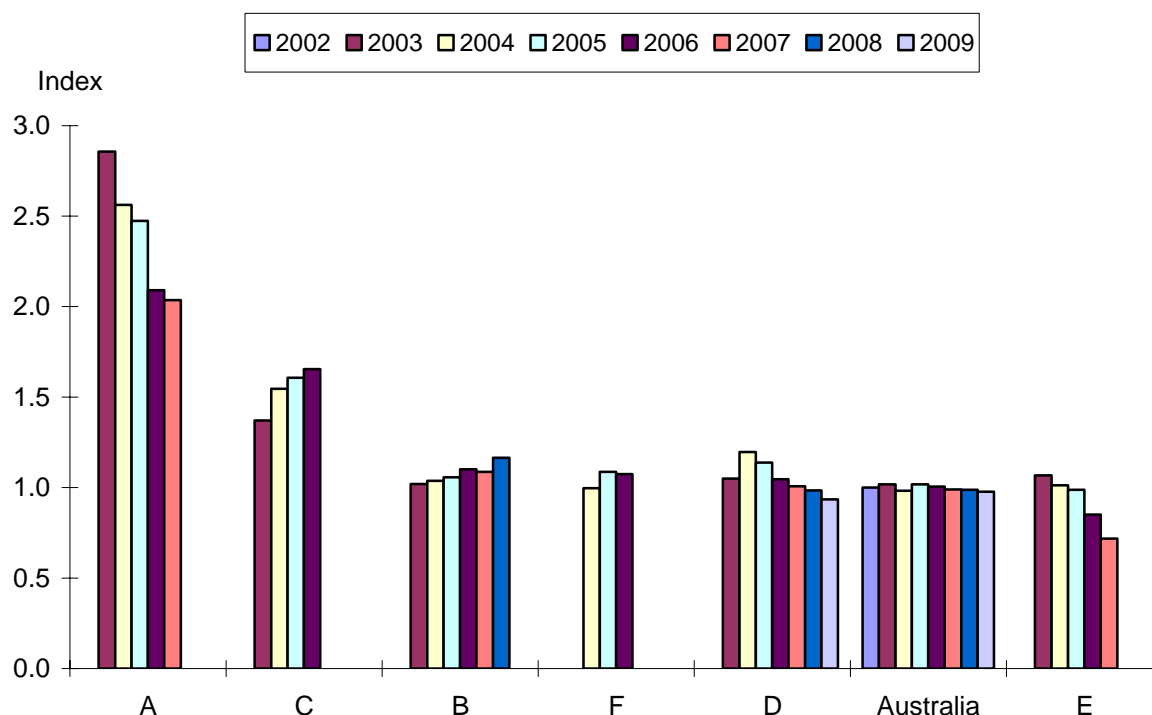
Land and buildings productivity

Australia Post is ranked third in terms of the productivity of land and buildings based on 2006 data (figure 8). However, the level measures are very similar to the second ranked postal service in 2009 and slightly less than for postal service E in 2007. There is little change in Australia Post's land and buildings productivity over the period 2002 to 2009.

Postal service A which was ranked first in terms of total factor productivity is ranked sixth in terms of land and buildings productivity and there is a marked deterioration in productivity of land and buildings for this postal service over the 2003 to 2007 period.

Figure 8: **Land and buildings productivity for 7 postal services, 2002 to 2009**

As the cost share of land and buildings is relatively small there is little impact of land and buildings productivity on TFP levels compared, for example, with the impact of labour productivity. This is demonstrated by the results for postal service A.

Other capital productivity

Figure 9: **Other capital productivity for 7 postal services, 2002 to 2009**
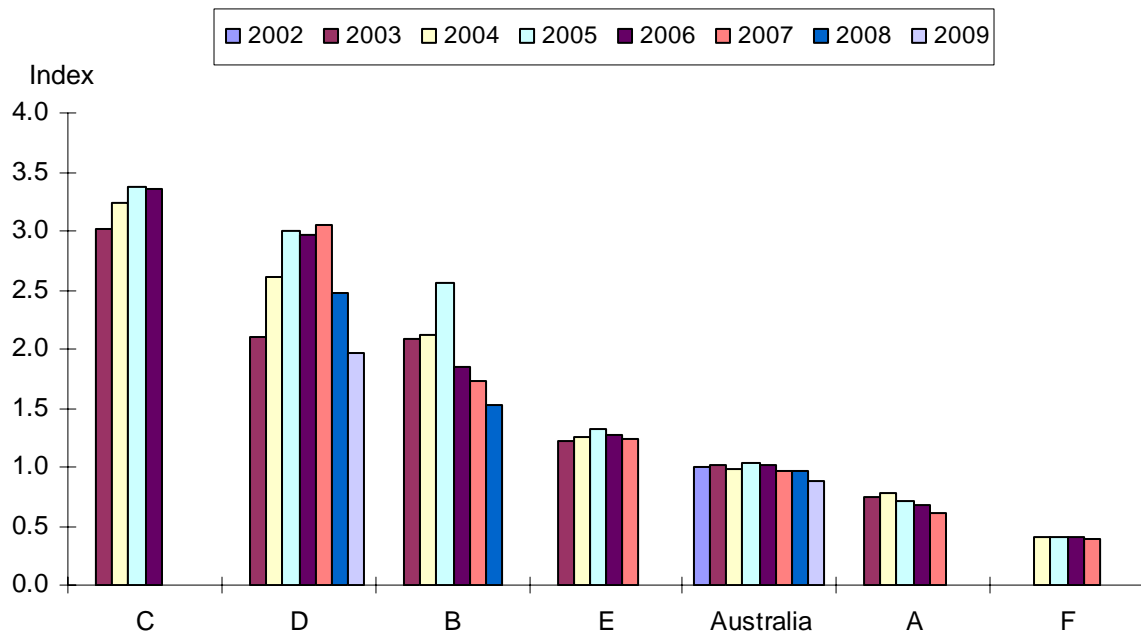
Australia Post is ranked fifth in terms of the productivity of other capital which comprises plant and equipment, motor vehicles and computer software (figure 9). There was also a small decline in other capital productivity for Australia Post over the period 2002 to 2009. Most of the postal services experienced a decline in the productivity of other capital in the latter part of the time period reviewed.

Postal service A which was ranked first in terms of TFP is ranked sixth in terms of other capital productivity, the same ranking it had for land and buildings productivity. However, again the impact on TFP levels is small because the other capital cost shares are relatively small.

Comparisons of raw TFP scores, while informative, do not convey an accurate picture of relative efficiency performance because they do not allow for operating environment differences beyond management control. We turn now to adjusting the TFP scores for the main operating environment factors.

5 ADJUSTING TFP FOR MAIL AND CUSTOMER DENSITY

The two stage regression analysis technique outlined in section 2 was used to determine the relationship between TFP and mail density and customer density, and to adjust for the influence of these density variables on TFP. The adjustments are described below.

5.1 Adjusting for mail density

Only 5 postal services provided data on the number of delivery points which was combined with the number of letters delivered to form the mail density variable (mail density = number of letters per delivery point). One of the services was only able to provide an estimate of the number of delivery points for a single year. This meant there were 27 observations of mail density.

A simple ordinary least squares linear relationship was preferred as follows:

$$(4) \quad \text{TFP}_i = \text{constant} + \alpha \times \text{mail density}_i + \text{error term}$$

Where

TFP_i = total factor productivity of postal service i;

α = estimated coefficient of the influence of mail density$_i$ on TFP_i ;

mail density$_i$ = number of letters per delivery point for postal service i;

error term = residual statistical error term in the regression.

The estimated equation was as follows:

$$(5) \quad \text{TFP}_i = 0.71182(8.0) + 0.68857(5.4) \times \text{mail density}_i$$

The t–statistics are shown in brackets and indicate a level of statistical significance at well under the 1 per cent. The adjusted R^2 was 0.52. A time trend was also initially included but was not statistically significant.

The estimated relationship in equation (5) confirms a positive and highly statistically significant relationship between TFP and mail density. Thus, postal systems with above average mail density could be expected to have above average productivity levels.

The coefficient on the mail density variable in equation (5) was used to adjust the TFP scores by adding the product of the coefficient and the difference between the mean mail density of the 27 observations and the actual mail density, as follows:

$$(6) \quad \text{Adjusted TFP}_i = \text{TFP}_i + 0.68857 \times (\text{mean mail density} - \text{mail density}_i).$$

Figure 10: **Total factor productivity for 5 postal services adjusted for mail density**
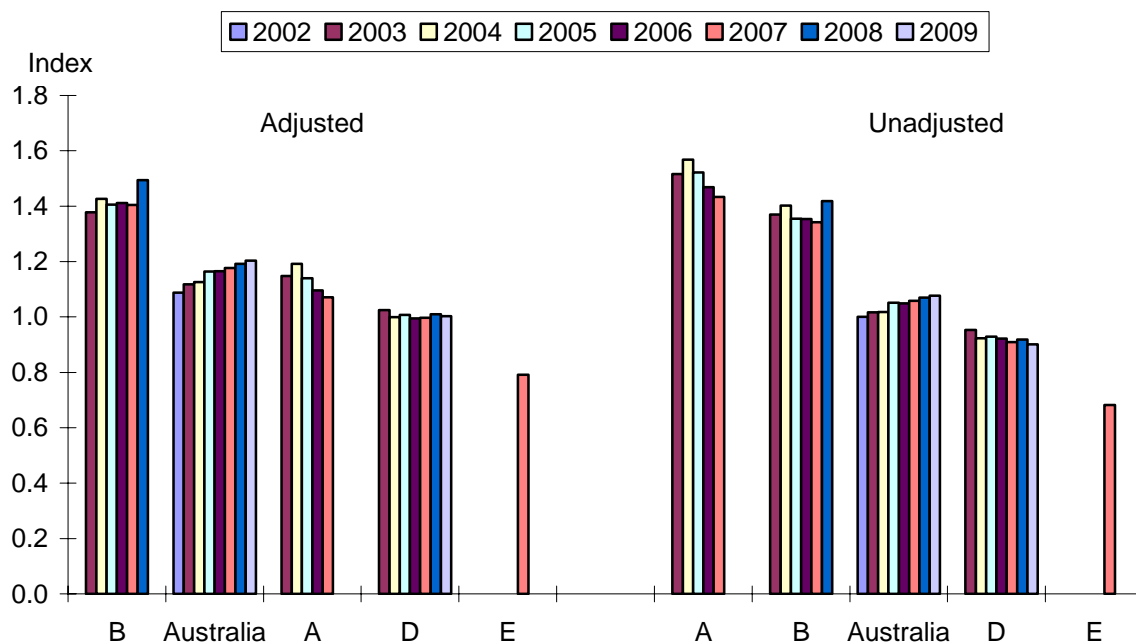
The adjusted TFP scores are presented in figure 10 along with the unadjusted scores. The country with the highest TFP score has a mail density figure higher than the average while the other countries have lower mail density figures than the average. Thus, when adjustment is made for mail density differences all but the one postal service with an above average mail density figure improve their relative TFP scores and the other postal service experiences a significant decline in its relative TFP score.

Australia improves its relative position from third to second when the adjustment is made to take account of mail density differences.

5.2   Adjusting for mail and customer density

Only four postal services provided data on average route length and in most cases this was not for every year. This meant there were only 10 observations of the customer density variable (customer density = delivery points per kilometre of route length).

A simple ordinary least squares linear relationship between TFP, mail density and customer density was preferred. The equations including both mail density and customer density and for customer density only are presented below.

The equation that included both mail density and customer density was as follows:

(7) $\text{TFP}_i = \text{constant} + \alpha \times \text{mail density}_i + \beta \times \text{customer density}_i + \text{error term}$

where:

TFP_i = total factor productivity of postal service i*;*

α = estimated coefficient of the influence of mail density$_i$ on TFP_i ;

mail density$_i$ = number of letters per delivery point for postal service i;

β = estimated coefficient of the influence of customer density on TFP_i ;

customer density $_i$ = number of delivery points per km of route for postal service i;

error term = residual statistical error term in the regression.

The estimated equation was as follows:

(8)　　$TFP_i = 0.26389(1.053) + 0.49902(1.0) \times$ mail density$_i$ +

$16.763(14.9) \times$ customer density$_i$

The *t*–statistics are shown in brackets. The mail density variable was not statistically significant at the standard 5 per cent level of significance but had the correct sign. A time trend initially included was also not statistically significant. The customer density variable was statistically significant at a level of statistical significance well under the 1 per cent level. The adjusted R^2 was 0.96.

The estimated equation without the mail density variable was:

(9)　　$TFP_i = 0.51634(16.5) + 16.974(15.3) \times$ customer density$_i$

The customer density variable was highly statistically significant and the adjusted R^2 was 0.96.

The estimated relationships in (8) and (9) confirm a positive and highly statistically significant relationship between TFP and customer density. Thus, postal systems with above average customer density could be expected to have above average productivity levels. Although it was not statistically significant with the smaller sample, mail density is still considered to be relevant as confirmed by its significance in the larger sample, which was examined in section 5.1. However, from the available evidence customer density appears to be the more important effect.

The coefficients on the mail density and customer density variables in equation (8) and from the customer density variable in equation (9) were used to adjust the TFP scores for the density influences.

The adjustment based on equation (8) was undertaken as follows:

(10)　　Adjusted $TFP_i = TFP_i + 0.49902 \times$ (mean mail density – mail density$_i$)

$+ 16.763 \times$ (mean customer density – customer density$_i$)

The adjustment based on equation (9) was undertaken as follows:

(13)   Adjusted $\text{TFP}_i = \text{TFP}_i + 16.974 \times$ (mean customer density - customer density $_i$)

The adjusted TFP scores are presented in figures 11 and 12 along with the unadjusted scores.

Figure 11: **TFP adjusted for mail and customer density, 2008 or latest year**
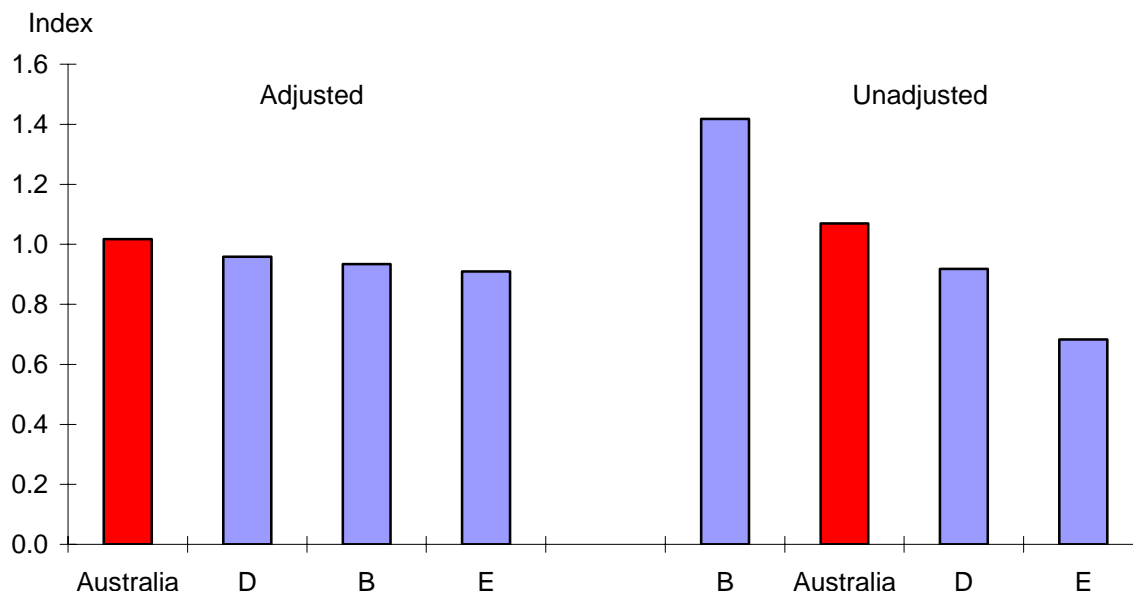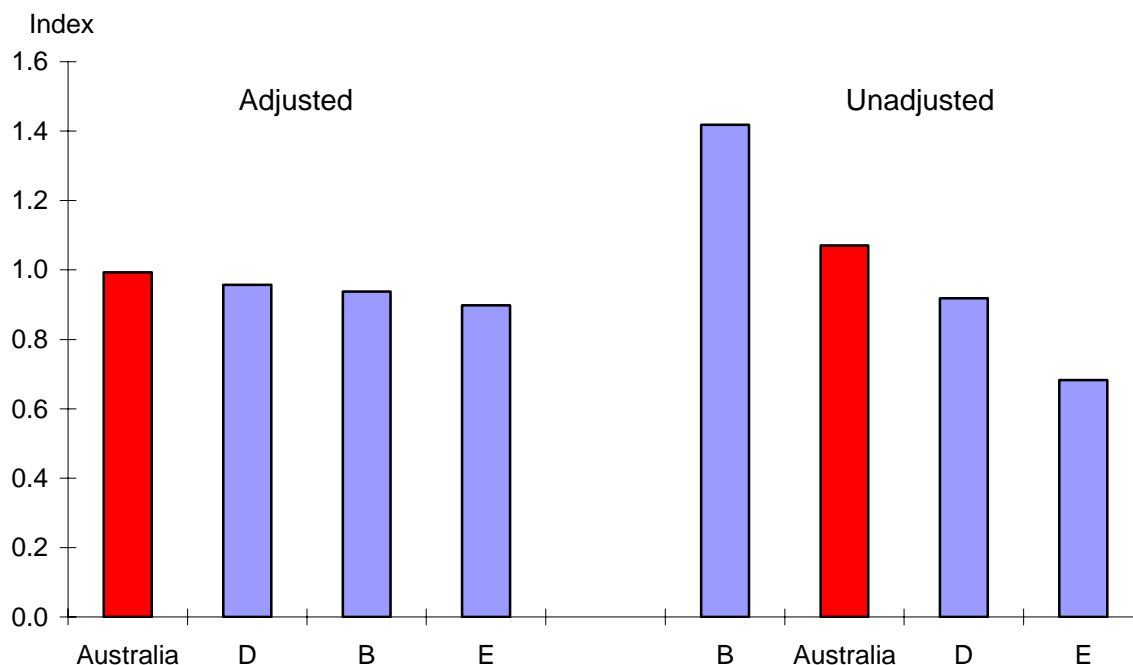

Figure 11 shows the TFP scores adjusted for mail density and customer density and the unadjusted TFP scores. Australia Post's ranking within this sample improves from second to first when mail density and customer density are adjusted for. Australia Post has a mail density figure that is the lowest in the sample and a reported customer density figure that is a little above the average. Australia Post improves its relative position from second to first when the adjustment is made to take account of mail density differences despite the fact that its TFP score deteriorates marginally when the adjustment for customer density differences is made.

The service with the highest TFP in the smaller sample of four postal services also had the highest customer density measure. As a result there was a significant impact on TFP for this service when the adjustment was undertaken for customer and mail density or customer density alone. When adjustment is made for mail and customer density differences the two services with below average customer density figures improve their TFP scores and the service with a customer density figure well above average experiences a significant decline in its TFP score.

It should be noted that this adjustment is likely to be conservative as Australia Post has not included route length associated with rural deliveries by roadside mail contractors in its route length data supplied (but contract street deliveries are included). Including rural contractor

route lengths could be expected to significantly reduce Australia Post's relative customer density and, hence, increase its relative TFP score when the adjustment is made.

Figure 12: **TFP adjusted for customer density, 2008 or latest year**

Finally, figure 12 shows the TFP scores adjusted for customer density only and the unadjusted TFP scores. Reflecting the relative importance of customer density as compared to mail density, the results are very similar to those presented in figure 11 and the relative rankings of the services after the adjustment are the same in both figures 11 and 12.

To conclude, Australia Post has shown the most consistent improvement in TFP of the seven postal services reviewed. Importantly, Australia Post improved its ranking when formal, statistically based adjustments were made for differences in mail density and customer density with its TFP level being ranked either first or second after the relevant adjustments were made.

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