ECONOMIC INSIGHTS Pty Ltd

Memorandum

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To: Mark Pollock, Australia Post
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Subject: Review of US and UK studies quoted by ACCC and Frontier Economics

Introduction

Australia Post (2010, p.21) has argued in its draft price notification to the ACCC that the elasticity of cost with respect to volume is of the order of 0.3 for delivery and 0.25 for processing.

Frontier Economics (2010, p.30) have argued that the elasticities should be more of the order of 0.6 to 0.7 based on econometric results reported in international studies.

However, Frontier Economics (2010, p.31) also note that Australia Post has forecasted that real aggregate costs will fall by 6% and volumes will fall 12% over the 2008/09 to 2011/12 period, which hence implies an aggregate cost elasticity of 0.5.

In this memo, we review the cited international studies and discuss the degree to which the results are reliable and applicable to the case of Australia Post.

However, before doing this we make note of the following points based on discussions with Australia Post:

- We understand that the elasticities cited by Australia Post (0.3 and 0.25) relate to the short run (SR). That is, cost reductions that can be achieved without major changes to the equipment employed and the structure of operations. Hence, long run (LR) elasticities are likely to be larger.
- We understand that the forecasted decrease in real costs is in part due to structural adjustments, such as the introduction of sequencing and reductions in overheads.

We now sequentially summarise and review the following five studies:

- Fenster, Monaco, Pearsall and Xenakis (2008)
- Bozzo (2009)
- Cohen, Robinson, Scarfiglieri, Sheehy, Comandini, Waller and Xenakis (2004)
- NERA (2004)
- Moriarty, Yorke, Harmin, Cubbin, Meschi and Smith (2006) (summary of LECG)

We then provide a brief summary of key points and a summary table at the end of this memo where we compare aspects of the five papers.

Fenster, Monaco, Pearsall and Xenakis (2008)

Data involves quarterly observations on 368 US processing plants over the period 1999-2005, providing approximately 8,000 observations in total.

Production function models are estimated.

A restricted translog functional form is used.

The estimation method involves stochastic switching regressions obtained using maximum likelihood estimation (MLE). This method is used to account for "dirty" data. That is, data where it is expected that there are a lot of measurement errors.

There were 16 production functions fitted relating to different shapes and processes:

1. Letter sorting – 5 models (total, 3 types of equipment, manual)
2. Flat sorting – 5 models (total, 3 types of equipment, manual)
3. Parcels and priority mail sorting – 3 models (total, 1 type of equipment, manual)
4. Cancellation – 3 models (total, 1 type of equipment, "other")

Various other productions functions were also fitted where some of the above cases were repeated for just inbound mail or just outbound mail with a total of 40 production functions fitted overall.

The (log) dependent variables used differ across these functions. They were

- *First handled pieces* (FHP) aggregated over each process (for shape totals)
- *Total pieces handled* (TPH) (for cancellations and manual sorts)
- *Total pieces fed* (TPF) (for equipment sorts)

Regressor variables used included:

- Labour in work hours
- Capital services index
- Number of delivery points
- Number of delivery units
- Quarterly dummy variables
- Annual trend variable
- Delivery point shares
    - City curb
    - City box
    - City central
    - Other city
    - Rural boxes
    - Highway contract
    - PO box
- Mail subclass shares
    - Originating
    - Destinating
    - Total
- Work share by shape
    - Letters

- Flats
- Parcels
- Shape dummy variables (used to identify missing shapes in process equations)
- Process dummy variables (used to identify missing processes in shape equations)
- Labour skill shares (by process type)

Five key measures are estimated (for the 40 fitted functions):

- Returns to density
- Returns to scale
- Labour variability (SR measure with capital fixed)
- Labour variability (MR measure with capital/labour ratio fixed)
- Labour variability (LR measure with capital/labour ratio assumed to vary to achieve cost minimization)

Results[1]

Returns to density estimates at the sample means are all (except in one case) less than one, with most values between 0.6 and 0.8.

Returns to scale estimates at the sample means are all (except in three cases) less than one, with most values between 0.8 and 1.0, implying decreasing returns to scale.

The authors argue that the elasticities with respect to delivery points are mostly positive, suggesting that these variables are acting as control variables rather than output variables, implying that mail processing is more of an industrial activity than a network activity.

We are surprised by the signs on these network variables. We would expect that the effect would be either insignificant or negative. It would be negative because extra delivery points should increase the need for extra capacity in the machines and more handling of trays before and after. Please see further discussion in the comments section below.

Trend coefficients (reflecting technical change) are mostly positive for automated and mechanized processes and negative for manual processes. The authors argue that this is possibly due to minor upgrades in equipment for the automated/mechanized processes and the fact that as a higher percentage of mail is processed in automated/mechanized processes, the average difficulty of the residual manual pieces increases.

It is noted that some delivery point types (central city, rural box and PO box) have a mostly negative effect on productivity, which the authors argue is perhaps due in part to the fact that mail needs to be sent to these categories earlier than the other categories and hence puts time constraints on processes.

Presort mail has a mostly positive effect on productivity, which the authors argue is perhaps partly because it "conforms to a higher degree of address hygiene".

Outgoing mail has a mostly positive effect on productivity, which they argue is perhaps partly because it requires fewer process handlings.

[1] In this *Results* section we report the key results and commentary provided by the authors. In the *Comments* section which follows we provide our comments on their analysis.

<u>Comments</u>

The estimation of a production function where output is exogenous to the firm (ie the manager must process all mail that customers send[2]) and input choices are arguably endogenous (ie the manager has some control) leads one to ask about the possibility of endogeneity bias in the econometric estimates because of endogenous regressor variables? The unexpected signs on the network variables may support this suspicion. Also note that Bozzo (2009) also makes this comment, and hence estimates a cost function instead.

The input variables only include labour used in the relevant process and capital equipment. Other inputs that do not appear include allied labour (loading, unloading and moving mail between processes, etc.), other capital (forklifts, buildings, etc.), other expenses and overheads. Many of these other input categories are likely to vary less with volume. For example, if the inputs included in the regressions cover 60% of total plant costs and the mean elasticity for these inputs is 0.7, while for the other 40% of inputs the mean elasticity is 0.2, then the total elasticity (making various simplifications) would be approximately 0.6×0.7+0.4×0.2=0.50.

What are the mean sizes of these plants? One could argue that plant size could affect the relative amount of process labour versus set up and pull down labour, and hence affect the volume elasticity. In 1999 we can (very roughly) approximately estimate the average US plant size as being 739×280/368=562 million pieces per year. This calculation assumes a population of 280 million people, 739 pieces per capita (Cohen, 2004) and 368 plants. From the data tables in the appendix of Economic Insights (2009) we obtain an approximate tally of pieces delivered for Australia in 2008 of 5,612 million.[3] If we divide this by 6 plants we calculate 5,612 /6=934 million pieces per year per plant, indicating that average plant sizes may be larger in Australia. This information suggests that a (correct) US elasticity could understate the Australian elasticity if the elasticity increases with plant size and if like-with-like comparisons are in fact being made.

However, the degree to which Australian and US MCs are conducting similar functions is not clear. The US MCs are likely to be more disaggregated and specialised in their functions than the six Australian MCs. This would be in part because in the US they have too many addresses given the size of the population for the BCR machines to handle in one pass so they have to break the process down into more stages (eg some MCs would just farm letters out to the next level of MCs down and so on). Hence, one may need to aggregate several US MCs to get the equivalent functions that are done by each of the six Australian MCs. The impact of this functional difference on elasticities requires further investigation.

The models are estimated using data from a time period when volumes are increasing, while Australia Post is currently facing decreasing volumes. We expect that SR elasticities will be larger during periods of increasing volumes (versus decreasing volumes) because hiring new staff and adding new pieces of equipment is generally easier than removing staff and retiring equipment. However, in the case of LR elasticities, one would expect the less difference in the estimates between periods of increasing and decreasing volumes.

[2] At least in terms of standard letters.
[3] We understand that using numbers of items delivered to approximate mail centre throughput will be a significant underestimate as it does not allow for items going through more than one mail centre.

Bozzo (2009)

Data involves quarterly observations on 371 US processing plants, from 1999 to 2006.

Factor demand models are estimated.

These were algebraically derived from a short run (SR) cost function.

A translog functional form is assumed for the cost function, which implies a Cobb-Douglas (log-linear) functional form for the factor demand equation.

A SR cost function model was defined because capital price data was unavailable (and hence capital quantity indices were used instead).

The cost function was chosen because of potential endogeneity problems in production function estimation and because cost functions can accommodate multiple outputs (eg processes).

The author notes that one can derive both SR and long run (LR) elasticities from the estimated functions if need be.

Output variables are modelled as hedonic functions in the labour demand equations. This is to account for heterogeneity in the outputs among plants.

Three output measures are defined:

- FHP = first handled pieces = number of pieces in each process if it is the first process that that piece sees in the plant
- TPH = total pieces handled = number of pieces in each process (hence there will be double counting when processes are aggregated)
- TPF = total pieces fed = TPH plus unsuccessful sort attempts

FHP is based on weights and conversion factors, while TPH and TPF are mostly machine counts.

The author notes that the data measures may have errors and hence ordinary least squares (OLS) regression may be biased and hence argue for the use of instrumental variables (IV) methods.

Labour data are obtained from clocking procedures on various processes.

The Postal Rate Commission (PRC) argues for unit elasticities for mail processing activities.

Bozzo argues that this may be reasonable for run-time labour, but that this is approx 60% of labour use and there is also labour use from moving mail between processes, set up and take down, waiting time, breaks, etc.

Hence economies of density could occur in these non-runtime activities, since there may be extra container handlings needed per unit of volume if density is low.

He also argues that pre-sort mail may have a higher non-runtime labour use percentage because there are less sort operations needed.

The dependent variable used is labour hours.

Regressor variables include:

- Output measures (TPF – or TPH for manual operations)
- Hedonic output function variables:
  - Depth of sort (TPF/TPH)
  - Density (destinating volumes per delivery point)
  - Preferential mail ratio (we assume that this is priority mail?)
- Number of delivery points
- Proportion of “city” delivery points
- Wage rate
- Capital quantity indexes
- Some additional control variables similar to those used in Fenster et al.

Various models are estimated for different outputs:

Including 8 process level models:

- OCR
- Outgoing BCS
- Incoming BCS
- Manual letters
- Incoming AFSM
- Outgoing AFSM
- FSM 1000
- Manual flats

and 4 shape level models:

- Letters BCS
- Letters BCS outgoing and incoming (ie 2 output variables)
- Flats AFSM
- Flats AFSM outgoing and incoming (ie 2 output variables)

Various estimation methods are used:

- Fixed effects limited information maximum likelihood with instrumental variables
- Fixed effects ordinary least squares
- Fixed effects two stage least squares

<u>Results</u>

Returns to density measures vary from 0.58 to 0.97, with most values in the 0.8 to 0.9 range.

Network effects are mostly insignificant. It is suggested that this may be because the fixed effects dummy variables are washing out these network characteristics (which do not differ a lot over time in a particular processing centre).

The hedonic adjustments to outputs that are used are found to have little effect on the estimated elasticities.

<u>Comments</u>

The labour demand equation is derived by assuming that the plants exhibit cost minimizing behaviour. Is this reasonable in a regulated monopoly business where interventions from regulators and unions are likely to affect manager decisions?

The model is a SR model in that the elasticities obtained are conditional on capital being held fixed. One could hence expect that the LR elasticities will be larger.

Please also refer to the three comments made in our earlier Fenster discussion regarding:

- the omission of other inputs (which could imply that the estimated elasticities are biased upwards)
- plant size and function issues (which could imply that the Australian elasticity is larger than the US elasticity if like-with-like comparisons are in fact being made but likely differences in individual MC functions between the US and Australia mean such comparisons are questionable)
- increasing volumes issue (which could imply that SR elasticities will be lower when volumes are decreasing as they currently are for Australia Post)

which are also relevant here.

Cohen, Robinson, Scarfiglieri, Sheehy, Comandini, Waller and Xenakis (2004)

US data are used.

The cost function models are not econometrically estimated.

They are constructed using information on (fixed and variable) costs at one point in time (1999) and an assumption of constant marginal costs (ie a linear cost function).

Point estimates of the cost elasticities are calculated as the share of variable costs in total costs in the USPS accounts.

<u>Results</u>

In table 1 the authors provide the following information for the USPS in 1999:

Activity	% of total costs	Cost elasticity
Delivery	35	.48
Processing	34	.96
Transport	7	.92
Window service	5	.46
Other	18	.23
Total	100	.63

The authors construct cost curves for each of the above five activities and an aggregate (total costs) curve.

The total costs (C) model has the form:

$$C = 0.2089 (V) + 74.31 (P)$$

where V is volume and P is population.

The marginal costs coefficients are calculated as (variable costs/V) and (fixed costs/P), respectively. For non-delivery cases, the authors decide that 25% of fixed costs are transferred into the variable costs category before these calculations are done (to reflect their assessment that some fixed costs will be variable in the long run).

We note that there could be some aggregation issues in table 1. When we insert the value of 739 pieces per capita into the above total costs model we obtain an elasticity of:

$$E = 0.2089 (739) / [0.2089 (739) + 74.31 (1)] = 0.68$$

which differs from the 0.63 reported in table 1.

The authors do not have access to international data on costs and volumes to directly validate their model. So they instead use data on cost shares for delivery and processing functions (which are publicly available) from 8 OECD countries to show that these observed shares and the shares predicted by their model are "close".

They attempt to illustrate this closeness by fitting exponential regression equations to the

observed shares and then reporting R-squared values of approximately 62% (see their figure 5). This is quite strange. It would make more sense to find the correlation coefficient between the observed shares and those predicted by their mathematical model. Then the square of this correlation coefficient will provide an R-squared value for their actual (mathematical) model.

Comments

A linear cost function model is assumed. A linear approximation may be reasonable in the vicinity of the observed data point, but any extrapolations away from this point are questionable.

The authors argue that their cost curves can be extrapolated to situations where there are less than 100 pieces per capita. Given that these curves are constructed using a single data point (from 1999) where deliveries of 739 pieces per capita occur, this extrapolation is in our assessment not reasonable.

Having noted these important qualifications, we do observe that the model used in this paper predicts that cost elasticities decrease as per capita volumes decline.

From the data tables in the appendix of Economic Insights (2009) we obtain an approximate tally of pieces for Australia in 2008 of 5,612 million, and when divided by a population of 21 million, we obtain 267 pieces per capita.

We note that this is "similar" to the values for Britain, France, Germany and Canada in the authors' Figure 5, which are around the 300 mark.

For the case of 267 pieces per capita we obtain

$$E = 0.2089\ (267) / [0.2089\ (267) + 74.31\ (1)] = 0.43$$

Thus Australia Post could argue that an elasticity of 0.43 would be a possible estimate of its elasticity.

However, one should again emphasize that considerable caution is needed here. First, this model is based on data from a single year in the US (1999) and the extrapolation of a linear production technology. Second, econometric studies based on UK and European data (eg NERA and Moriarty et al), which involve similar pieces per capita, do not obtain elasticity estimates as low as this.

Furthermore, the authors report in table 2 results of an empirical analysis of Universal Postal Union (UPU) data from 2002 on 146 countries. Data is divided into four different quartiles ranked by pieces per capita. Then labour data is regressed on volume data (within each quartile). Mean elasticity estimates are reported across the four quartiles. The fourth quartile relates to 67 pieces per capita or more (which would contain Australia, the US and most OECD countries) and has a mean elasticity of 0.91. This result appears to contradict their main model which predicts elasticities of half this value. However, no detail of the regression analysis is given, such as the functional form used, control variables used (if any), etc. And UPU data are likely to be less consistent given likely differences in interpretations of respondents and differences in definitions in the information systems they have access to.

NERA (2004)

Data involves 23 (of 25) EU member states over the 1998-2003 period, providing a total of 99 observations.

Our review here mostly focuses on the discussion in chapters 7 and 8 of the econometric analysis.

A cost function model is estimated.

The Cobb-Douglas functional form is used.

The cost function and a labour share equation are estimated together in a system of equations.

Therefore cost minimising behaviour is assumed.

Five models are estimated for:

- Collection
- Sorting
- Transport
- Delivery
- Total

The sample data indicates that costs are 63% labour and 5.2% capital charges, on average.

The sample data (for letters operations) indicates that costs are:

- Delivery 50%
- Sorting 15%
- Collection 12%
- Transport 7%
- Overheads 16%

The dependent variable used is total costs.

Regressor variables (which varied by the model used) include some of:

- Letter volumes
- Parcel volumes
- Wage price index
- Materials rents and services price index (not used as a regressor but instead used to deflate costs and the wages price index to impose homogeneity of degree one on the cost function)
- Infrastructure variables:
    - Number of sorting offices
    - Number of delivery offices
    - Number of post boxes
- Network variables:
    - Number of post offices
    - Number of households
- Geographic variables
    - Population density

  - Percentage of urban population
  - Surface area
- Quality variables
  - Percent of mail delivered in D+1
  - Dummy variable for existence of quality regulation
  - Average number of collections per week
  - Average number of deliveries per week
- New member state (non EU15) dummy variable

Results

The results for the EU15 are:

Activity	Returns to Density	Returns to Scale
Collection	0.68	0.99
Sorting	0.56	1.18
Transport	0.49	1.28
Delivery	0.64	1.06
Total	0.65	1.03

The new member states generally had lower elasticities (estimated by having dummy variables interacting with the volume measures). We note that these countries also generally have lower pieces per capita.

Comments

The capital costs included in total costs appear to be simply depreciation and amortization from the books and hence are unlikely to reflect true economic cost (economic depreciation and opportunity cost).

From page 62 we infer that the CPI index (in each country) was used to convert local currencies to 2003 currencies, and then the GDP PPP price index was used to convert these figures into Euros. It is not clear that either of these deflators are likely to reflect changes in the prices of postal inputs (particularly labour) across these various countries and time periods. Hence, the monetary values in the data could be biased across time and countries.

Also, extreme caution needs to be used when interpreting results from such aggregated cross-country models. There are a host of measurement problems for each country on its own and these are multiplied many fold when cross country data are pooled together. It is unlikely that the relatively simplistic and restrictive functional form used could adequately capture the complexities present in such a pooled sample.

Moriarty, Yorke, Harmin, Cubbin, Meschi and Smith (2006)

This report summarises sections of the LECG (2005) report. We include some extra detail from this latter report in our summary here as well.

Data are from the UK in 2003/04.

There are two data sets:

- Delivery centre data on 1,108 units (out of a possible 1,377)
- Mail centre data on 69 units (out of a possible 70)

A cost function model is used.

The focus of the analysis is on measuring cost efficiency levels.

Three estimation methods are used:

- DFA = deterministic frontier analysis = ordinary least squares (OLS) with an adjusted intercept so that the cost data is bounded from below by the function
- SFA = stochastic frontier analysis = a "regression-like" method which is used to fit a stochastic cost efficiency frontier under the cost data
- DEA = data envelopment analysis = a linear programming method that is used to fit a non-stochastic piece-wise frontier under the cost data

A Cobb-Douglas functional form is assumed (for OLS and SFA)

The authors also tried translog and quadratic functional forms but they could not get plausible results.

The dependent variable in the delivery model is labour costs.

The regressor variables considered in the delivery model are:

- Delivery points
- Volume/delivery point (weighted volume)
- Road kms/delivery point
- Urban/Rural dummy variables (five zones)
- Proportion of business delivery points
- Level of mechanization (number of RM2000 sorting frames)
- Number of redirections
- Percent of mail walk sorted in the MC
- Distance to MC
- Number of vehicles
- Post wage rate
- Local wage rate
- Percent of mail delivered on time

The dependent variable in the processing model is labour costs (deflated by the wage rate)

The regressor variables considered in the processing model are:

- Volume (weighted)
- Small/large dummy (split at median)
- Percentages of inward mail that is distant, neighbouring or intra-MC

- Percent of inward mail from RDC
- Percentages of mechanized mail (inward, outward and total)
- Percent of walk sorted mail
- MC service area surface
- Percent of MC area that is urban
- Size of MC floor area
- Number of floors in MC
- Distance to other MCs
- Co-location of other services in the building (e.g., delivery office)
- Post wage rate
- Local wage rate
- Percent of processing completed on time
- Percent of mail delivered on time

In the processing model the authors tested for homogeneity of degree one and then imposed this condition. That is, they set the coefficient of the wage rate to 1, which is the same as deleting the wage (regressor) variable and deflating the cost (dependent) variable by the wage rate. Thus these costs are now in real terms (ie implicit quantities).

OLS and SFA coefficient estimates were similar. OLS results are discussed below.

Results

Delivery:

Returns to density = 0.67

Returns to scale cost elasticity = 1.02

Average cost inefficiency = 10.9% (using the 10th percentile as the benchmark)

Processing:

Returns to scale cost elasticity = 1.25 for large MCs (decreasing RTS)

= 0.96 for small MCs

Average cost inefficiency = 14% (using the 15-th percentile as the benchmark)

Potential cost savings from scale economies = 7%

Comments

The costs only involve labour costs. Given that non-labour costs are less volume-variable, one could argue that this labour costs elasticity could overstate the total costs elasticity.

Data is cross-sectional only. It does not involve panel data. This differs from the other three econometric studies.

The processing model assumes no network density effects. This differs from the other four studies.

For the case of large MCs, the results show that costs increase more than proportionally with volume. This result differs from the other four studies which show costs increasing equally or less than proportionally with volume.

Could this be a compositional effect? That is, do larger MCs process mail that is “different” in some way, where this difference is not captured by the regressor variables?

Alternatively, could this be a London wage-loading effect? In other parts of the public sector (eg schools), staff in London get an extra loading. Could the higher costs of larger MCs be partly because the average MC size is larger in London, where wage rates are higher?

Summary of Key Points

The main objective of this review is to determine if the elasticity estimates reported in these international studies provide information that is reliable and comparable in terms of providing an indication of the elasticity that may be applicable to the case of Australia.

Some relevant questions for each study are:

1. Is the model SR or LR?
2. Are mail volumes increasing or decreasing over the sample period?
3. Is the econometric method appropriate?
4. Are the data reliable?
5. Are all inputs (costs) included?
6. Are all aspects of mail services included (collection, processing, delivery, etc.)?
7. Is population density comparable to that in Australia?
8. Is the functional coverage similar to Australia?

We now briefly address each of these questions. Note that an additional summary table is provided at the end of this document.

1. *Is the model SR or LR?*

   Four of the five papers estimate models that could be classed as LR models, with the exception of Bozzo (2009) which estimates a SR model where capital quantity is held fixed. As a consequence, this SR model is likely to underestimate the LR elasticity (all else equal).[4]

2. *Are mail volumes increasing or decreasing over the sample period?*

   In all five papers the sample data covers periods of increasing or constant volumes. The current situation in Australia is one of rapidly decreasing volumes. We expect asymmetry in elasticities in at least the short run, because it is usually easier to expand labour and capital rather than contract it. Thus the SR elasticity estimates reported are likely to be over estimates.

3. *Is the econometric method appropriate?*

   We have econometric concerns with a number of the papers. Cohen (2004) does not use any econometrics, and instead "estimates" a cost function using a single data point from 1999 and relies upon the assumption of a linear technology and a (not clearly explained) allocation of costs among volume and network activities. Fenster (2008) estimates a production function, which assumes output is endogenous and inputs are exogenous. Given that it is more likely that the converse applies, these estimates could suffer from endogeneity bias. The Bozzo (2009) and NERA (2004) studies estimate models that rely upon an assumption of cost minimizing behaviour. One could argue that this is brave in a

[4] This all other things being equal assumption will be implicit in our comments here, even if not explicitly stated.

regulated monopoly, where interference in input allocation decisions (eg involving labour) is likely to be influenced by political considerations.

4. *Are the data reliable?*

   The data used in Fenster (2008) and Bozzo (2009) are acknowledged to suffer from recording errors (but both studies do use estimation methods which attempt to ameliorate these effects). As noted above, Cohen (2004) is based on a single data point. The NERA (2004) data involves data across 25 countries, where price deflators and capital cost measures are a particular concern.

5. *Are all inputs (or costs) included?*

   Fenster (2008) and Bozzo (2009) only include direct (run-time) labour and capital for each process, and exclude ancillary labour and other items. Given that ancillary labour tends to be less variable with volume, this could produce upward biased elasticity estimates. Bozzo (2009) and Moriarty (2006) only include labour inputs, which tend to be more variable with volumes (relative to other inputs), and hence also may produce elasticities which are larger than total elasticities.

6. *Are all aspects of mail services included (collection, processing, delivery, etc.)?*

   Fenster (2008) and Bozzo (2009) only look at processing centres. These are expected to have higher elasticities relative to other activities (such as collection, transport, delivery and corporate overheads) which tend to have higher proportions of fixed costs. Moriarty (2006) only considers processing and delivery centres. Other activities (such as collection, transport, corporate overheads) which tend to have high proportions of fixed costs are not included.

7. *Is population density comparable to that in Australia?*

   In all five studies, the countries considered (USA, UK and EU members) have population densities that are notably higher than Australia's. As a consequence, the proportion of fixed costs in the collection, transport and delivery functions are expected to be lower than in Australia, and hence elasticities would be expected to be higher.

8. *Is the functional coverage similar to Australia?*

   The Fenster (2008) and Bozzo (2009) studies look at US mail centres which are likely to have a different functional coverage to Australian MCs. The US MCs are likely to be more disaggregated and specialised in their functions than the six Australian MCs. This would be in part because in the US they have too many addresses given the size of the population for the BCR machines to handle in one pass so they have to break the process down into more stages. Hence, one may need to aggregate several US MCs to get the equivalent functions that are done by each of the six Australian MCs. The impact of this functional difference between the US and Australia means that using the results of these studies to infer appropriate values for Australia is not likely to be appropriate.

References

Australia Post (2010), *Supporting Information to Australia Post's Notification of Domestic Reserved Letter Service Price Changes*, Attachment 2 to Draft Notification of Change in Domestic Reserved Letter Pricing to ACCC, April.

Bozzo, A.T. (2009), "Using operating data to measure labor input variability and density economies in United States Postal Service mail processing operations", in M. Crew and P. Kleindorfer (eds), *Progress in the Competition Agenda in the Postal and Delivery Sector*, Edward Elgar.

Cohen, R, M. Robinson, G. Scarfiglieri, R. Sheehy, V.V. Comandini, J. Waller and Spyros Xenakis (2004), The Role of Scale Economies in the Cost Behavior of Posts, Mimeo, December.

Economic Insights (2009), Australia Post's Aggregate and Reserved Service Productivity – 2009 Update, Report prepared for Australia Post, Canberra, 1 July.

Fenster, L, D. Monaco, E. Pearsall and S. Xenakis (2008) "Are there economies of scale in mail processing? Getting the answers from a large-but-dirty sample", in M. Crew and P. Kleindorfer (eds), *Competition and Regulation in the Postal and Delivery Sector*, Edward Elgar.

Frontier Economics (2010), *Review of Australia Post's volume and input cost forecasts*, Report Prepared for the ACCC, May.

LECG (2005), *Future Efficient Costs of Royal Mail's Regulated Mail Activities*, Report prepared for Postcomm, London, 2 August.

Moriarty, R, S. Yorke, G. Harmin, J. Cubbin, M. Meschi and P. Smith (2006), "Economic analysis of the efficiency of Royal Mail and the implications for regulatory policy", pp. 165-182, in M. Crew and P. Kleindorfer (eds), *Liberalization of the Postal and Delivery Sector*, Edward Elgar.

NERA (2004), *Economics of Postal Services: Final Report: A Report to the European Commission DG-MARKT*, London.

Appendix: Summary Table

Item	Fenster	Bozzo	Cohen	NERA	Moriarty
What is the unit-level?	Processing centres	Processing centres	Country	Country	Processing centres and delivery centres
What activities are modelled?	Various processes & shapes (40 models)	Various processes & shapes (12 models)	Delivery, processing, transport, window service, other, total (6 models)	Collection, delivery, sorting, transport, total (5 models)	All within each centre (2 models)
Cross-sectional or panel data?	Panel	Panel	One data point only	Panel	Cross-sectional
Location of data	USA	USA	USA	EU	UK
Years of data	1999-2005	1999-2006	1999	1998-2003	2003/04
Number of units	268	371	1	23	1,108 and 69
Period of increasing or decreasing volumes?	Increasing	Increasing	NA	Increasing	NA
Any data reliability issues?	Recording errors	Recording errors	Small sample size	Price deflators and capital measures questionable	Recording errors
Function?	Production function	Labour demand function	Cost function	Cost function	Labour cost
Functional form?	Restricted translog	Cobb-Douglas	Linear	Cobb-Douglas	Cobb-Douglas
Any issues with econometric methods?	Endogenity of regressors	Model is derived assuming cost minimization in a regulated monopoly.	No econometrics used	Estimated in a system with a labour share equation and hence assumes cost minimization in a regulated monopoly.	No non-labour cost information
What is the dependent variable?	Volume	Labour hours	Total cost	Total cost	Labour cost
Short run or long run?	LR	SR	LR	LR	LR
Similar population density to Australia?	Higher	Higher	Higher	Higher	Higher
Similar volumes per capita to Australia?	Higher	Higher	Higher	Yes	Yes
Other issues?	Results suggest that extra delivery points result in extra productivity	Only considers run-time labour and not allied labour (or other inputs)	Extrapolations very brave		Assumes no effect of density on processing centres
Returns to density estimates	*Mostly 0.6-0.8*	*Mostly 0.8-0.9*	*0.63 for USA But can predict 0.43 for Australia*	*0.65 for total*	*0.67 for delivery*