Economic Analysis of the Efficiency of Royal Mail Units and the Implications for Regulatory Policy

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Section 1 - Introduction
Since early 2004 Postcomm has been reviewing the price and service quality controls that should apply to Royal Mail from April 2006. In March 2006, Postcomm published its final decision for the price control. Part of this final decision was a 3% per annum efficiency factor for Royal Mail’s operating costs. Estimating an efficiency factor is particularly difficult for Royal Mail as there are no regulatory comparators, as is the case in the water and energy sectors. This decision about the level of the efficiency factor, therefore, was informed by extensive analysis of a range of analytical techniques, including bottom-up analysis of Royal Mail’s forecasts, total factor productivity analysis, international benchmarking with other postal operators and internal benchmarking of Royal Mail’s mail centres and delivery offices. This analysis was carried out for Postcomm by LECG.

The operations of postal operators with a universal service obligation (USO) are generally organised so that the same activities are carried out in each geographic area covered by the USO. For example, the delivery of mail to domestic and business

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1 The views expressed in this paper are the authors’ own and not necessarily those of Postcomm or LECG.

2 John Cubbin is Professor of Economics at City University, London. Meloria Meschi is Associate Professor of Economics at John Cabot University, Rome. John Cubbin and Meloria Meschi are responsible for sections 4 to 8 of this paper.

3 Postcomm, Royal Mail’s Price and Service Quality Review 2006-10 – Licence Modifications Proposals, March 2006

4 LECG, Future Efficient Costs of Royal Mail’s Regulated Mail Activities, August 2005
premises generally takes place from an office that covers a particular geographic area. The repetition of functions, such as delivery, across large number of units within a postal operator provides the opportunity to assess the comparative efficiency of each unit carrying out a particular function. In this paper we refer to this analysis as internal benchmarking. Such analysis can provide the management of the postal operator with valuable information about sources of best practice and areas where performance is below comparable units elsewhere in the organization. The analysis can also be used by regulators setting ex ante RPI-X price and revenue controls to help identify achievable efficiency targets, alongside other analytical techniques.

In this paper we explain the analysis commissioned by Postcomm and carried out by LECG to assess the comparative efficiency of Royal Mail’s delivery offices and mail centres. A delivery office carries out the final delivery of mail to domestic and business customers, including some walk sorting and walk sequencing of mail. Royal Mail has over 1400 delivery offices in the UK. A mail centre carries out sorting of mail for distribution to other mail centres and delivery offices covered by its geographic area. Royal Mail has about 70 mail centres in the UK. After explaining the results of the analysis the paper considers the lessons that can be learnt when carrying out similar analysis in the future, and the regulatory implications and uses of such information.

Section 2 places internal benchmarking in the context of analysis of efficiency opportunities for a postal operator. Section 3 explains what internal benchmarking involves, including the econometric techniques to be used. Sections 4 and 5 explain the analytical approach used for the analysis of delivery offices and mail centres respectively. Sections 6 and 7 explain the results of the analysis of delivery offices and mail centres respectively. Section 8 discusses the lessons that can be learnt for carrying out internal benchmarking analysis in the future. Section 9 discusses the implications of this type of analysis for regulatory policy.

Section 2 – Analysing the efficiency opportunities for a postal operator
A key concept in determining future efficient costs is the idea of an “efficient cost frontier”, which represents the minimum level of costs required to achieve each potential
level of output. In Figure 1 below this efficient frontier is illustrated by the line OP. Inefficient firms can reduce costs for a given level of output by moving towards the efficient frontier. In Figure 1, an example of this would be a move from point A towards point B. When costs are on the efficient frontier, the firm is said to be productively efficient. An example of this is point B in the figure below.

**Figure 1 - Typical methodology to assess future efficient costs**

If a firm is on its efficient frontier and varies its level of output while remaining efficient, it is said to have moved along the efficient frontier. This is illustrated by a move from B to C in the figure above. Firms which are productively efficient can only reduce their costs for a given level of output if there is a *shift in the efficient frontier* and they take advantage of that shift to reduce costs. In the figure above, a shift in the efficient frontier would take place if the frontier moved from OP to OP\_1, and the firm could take advantage of that shift by reducing its costs from point B towards point E.

In considering a future efficient cost path for a firm, it is crucial to maintain and be clear about the above-mentioned distinctions between moves towards the efficient cost frontier, moves along the efficient frontier, and a shift in the efficient cost frontier itself. The forecast of a future efficient cost path for a firm brings together a firm’s current efficiency, the current and likely future level of the efficient cost frontier, and the speed with which the firm is likely to be able to move towards that efficient cost frontier.
Figure 2 below illustrates the techniques typically employed to assess this future efficient cost path. This consists of a projection of baseline costs, which identifies the cost path the regulated entity would most likely achieve based only on existing management cost-saving initiatives and output volume and mix effects. This is supplemented by a determination of achievable efficiencies that the regulated entity could be expected to make over the price control period.

Figure 2 - Typical methodology to assess future efficient costs

Internal benchmarking is one of three analytical techniques used to determine a firm’s future efficiencies. The other two are top-down and bottom-up techniques.

Top-down analysis seeks to draw lessons from cost trends or levels achieved by the firm in the past, firms in other industries, or by firms in the same industry but different geographies. One top-down method is to examine the firm’s historic cost trends, adjusted for volume and product mix effects. The fact that a firm has achieved a certain cost trend in the past might be a strong reason for thinking it could achieve such a trend in the future. A second top-down method is total factor productivity (“TFP”) analysis. This technique involves analysing cost trends in related industries to assess what annual percentage cost savings might be achievable by the firm being analysed. TFP analysis therefore also aims to identify a sustainable rate of change in the efficient frontier. A further top-down technique is to examine cost levels or trends achieved by firms in the same industry but in different geographies or countries. After making any relevant
adjustments, this technique could in theory be used to identify both the level of the efficient cost frontier and its potential future rate of change.

Bottom-up analysis builds up estimates of aggregate future efficient costs by considering in detail individual cost categories, activities and projects. Bottom-up analysis typically starts with a review of the firm’s strategic and business plans. The regulator will apply a number of techniques in reviewing these plans including benchmarking activities and their associated cost levels against those employed in firms in the same industry in other geographies and benchmarking functional cost levels – relating to remuneration, property, vehicles, etc – against appropriate functional benchmarks achieved by other firms in the same geography.

We discuss below another form of top-down analysis, which is internal benchmarking.

Section 3 - Internal benchmarking
Internal benchmarking compares the cost performance (or efficiency) of similar units within the same company against each other. Internal benchmarking can be based on simple performance ratios such as mail volume, overall cost performance, labour productivity, overtime cost or absenteeism. The main weaknesses of single performance ratios are that they are susceptible to the bias of the observer and cannot reliably test the interaction of more than one efficiency driver. That is, simple ratio analysis cannot explain performance variations between operational areas due to, for example, output volume mix, technology/equipment differences, building structure, the external labour market, local geography, or other factors. Simple ratio analysis can be extended, however, using advanced quantitative (i.e. econometric) techniques.

Econometric analysis involves fitting a mathematical function to the data. This function can contain many arguments reflecting the factors just discussed. Different criteria may be adopted to specify what constitutes a good fit to the data, and these form the basis of alternative estimating methods such as stochastic frontier analysis (SFA) and Data Envelopment analysis (DEA).
As internal benchmarking techniques are based on the current performance of units within the firm being analysed, they can only identify the efficiency savings that can be achieved by moving to the current best practice being exhibited within the firm. If even the best practice units are inefficient in some way, the potential savings internal benchmarking techniques identify will be less than those that could be achieved by moving to the current efficiency frontier. In Figure 3 below, internal benchmarking may identify current best practice as represented by OP\(_2\) rather than the true current efficiency frontier OP. Moreover, internal benchmarking is not able to identify potential future movements in the efficiency frontier. Due to these limitations, internal benchmarking is typically used as one of a range of analytical techniques to forecast future efficiency opportunities for a company.

**Figure 3 - Identification of best practice through internal benchmarking**

![Figure 3 - Identification of best practice through internal benchmarking](image)

**Section 4 - Analytical approach for delivery offices**

Benchmarking for purposes of cost targeting requires account to be taken of those factors outside the control of management, which have an impact on attainable costs levels. We asked Royal Mail to provide us with a list of the factors they considered to be most important in driving the difference in costs in between mail centres and between delivery offices. We used this and our own knowledge of the postal system to indicate the possible cost drivers.

**Cost drivers and factors outside management control**

We considered that for delivery offices we should include both volume of mail and type of mail. The volume of mail will impact final sorting and the weight/volume to be carried...
by the delivery person. The type of mail will impact the carrying capacity with bulky or heavy mail taking up more capacity than light mail. In practice, we used Royal Mail's figures for weighted volume based on their own work-study analysis for typical delivery patterns.

Also included were the number of delivery points, the distance between delivery points and the details of the terrain. The number of delivery points was considered important because it takes time to go from one delivery point to another, and the number of delivery points is expected to be a major determinant of delivery costs. A large volume delivered to a single delivery point may have small unit costs compared to a smaller volume spread over many delivery points. Similarly, the distance between delivery points was included as again this affects the time taken to complete a delivery round with a given volume and number of delivery points. The details of terrain were included as narrow, twisting, or hilly rural routes might be expected to incur higher unit costs than flat suburban delivery routes.

Factors influencing the availability and quality of the workforce were considered, including the wages paid by Royal Mail compared to local wage levels for equivalent jobs and the quality of the workforce available. Royal Mail has a national pay rate for jobs, with limited account taken of regional labour markets, except in London, where an additional allowance is paid. We considered that in some locations Royal Mail would be competing with other attractive occupations, while in others it would be able to choose from relatively highly motivated and able individuals. In practice we measure this effect through the average manual wage locally (the local level of the Royal Mail wage is also included, for obvious reasons.)

Finally, we included the level of mechanisation, although we appreciate that there is limited scope for mechanisation at the final delivery stage, and we expect that Royal Mail would have applied technology as appropriate to the location, e.g. use of trolleys, bicycles or vans.

**Information**
The data for this study was provided by Royal Mail, after consultation on cost drivers.
We examined the data for possible errors by examining summary statistics, scatter graphs and frequency distributions, which gave rise to certain questions. Royal Mail examined the data further, and suggested that we omit certain delivery offices, as the data on weighted volume for these observations was likely to be inaccurate. We also omitted data for the Northern Ireland offices as data on geographic variables, such as road distances were missing. The sample used for the empirical analysis comprised 1,108 delivery office, representing 80.5% of the UK delivery offices, which total 1,377.

**Estimation**

In choosing a functional form it is necessary to capture essential features of the data generating process. In this case we need a function that would reflect potential economies of density, allow for increasing or decreasing returns to scale if relevant, and contain other possible cost drivers such as terrain, mechanisation, input prices, and other activities. A Cobb-Douglas cost function fulfilled most of these requirements.

This takes the form, for the $k^{th}$ observation:

$$\log C_k = a + b \log Q_k + \sum c_i \log X_{ik} + w_k$$ (1)

Where $Q = output$ and $X$ are the other factors which determine the cost level.

The trans-log functional form is a popular alternative in academic circles. This is considerably more complex, containing terms for the cross products of the variables in (1):

$$\log C_k = a + b_0 \log Q_k + d (\log Q_k)^2 + \sum c_i \log X_{ik} + \sum c_{ij} \log X_{ik} \log X_{jk}$$

$$+ e b_j \log Q \log X_j + w_k$$ (2)

This functional form greatly increases the number of parameters since each variable is multiplied by itself and all the other variables. So if we start with nine variables in a Cobb-Douglas model we can end up with $9^2 = 81$ variables with a trans-log form. (The trans-log form was originally developed in a context where the number of $X$ variables was strictly limited.)
In the present application we looked at the results of a trans-log formulation, but the implied elasticities were wildly implausible and violated all norms of economic theory. We also experimented with some versions involving a limited number of quadratic and interaction terms but again, we were unable to get plausible results for these more complex forms.

We carried out both ordinary least squares and stochastic frontier estimation. Stochastic frontier estimation assumes that the error term is a composite:

$$\epsilon_k = v_k + \mu_k \quad (3)$$

Where $\mu_k$ is the one-sided inefficiency term and $v_k$ is the symmetric error term reflecting stochastic occurrences, measurement error in the dependent variable, and the effect of omitted variables uncorrelated with the included variables.

For most of our estimation we used William Greene's Limdep software package (Version 8) but the results were cross-checked with Stata (version 8.1).

**Variables employed**

Our primary output measure, reflecting the scale of operations of the delivery office, was the number of delivery points (NDP in the table below). Output density was measured by weighted volume per delivery point (VOLNDP), with the weightings provided by Royal Mail. Taken together, these two variables represented the main output dimensions of the delivery function. Terrain was captured by the length of road/delivery points (ROADNDP) plus a series of dummy variables (DELZONE1, etc.) representing rural, suburban, urban and city centre locations. Avoiding the "dummy variable trap" meant that the "deep rural" dummy variable was omitted so these locations were the base from which other locations were measured. We used Royal Mail's groupings of areas to decide whether delivery offices were classified as rural, suburban, urban and city centre locations. Royal Mail makes these classifications based on the density of delivery points and the number of business delivery points.
The input price was measured by the Royal Mail local wage rate \((WAGE)\) and input quality was measured implicitly by taking the local average manual hourly wage rate \((LOCALW)\). Mechanisation was measured by the number of "RM2000" sorting frames. These are not high technology, but reflected what we took to be Royal Mail’s view of a possible difference in sorting technique.

We should expect a high proportion of business mail to result in a somewhat different distribution of mail because it is often delivered on separate routes to household mail using vans to deliver the mail. Therefore, we included the proportion of delivery points which were to businesses as an additional possible cost driver \((BUSNDP)\), although we had no strong prior views about the net effect on costs. Royal Mail told us that this was an important cost driver as it influenced the volume per delivery point and the mode of transport used for that mail.

Finally, we took account of the fact that local sorting offices have additional costs when people move house and have their mail re-directed to their new address. This was provided to us by Royal Mail as the number of redirections \((REDIRECTIONS)\).

**Section 5 - Analytical approach for mail centres**

**Cost drivers and variables outside management control**

The cost function for mail centres included, as measures of output and factor prices, volume and type of mail, with a measure for these variables provided by Royal Mail in the form of weighted volume, and local wages paid by Royal Mail.

Mechanisation was also included as we thought the availability of sorting machines by type might influence how the mail is handled, and hence have an impact on costs. Although this is strictly speaking under management control, we were interested to check for the possibility of trade offs between labour and capital costs. Also included was the proportion of mail within each mail centre that had to be walksorted.

We also included the mail destination and the details of the terrain as cost drivers. Mail for local, neighbouring or distant destinations has different handling requirements and dispatch times, so that the composition of mail by destination can be expected to have a
material impact on costs. Royal Mail classifies mail as local where it is for an address covered by the same mail centre, neighbouring, where it is for an address covered by an adjacent mail centre and distant, for an address covered by any other mail centre. As for the details of terrain, urban areas, being more congested for transport, will affect collection time windows and hence costs.

Finally we considered the physical characteristics of the mail centre as different layouts of, and functions within mail centres might impact costs by facilitating or impeding the smoothness of sorting operations.

Information
Data on 70 Mail Centres were provided by Royal Mail, after consultation on cost drivers. As with delivery offices, the data was subject to preliminary consistency checks, which gave rise to questions on volume measures. Royal Mail examined the data further, and informed us that the discrepancies that we had found between total weighted volume and its individual components were due to the exclusion of one component from the dataset. Mail delivered directly to large customers had been excluded from the original data set sent to us. Delivered mail was a small amount, and it was only present in 6 mail centres. Royal Mail informed us that the weights attached to this delivered volume were delivery office weights, and as such the weighted delivered volume figures were overstated and would lead to an over estimate of the workload of the 6 mail centres and hence their relative efficiency. For this reason, we omitted weighted delivered volume from the weighted volume figures.

Estimation
For mail centres, as well as for delivery offices, the Cobb-Douglas function was found to be the best functional form for the cost function, on the basis of statistical tests and adherence to economic theory.

Given the relatively small size of the sample, 70 observations, degrees of freedom were important. For this reason, after having tested that the wage elasticity was indeed equal to the required value of 1, we divided total labour costs by the wage rate, and used this transformed variable as the dependent variable of the model. We also eliminated those
variables, which were highly insignificant – again to save degrees of freedom. Finally, we estimated the cost model using both OLS and a stochastic frontier model with a half-normal distribution for the efficiency component of the error term.

Variables employed
Weighted mail volume was employed as an output measure, reflecting the scale of operations of the mail centre. The main measure for the effect of mail destination on costs was the percent of inward mail whose destination is to areas within the territory covered by the mail centre. The percentage of mail walksorted at the mail centre captured the impact of walksorting, and finally the terrain was captured by the percentage of the mail centre area that is urban.

Section 6 - Results for delivery offices
In table 1, we report the results of the OLS regression and the stochastic frontier half-normal specification for the inefficiency error component, \( u_k \). Coefficients which are not significant at the 5% level have been reported in bold.
Table 1  Estimated cost functions for Delivery Offices

<table>
<thead>
<tr>
<th>Variable</th>
<th>DFA Coeff</th>
<th>DFA T-ratio</th>
<th>SFA Coeff</th>
<th>SFA T-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.78</td>
<td>-6.71</td>
<td>-2.63</td>
<td>-10.45</td>
</tr>
<tr>
<td>WAGE</td>
<td>1.09</td>
<td>10.69</td>
<td>1.03</td>
<td>10.67</td>
</tr>
<tr>
<td>LOCALW</td>
<td>0.12</td>
<td>1.58</td>
<td>0.10</td>
<td>1.36</td>
</tr>
<tr>
<td>VOLNDP</td>
<td>0.67</td>
<td>18.15</td>
<td>0.66</td>
<td>34.32</td>
</tr>
<tr>
<td>NDP</td>
<td>1.02</td>
<td>51.52</td>
<td>1.01</td>
<td>135.76</td>
</tr>
<tr>
<td>ROADNDP</td>
<td>0.08</td>
<td>5.66</td>
<td>0.08</td>
<td>5.89</td>
</tr>
<tr>
<td>DELZONE1</td>
<td>-0.10</td>
<td>-1.28</td>
<td>-0.10</td>
<td>-1.95</td>
</tr>
<tr>
<td>DELZONE2</td>
<td>-0.13</td>
<td>-1.99</td>
<td>-0.13</td>
<td>-2.58</td>
</tr>
<tr>
<td>DELZONE3</td>
<td>-0.10</td>
<td>-1.57</td>
<td>-0.09</td>
<td>-2.19</td>
</tr>
<tr>
<td>DELZONE4</td>
<td>-0.11</td>
<td>-1.88</td>
<td>-0.11</td>
<td>-2.87</td>
</tr>
<tr>
<td>BUSNDP</td>
<td>0.11</td>
<td>7.34</td>
<td>0.10</td>
<td>7.43</td>
</tr>
<tr>
<td>REDIRECTIONS</td>
<td>0.03</td>
<td>1.59</td>
<td>0.04</td>
<td>12.41</td>
</tr>
<tr>
<td>FRAMES</td>
<td>-0.002</td>
<td>-1.41</td>
<td>-0.001</td>
<td>-1.29</td>
</tr>
</tbody>
</table>

N 1108 1108
Log-Likelihood (adj R²=0.965) 677.3
Proportion of error that is inefficiency 1 (implicitly) 0.83

The column headed "coeff" shows the estimated impact of the variable on Royal Mail's costs. Since the variables are in logarithms, the coefficients can be interpreted as elasticities, that is the percentage increase in costs resulting from a 1% increase in that variable. The second column shows a standard diagnostic statistical test, the Student t-ratio. With 1108 observations a value above 1.96 indicates that it is very unlikely (< 1 in 20) that the observed relationship is due simply to chance, so it is said to be "statistically significant at the 5% level". We have indicated coefficients that are not significant at this level by bold type.

The Table shows the results of two estimation techniques: deterministic frontier analysis
(DFA) based on the standard method of ordinary least squares (OLS), and the more complex Stochastic Frontier Analysis (SFA) described above, which allows us to form an estimate of the proportion of deviations from the fitted curve which is due to error and the proportion due to variations in efficiency.

As Table 1 shows, the coefficients do not change very much in moving from OLS to stochastic frontiers we can’t say this because the SE in the SFA are biased. Regarding the values of the estimated coefficients, it is worthwhile to note that the coefficient on log (number of delivery points), being very close to 1.0 indicates constant returns to scale (CRS). The CRS hypothesis is not rejected according to a standard test.

The coefficient on volume per delivery point indicates substantial returns to density. Other things equal a 10% rise in volume raises costs by roughly 6.5-7%. As expected, a rise in Royal Mail wages of 10% gives rise to a 10% rise in labour costs. The coefficient on local wages is also interesting, tending to confirm that higher local wages results in a reduced level of productivity in Royal Mail employees, but the coefficient is only significant at 11%.

We also carried out a data envelopment analysis (DEA), which instead of fitting a curve through the observed data points, in effect fits an “efficient frontier” around the observations using a technique of linear programming. Because of the hybrid nature of our econometric cost function, which involves a mixture of constant returns to scale and increasing returns to density, we used a DEA specification which allowed us to incorporate these two aspects. There is insufficient space to provide details here (a separate paper is in preparation), however the hybrid DEA estimation provided estimates which are consistent with the econometric approach reported here.

Royal Mail response
Royal Mail asked its consultant to looks at our results, and it offered a number of comments and suggestions for improvements. Most of the suggestions would have

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5 Oxera, A review of LECG’s Delivery Office and Mail Centre data envelopment analysis modelling – report prepared for Royal Mail, September 2005; and
resulted in a reduction in the estimated scope for cost savings.

First, it suggested using a translog functional form (discussed above). However, this gave rise to estimated elasticities that were implausible and we deduced that this was probably the result of overfitting. Second, the consultant also claimed that we should ignore the OLS results because SFA worked well for delivery offices. We preferred to be sure that all the methods yielded coherent results. Finally, it suggested using a truncated normal or exponential form for the distribution of the inefficiency term. However, the results which the consultant provided to us on the truncated normal model were not valid because the model did not converge. The exponential model did converge but it did not have the same well-studied properties as the half-normal. We did however take the consultant’s point and in calculating efficiency savings from the frontier models we took the average between the savings from the half normal and those from the exponential distribution.

**Implied efficiency savings**

Our initial findings were that savings in the range £263m to £270m per year were achievable simply by applying existing best practices within the delivery office network. These savings were obtained using the decile benchmark for DFA and DEA (that is, setting the efficiency level of the worst delivery office of the top decile at 100%), to which a 10% discount was added, to account for measurement error and the effect of casual events and omitted variables. The relevant benchmark for SFA was the average value of the inefficiency component. For our initial conclusions, the DFA and SFA estimates were within 5% of each other. For our final conclusions, under our central case, we find that the DFA and SFA results remain close. However, after taking account of the applicable points made by Royal Mail’s consultant, we derived a lower case estimate of £220m, based on the average of the half-normal and the exponential distributions. This is around 10.9% of Royal Mail’s relevant costs.

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Oxera, A review of LECG’s Delivery Office and Mail Centre deterministic frontier analysis and stochastic frontier analysis modelling – report prepared for Royal Mail, September 2005
Section 7 - Results for mail centres

Table 2 reports the results of the OLS regression and the stochastic frontier half-normal specification for the inefficiency error component, $u_k$.

Table 2 – Estimated cost functions for mail centres

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS Coefficient</th>
<th>OLS T-ratio</th>
<th>SFA Coefficient</th>
<th>SFA T-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-8.71</td>
<td>-5.39</td>
<td>-9.31</td>
<td>-5.17</td>
</tr>
<tr>
<td>Dummy for small MCs</td>
<td>5.02</td>
<td>2.58</td>
<td>5.25</td>
<td>2.56</td>
</tr>
<tr>
<td>Volume</td>
<td>1.25</td>
<td>13.98</td>
<td>1.27</td>
<td>12.6</td>
</tr>
<tr>
<td>Volume * Dummy for small MCs</td>
<td>-0.29</td>
<td>-2.63</td>
<td>-0.29</td>
<td>-2.6</td>
</tr>
<tr>
<td>Percent of intra-MC inward mail</td>
<td>0.81</td>
<td>1.61</td>
<td>0.85</td>
<td>1.29</td>
</tr>
<tr>
<td>Percent of mail that is walk sorted at MC</td>
<td>0.89</td>
<td>3.05</td>
<td>0.91</td>
<td>3.98</td>
</tr>
<tr>
<td>Percent of MC area that is urban</td>
<td>0.39</td>
<td>3.86</td>
<td>0.37</td>
<td>3.83</td>
</tr>
<tr>
<td>Number of observations</td>
<td>69</td>
<td></td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>R$^2$/Log-L</td>
<td>0.959</td>
<td></td>
<td>43.11</td>
<td></td>
</tr>
<tr>
<td>Adj. R$^2$</td>
<td>0.955</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Estimation of a basic Cobb-Douglas model, with the same volume coefficient across the 70 mail centres showed that the hypothesis of constant returns to scale was rejected. We carried out statistical tests to ascertain whether the CRS assumption held for at least part of the sample. Our results, which are reported in table 2, showed that the impact of volume on costs was different for small and large mail centres.

Large mail centres, defined as those with volume above the median value, experienced diseconomies of scale, with a 10% increase in volume bringing about a 12.5% increase in costs. Small mail centres had instead constant returns to scale. The coefficient on volume for small mail centres, given by the sum of the two volume coefficients in table 2, is not statistically different from 1. Our results therefore showed that large mail centres were experiencing additional costs, i.e. efficiency losses, because their size in terms of
output had been extended past the region where returns to scale are constant. Figure 4 shows these additional losses.

**Figure 4 - Heuristic description of Mail Centre cost function**

Royal Mail’s response

As with the delivery office results Royal Mail asked its consultants to critique our results. It was claimed that our findings of diseconomies of scale at large mail centres only was driven by two factors - the exclusion of delivered volume from the volume figure and the inclusion of an outlier, London Central mail centre, in the sample. However, we found that our findings of diseconomies of scale were robust to the inclusion of delivered volume in the volume figure, and that the results obtained in the critique to our work were due to a data error. Also, applying statistical testing procedures we found that London Central, albeit a large mail centre, is not an outlier. We also found our findings of diseconomies of scale to be robust to functional specification, because it was confirmed by the results from an alternative and equally valid cost model, which was a quadratic specification.

It was also pointed out that our stochastic frontier model could not distinguish between
noise and inefficiency. However, we found the inability of the stochastic frontier model to distinguish between noise and error to be caused by the effect of an outlier – Inverness mail centre. The exclusion of this mail centre had no impact on either the estimated cost functions or inefficiencies, whilst allowing our original and alternative models to distinguish between noise and inefficiency.

**Implied efficiency savings**

On the basis of the cost functions presented here, we estimated that efficiency savings for mail centres could total approximately £100m (around 14% of relevant Royal Mail costs. These savings were obtained using the decile benchmark for DFA and DEA (that is, setting the efficiency level of the worst delivery office of the top decile at 100%), to which a 15% discount was added, to account for measurement error and the effect of casual events and omitted variables. The relevant benchmark for SFA was the average value of the inefficiency component. These savings would originate from bringing the performance of all mail centers close to that of the best one. These savings did not include those that could be achieved by removing the losses due to diseconomies of scale, as shown in figure 2 above. These additional savings would amount to £50m.

**Section 8 - Lessons learnt**

We believe that the internal benchmarking results provide very powerful information to inform the regulatory price setting process about the spread of efficiency performance within the postal operator. The large sample sizes for delivery offices and mail centres help ensure that the results are robust.

If Postcomm carried out this analysis in the future there are a number of extensions that could be made to further improve its quality.

First of all, the quality of data collection could be improved. This first round of cost analysis has uncovered a number of areas in which Royal Mail could improve on data measurement. Data problems were analysed at length as part of LECG’s cost analysis, and the results from that analysis, although beyond the scope of this paper, are
discussed extensively in its report\textsuperscript{6}.

Also, the analysis carried out by LECG for Postcomm was based on only one year of information. Developing the analysis to cover multiple years would make results even more robust. Multiple years of information would help eliminate the importance of any inaccuracies in information that affect annual information. They would allow the analyst to take into account the heterogeneity that characterises delivery offices and mail centres. And lastly, but not less importantly, having repeated information for each delivery office or mail centre would allow the estimation of stochastic frontier models which would yield correct and precise estimates of the efficiency of a single unit. This estimation is not possible with single-year data.

Section 9 - Policy implications

Postcomm used the conclusions of the internal benchmarking analysis to inform its decision to base its proposals for Royal Mail’s price control on a 3% annual efficiency saving for operating costs. Although Postcomm’s decision was based on the range of analytical techniques discussed above, the internal benchmarking results were regarded as particularly powerful because they were based on Royal Mail reaching levels of performance already being achieved elsewhere in Royal Mail. As the internal benchmarking took account of the technology used in delivery offices and mail centres, the efficiency savings did not depend on any investment by Royal Mail.

When regulating a number of companies operating in the same industry, such as regional water companies in the UK, regulators can compare the performance of each company to identify the efficiency frontier and provide incentives for companies not currently at the frontier to reach and exceed it. This has sometimes been called yardstick competition. When regulating a single company, the regulator does not have access to this type of comparative efficiency information between companies. This tends to increase the reliance regulators place on other analytical techniques such as bottom-up analysis, total factor productivity and international benchmarking. While all of these techniques can yield powerful results, they do not involve comparative

\textsuperscript{6}LECG, Future Efficient Costs of Royal Mail’s Regulated Mail Activities, August 2005
benchmarking of identical or very similar activities carried out by another company.

The organisation of postal operators, based on repeating the same functions in each geographic area can provide internal company comparisons of performance that can yield very similar information to comparisons between companies carrying the same or very similar functions. Internal benchmarking analysis of this type allows regulators to identify the internal efficiency frontier. As all units are within the same company there will not be the same incentive to extend the frontier as with yardstick competition between companies, unless internal performance incentives encourage this type of internal competition. Therefore, it will be necessary for the regulator will have to supplement internal benchmarking with such techniques as international benchmarking to identify an industry efficiency frontier. We believe that internal benchmarking of the type carried out in this paper can be used by regulators setting ex ante price controls for postal operators, although it will need to be supplemented by other analytical techniques.

Section 10 - Conclusions
This paper explains how Postcomm and LECG applied advanced quantitative econometric techniques to analyse the relative efficiency of Royal Mail delivery offices and mail centres. This analysis showed the potential for very significant efficiency savings within Royal Mail by moving units towards internal best practice. Postcomm was able to use the results of the analysis alongside other analytical techniques to set a price control for Royal Mail from 2006 to 2010, with strong efficiency incentives.

Postcomm and LECG consider that internal benchmarking of the type explained in this paper can be used by regulators and company management within postal operators to identify internal efficiency frontiers. While internal benchmarking will not necessarily identify industry efficiency frontiers it provides strong evidence of what a company can achieve without further investment because the frontier is based on performance being achieved somewhere else in the company.
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