Productivity, efficiency and growth

Prepared for National Grid

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1 Introduction

Ofgem has recently published its initial proposals for RIIO-GD1 and RIIO-T1.[1] National Grid commissioned Oxera to set out the key issues regarding efficiency and productivity, and the relationship with changes in volumes and consequent implications for cost forecasts. As such, this report considers the notions of productivity and efficiency, based on economic theory and current academic thinking. These theoretical notions are then linked to applied work undertaken in the regulated setting, specifically in discussion about cost-reduction targets and the relationship with changes in volumes. This report does not examine the robustness of National Grid's business plan or the assumptions therein, but considers what information, within the context of efficiency and changes in volume, is required in order to be able to provide a robust case.

This is particularly important since, in electricity transmission for example, NGET is forecasting significant growth in workload, driven by the need to connect new renewable sources of generation and replace old assets (eg, a 21% increase in switchgear and modern equivalent asset value (MEAV) over the RIIO-T1 period). In contrast, for gas distribution, gas demand has been falling for around a decade, and repair workloads are expected to fall significantly over the RIIO-GD1 period.

The underlying aim of the report is to clarify these issues in order to provide a basis for assessing National Grid's potential for future efficiency improvements.

[1] Ofgem (2012), 'RIIO-T1: Initial Proposals for National Grid Electricity Transmission and National Grid Gas: Initial Proposals – Overview Document', July; and Ofgem (2012), 'RIIO-GD1: Initial Proposals – Overview: Consultation', July.

2 Productivity and efficiency

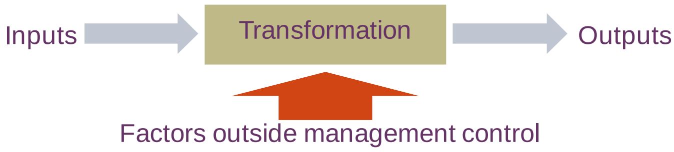
The notions of productivity and efficiency are related yet separate.

Productivity measures the performance of a single company over time. Growth in productivity means that the company has improved its performance relative to the past, while a decline in productivity means that performance has deteriorated. Formally, productivity is defined as the ratio of a volume measure of outputs, be it goods or services, to a volume measure of the inputs used in their production. Productivity can also be estimated using cost information, which is the more common approach used in regulated industries. In this case, productivity is the ratio of costs to outputs and input prices.

One of the simplest productivity measures, real unit operating expenditure (RUOE) is a partial productivity indicator based on operating expenditure (OPEX) only. It assumes that input price changes over time for the assessed company are captured by the Retail Prices Index.

Efficiency measures the performance of a company at a particular point in time relative to a set of peers—ie, a number of other similar companies. Formally, efficiency is defined as the ratio of actual outputs to 'optimal' outputs, for set input levels, or the ratio of 'optimal' inputs to actual inputs, for set output levels. The efficiency of a self-contained unit can be considered in terms of the efficiency in its transformation of inputs into outputs, given external factors that might have an impact on this relationship (eg, bad weather). This is illustrated in Figure 2.1.

Figure 2.1 Illustration of the production process



Source: Oxera.

These issues are discussed in more detail below.

2.1 Productivity

Productivity is defined as the performance of a unit (eg, a company) over time, and can be measured as:

$$\text{productivity (production)} = \frac{\text{outputs}}{\text{inputs}} \qquad \text{Equation 2.1}$$

$$\text{productivity (cost)} = \frac{\text{costs}}{\text{outputs, input prices}} \qquad \text{Equation 2.2}$$

An example of the former measure is total factor productivity (TFP), which Ofgem uses (based on EU KLEMS data) in its assessment of the potential for ongoing improvements. An example of a productivity (cost) measure is RUOE, where:

$$\text{RUOE} = \frac{\text{operating costs (real)}}{\text{single output}} \qquad \text{Equation 2.3}$$

RUOE is a partial productivity measure, since it considers only part of the cost base and only a single output. It is simple to estimate, but might not provide a comprehensive estimate of productivity change.

The main focus of interest with productivity measures is changes in productivity over time; the productivity of a single time period is meaningless if there is no reference point (ie, past performance or external benchmarks). Such measures are generally used in a regulatory setting to establish a benchmark for rate of change in ongoing performance, or frontier shift as a result of technological progress.

2.2 Efficiency

Efficiency is defined as the performance of a unit (eg, a company) at a particular point in time *relative* to a peer set (a set of other similar units), and can be measured as:

$$\text{efficiency (production)} = \frac{\text{outputs}}{\text{optimal outputs (given inputs)}} \qquad \text{Equation 2.4}$$

or

$$= \frac{\text{optimal inputs (given outputs)}}{\text{inputs}} \qquad \text{Equation 2.5}$$

$$\text{efficiency (cost)} = \frac{\text{optimal costs (given outputs and input prices)}}{\text{costs}} \qquad \text{Equation 2.6}$$

Efficiency (cost) is a more general measure than the efficiency (production), since it contains information on input prices.

Efficiency is always a positive number, less than or equal to 1 (with a value of less than 1 indicating inefficiency). It measures performance at a particular point in time, but it can be compared over time to examine whether efficiency is improving.

There are a number of methods to estimate ‘optimal’ (or benchmark) costs; although all of them require access to external information (a peer set or industry experts), such as the International Transmission Operations & Maintenance Study (ITOMS).[2]

2.3 Productivity and efficiency over time

Efficiency and productivity analysis can be combined, which allows for the productivity change to be broken down into catch-up and frontier shift:

productivity change = efficiency change (catch-up) × technological change (frontier shift)

where:

[2] UMS Group (2011), ‘International Transmission Operations & Maintenance Study (ITOMS): Report prepared by UMS of National Grid Electricity Transmission’s 2009 Results’, February.

- *efficiency change* measures how performance has changed from one period to the next, with reference to a peer set;
- *frontier shift* measures how 'best practice' (optimal performance) has changed from one period to the next.

This can be further decomposed into:

productivity change = efficiency change (catch-up) × technological change (frontier shift) × scale efficiency change

where:

- *scale efficiency change* measures improvements in efficiency owing to a company moving closer to the most productive scale size.

The scale efficiency change can be important where companies have control over outputs and can improve their cost efficiency by increasing their size, provided that they are currently operating under economies of scale,[3] as this will result in lower unit costs.[4] In a regulated sector, it is generally not an objective of a regulator at a price control review to move companies towards a more productive scale size.[5] However, what is important in a price control context is that any future cost forecasts or productivity comparisons over time take into account the impact of changes in volume on costs. This is considered in the next section.

2.4 Growth in output and workload

2.4.1 Output versus workload

In all the efficiency and productivity measures discussed, the volume measure is based on a measure of *output*. Thus, an increase in output, for a given level of input, would be considered an improvement in productivity, all else being equal. Given the impact of output growth on costs and measures of efficiency and productivity, it is important that output forecasts are robust and assessed by Ofgem. (Although not the focus of this report, it is worth noting that any outturn errors in the forecasts can also be mitigated through the use of uncertainty mechanisms.)

In contrast, an increase in *workload* represents an increase in inputs, and would be considered as a reduction in efficiency, unless such an increase results in a proportionate increase in output. Thus, any increase in workload would need to be justified on the basis of the resultant improvement in output, or justified on cost–benefit terms owing to network need/condition of assets and mitigating reductions in service if such expenditure were not undertaken.

Once forecasts of both output and workload are agreed, the implication for costs has to be considered. This is examined below in subsequent sections. First, however, the appropriate measures for output or workload are considered.

[3] Or by decreasing their size, if they are currently operating under diseconomies of scale.

[4] Economies of scale are measured in terms of the relationship between costs and volume. In network industries there tend to be high fixed costs of production. In such circumstances, increasing volumes results in lower unit costs as the fixed costs can be spread over a greater number of units. In such instances the economies of scale estimate is less than 1—ie, for a 1% increase in scale, costs increase but by less than 1%. However, this does not apply if the increase in volumes also requires additional fixed costs (ie, a larger network).

[5] Although it might be a longer-term government policy objective to do so (eg, by encouraging consolidation), for example if the industry is particularly fragmented.

2.4.2 The appropriate measures of output or workload

When talking about economic growth in the microeconomic setting (ie, at company level), economists mean growth in either the volume of outputs produced or their value. Given that National Grid is a regulated transmission and distribution company with a well-defined mandate regarding its operations, growth in this context should be linked with increased demand in National Grid's outputs.

To explore this issue further, the outputs of National Grid's businesses need to be defined in economic terms. A narrow assessment might be that the most important output for an electricity transmission operator, for example, would be the amount of electricity transmitted over the network. However, while electricity transmitted is an important metric, the main function of a transmission company is to operate, maintain, expand and enhance the electricity transmission system under its care, according to current and future customer needs. In more detail, the main functions of a notional transmission system operator (TSO) are as follows:

- overseeing the function of the electricity exchange (wholesale market);
- operating the transmission system (load balancing);
- network planning;
- network construction;
- network maintenance;
- financing/headquarter activities (including administration and support).

These functions are complex and cover many activities. As such, there is no one clear 'output' that the regulator could use to monitor the performance of the transmission company undertaking them. For example, NGET considers its key output measures to be reliability, connections, safety, environment and customer satisfaction.[6] In addition, in some cases the output measure (eg, reliability or safety) can remain relatively fixed, while the related workload may require significant increase.

There are several options that could be considered to address this issue.

- *Use a single measure* that is as broad as possible that captures the above functions, such as switchgear or connections, although this measure might be considered not to encompass enough (in which case, several measures or a composite measure might be chosen, such as a composite output (or scale) variable, CSV, or, on the workload side, MEAV).

- *Identify the key output measures for each cost line within the plan*, and/or, if considering the impact of workload, the key workload measures for each cost line. For example, it might be possible to align each cost line of the plan with the most significant (or primary) cost driver in each case, such as NGET's key output measures.[7] The key workload measures for each cost line might include length of overhead line, length of cables, number of transformers, and amount of switchgear. Given that some output measures will remain relatively fixed, the related workload measure(s) required to maintain that level of output would need to be justified on cost–benefit terms. The implication for the required costs would then need to be calculated according to the required workload.

- *Use outcomes instead of outputs*—the impacts of the activities undertaken by the notional transmission company on the services it provides. The use of outcomes in performance monitoring is not new; the Office for National Statistics (ONS) and Eurostat have both been strong advocates of using outcomes to measure the performance of the

[6] National Grid (2011), 'National Grid's Electricity Transmission RIIO-T1 business plan headlines', July, pp. 6–7.
[7] As National Grid has done. See National Grid (2011), 'National Grid's Electricity Transmission RIIO-T1 business plan headlines', July, p. 6.

public sector.[8] Ofgem also supports the use of outcomes when monitoring NGET. The regulator's proposed output and incentive parameters for NGET in RIIO-T1 include outcomes on:

– safety;
– reliability;
– availability;
– customer satisfaction;
– connections;
– environmental;
– wider works (new investment).

These outcomes overlap considerably with NGET's key output measures. However, outcomes are almost always relatively general in nature; to incorporate them in any planning, strategy or performance analysis, one would need to find quantifiable indicators. However, at this stage it is not clear whether all the proposed indicators are fit for use in a performance assessment, given the relatively fixed nature of some of these measures (eg, safety and reliability) versus the workload required to maintain them at that level. In some cases, therefore, the focus may need to be on workload. Nevertheless, these outcomes, together with robust evidence on the required workload to deliver them, would be key in supporting the case on future cost requirements.

As such, the identification of the most relevant output and workload measure(s) will be critical.

2.5 The impact of output growth

The fact that most natural monopolies have high fixed costs means that, in general, unit costs decline as more units of output are produced (ie, increasing returns to scale). Costs can be adjusted to account for the presence of economies of scale using the following formula, all else being equal:

$$cost_t = cost_{t-1} \times (1+\triangle output_{t-1,t} \times \varepsilon) \quad \text{Equation 2.7}$$

where $cost_t$ is the cost in the current year; $\triangle output_{t-1,t}$ is the change in output from (t – 1) to t; ε is the cost elasticity (or economies of scale). For example, if $\varepsilon = 0.9$ then a 1% increase in the relevant output measure results in a 0.9% increase in cost.

When considering improvements in productivity (cost) over time, changes in real unit costs can be examined. The change in RUOE is defined as:

$$\Delta RUOE_t = ((unit\ cost_t/unit\ cost_{t-1}) - 1) \times 100 \quad \text{Equation 2.8}$$

where $unit\ cost_t$ is the current unit cost at year t, and $unit\ cost_{t-1}$ is the unit cost in the previous year.

As a unit cost measure, Equation 2.8 assumes that costs change in direct proportion to the unit of output. However, Equation 2.7 above implies that:

$$RUOE_t \times output_t = cost_{t-1} \times (1+\triangle output_{t-1,t} \times \varepsilon) \quad \text{Equation 2.9}$$

As such, RUOE can be adjusted to account for the presence of economies of scale using the following formula:

[8] See Atkinson, T. (2005), 'Atkinson Review: Final Report—Measurement of Government Output and Productivity for the National Accounts', available at http://ons.gov.uk/ons/about-ons/what-we-do/programmes---projects/completed-projects-and-reviews/atkinson-review/final-report/atkinson-review-final-report---download.pdf, accessed September 7th.

$$RUOE_t = cost_{t-1} \times (1+\triangle output_{t-1,t} \times \varepsilon)/output_t \qquad \text{Equation 2.10}$$

where $output_t$ is output in the current year. This implies that:

- **any comparison of RUOE trends needs to take account of the above relationship in order to provide a like-for-like comparison;**
- **any forecasts of costs need to take into account the relationship between costs and output.**

Appendix 1 presents examples of regulatory precedent where the relationship between cost and volume has been taken into account.

3 Implications for National Grid

Having examined productivity and efficiency from an economic theory perspective, this section considers the implications for National Grid.

3.1.1 Distinguishing between frontier shift and catch-up

When a regulator sets targets, it often considers both:

– the efficiency of the regulated company at the time of the price control review, in order to identify the potential for catch-up efficiency improvements; and
– the potential for frontier shift that could be achieved within the subsequent regulatory period.

This is especially the case in regulated sectors that have a regional structure, such that comparative efficiency assessments are relatively straightforward. Indeed, this is the approach that Ofgem adopts for gas distribution. While, for gas transmission, Ofgem has derived a frontier shift, it is less clear how the catch-up assumption is derived. For example, Ofgem does not provide an explicit split; rather, it states that:

> In their methodology the consultants have applied an efficiency factor of 2.25 percent. We agreed with the consultants proposals although it is higher than our assumed efficiency of 1 percent. NGET have consistently overspent (or forecast to overspend) in the TPCR4+R period and therefore we believe an element of catch up efficiency is required. We note that the efficiency factor of 2.25% is less than the efficiency factor of 2.50% claimed by NGET in their business plans.[9]

Similarly, the basis of NGET's efficiency assumptions is somewhat unclear. Indeed, Pöyry (2012) argued that 'the method of application of these efficiency improvements to the forecasts is not clear'.[10] **As such, it would be helpful to provide a more transparent exposition of the assumptions for catch-up (and, thus, relative efficiency) and frontier shift when deriving the forecast costs, including what volume growth represents: output growth and/or input/workload growth.**

In addition, the relationship between costs, outputs and volumes needs to be carefully considered. This is examined below.

3.1.2 The impact of output growth on future unit costs

As discussed above, there is an important distinction between volume related to *output* and that related to *workload*. The former represents an increase in outputs and would be considered an increase[11] in efficiency; while the latter represents an increase in inputs and would be considered a reduction in efficiency. As such, when forecasting future cost requirements:

– reductions in output would be expected to increase unit costs through reduced economies of scale, while increases in output would be expected to reduce unit costs. National Grid should examine its efficiency case in terms of the improvement in unit costs, taking account of any increase in output or workload. A simple comparison of unit costs over time, however, would give a biased view of improvements in efficiency, as National Grid's unit costs should naturally fall as output increases due to the effect of

[9] Ofgem (2012), 'RIIO-T1: Initial Proposals for National Grid Electricity Transmission and National Grid Gas: Cost Assessment and Uncertainty Supporting Document', para 6.34.
[10] Pöyry (2012), 'RIIO-T1 Stage 4: NGET Controllable OPEX Final Assessment: A Report to Ofgem', p. 55.
[11] Unless such an increase results in a proportionate increase in output.

economies of scale (even if efficiency were unchanged). Such a comparison—or, indeed, **any forecast of National Grid's costs—should take into account the relationship between costs and output (as given by the cost elasticity)**. Furthermore, identification of the most relevant output measure would also be critical (eg, MEAV or switchgear volumes);

and:

– **any increase in workload[12] should be justified on the basis of the resultant improvement in output or on cost–benefit terms owing to network need/condition of assets and mitigating reductions in service if such expenditure were not undertaken**. (For example, not undertaking the workload could ultimately reduce outputs given that not maintaining the assets would be likely to lead to reliability or safety issues.)

For example, for NGET, of £14 billion of capital expenditure (CAPEX), 40% is related to replacing existing equipment and 60% to new connections (with MEAV or switchgear volumes increasing by around 2.5% per annum).[13] These components require different evidence/justification. In particular, in the first instance, NGET should provide a robust case with respect to its future volume growth and workload growth. (Oxera has not examined this aspect of NGET's plan.)

Having established a robust set of forecasts for workload and output, **the next step is to consider their impact on costs, which requires information on economies of scale** (see section 2.5). In terms of what adjustment should be made for economies of scale, Table 2.1 summarises some of the evidence on the relationship between costs and outputs in transmission. (The table does not represent an exhaustive literature review, although the literature on electricity transmission is not as extensive as some other sectors).

[12] For example, the additional maintenance workload that results from additional assets.
[13] NGET (2011), 'RIIO-T1 overview', July, p. 16.

Table 2.1 Economies of scale in electricity and gas transmission

Cost base	Volume measure	Economies of scale estimate	Source and country(ies) of analysis
Electricity transmission			
Total expenditure (OPEX + CAPEX)	Grid size, connection density, connected renewable energy sources	0.86, of which grid size, 0.73; density, 0.09; connected renewable energy sources, 0.04 (unit elasticity utmost)	Agrell and Bogetoft (2009) (19 European countries)
Average variable cost	Transformer capacity (MVA), transmission wages	0.66 (0.62–0.72)[1]	Dismukes et al. (1998); USA
Gas transmission			
Total expenditure defined as operating and maintenance expenditure plus depreciation and cost of capital (gas T)	Delivery volume, compressor capacity and network length	0.7 (the authors argue that the scale drivers, network length and compressor capacity are key since most costs are fixed)	Jamasb, Pollitt and Triebs (2008), USA
Variable cost	Gas transported (billion cubic feet-miles)	0.63–1.17 (but indifferent to unit elasticity)	Sickles and Streitwieser (1998), USA
Variable cost (sum of maintenance and operational expenses)	Total volume of gas transmitted, pipeline length	0.63	Granderson and Linvill (1996), USA
NGET			
Total controllable OPEX	MEAV Switchgear	0.74 0.71	Oxera calculation based on NGET data

Note:[1] In the USA, transmission and distribution are vertically integrated.[2] These are estimates for power transmission and distribution together.
Source: Agrell, P. and Bogetoft, P. (2009), 'International Benchmarking of Electricity Transmission System Operators e3GRID Project: Final Report', Sumicsid. Dismukes, D.E., Cope III, R.F., Mesyanzhinov, D. (1998), 'Capacity and economies of scale in electric power transmission', *Utilities Policy*, **7**, 155–62. Jamasb, T., Pollitt, M. and Triebs, T. (2008), 'Productivity and Efficiency of US Gas Transmission Companies: A European Regulatory Perspective', April, working paper. Sickles, R.C. and Streitwieser, M.L. (1998), 'An analysis of technology, productivity, and regulatory distortion in the interstate natural gas transmission industry: 1977–1985, *Journal of Applied Econometrics*, **13**, pp. 377–95. Granderson, G and Linvill, C (1996), 'The impact of regulation on productivity growth: an application to the transmission sector of the interstate natural gas industry', *Journal of Regulatory Economics*, **10**, pp. 291–306.

This brief literature review suggests that economies of scale are between 0.6 and 1 in both gas and electricity transmission (with a central estimate of 0.8). Although it should also be noted that the relationship between costs and volumes depends on the cost base being considered—for example, the cost–volume relationship is likely to be more proportionate (ie, close to 1) when considering direct maintenance costs, whereas business support costs are more likely to be fixed in nature, and thus exhibit much lower economies of scale (ie, much less than 1).

A figure within the above range could then be used in Equation 2.7 above to adjust future cost growth, given forecasts for output growth. This should be combined with assumptions on efficiency. That is, **future cost forecasts can be established by accounting for economies of scale and future expected changes in volumes, together with forecast**

efficiency improvements, which are given by a combination of efficiencies in catch-up and frontier shift: Thus, future costs are given by:

cost × (1+ % volume change × e) × (1 – (catch-up + frontier shift))

The appropriate economies of scale estimate depends on both the cost base to which it is being applied and the related volume measure. Third-party evidence is unlikely to be available at a detailed cost-line level. Therefore, an aggregate or overall cost-level calculation[14] could be used to cross-check any bottom-up, or cost-line-based, calculations using internal estimates of economies of scale for each cost line. Estimates of economies of scale for each cost line could be based on an examination of historical evidence. Alternatively, the calculations could be undertaken at a more aggregate, or overall, cost level.

3.1.3 The impact of output growth on frontier-shift targets

The frontier-shift assumption will require adjustment depending on the forecast output growth.

The EU KLEMS analysis shows that average, long-run productivity growth in the UK economy as a whole is approximately 0.6% per annum.[15] Throughout this period, the total output of the UK economy has been increasing at an average rate of approximately 2%. The consensus in the academic literature is that productivity is *pro-cyclical*.[16] This means that productivity will grow more quickly in periods of economic expansion (growth), and, similarly, will deteriorate more quickly in periods of economic contraction (decreasing demand). To address this issue, frontier-based assessments usually examine trends over business cycles.

However, when subsequently applying the benchmark frontier-shift assumption to forecast future costs, the future output growth of the company will need to be considered. For example:

– NGET is forecasting significant growth in workload (eg, a 21% increase in switchgear and MEAV over the RIIO-T1 period) and in output (eg, increasing capacity flows across key boundaries). This volume growth might suggest that a greater frontier shift is possible than that achieved over one business cycle. (Based on discussions with National Grid, Oxera understands that both NGET and NGGT have considered the impact of this issue as part of their business plans on the transmission side);

– gas demand has been falling for around a decade, so NGGD and Ofgem both expect the key driver of OPEX activity—repair workload—to fall significantly over the RIIO-GD1 period. In this context, a smaller frontier shift is possible than that achieved over one business cycle.

[14] Based on third-party evidence for economies of scale, such as that given in Table 2.1.

[15] Based on value-added output measures, estimated using growth accounting over the 1970–2007 period.

[16] See, for example, Boisso, D., Grosskopf, S. and Hayes, K. (2000), ‘Productivity and efficiency in the US: effects of business cycles and public capital’, *Regional Science and Urban Economics*, **30**:6, December, pp. 663–81; and OECD (2001), ‘Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth’.

A1 Mechanisms to account for volume changes in the regulatory setting

There have been a number of cases where output volumes have changed significantly in regulated industries. This appendix presents three case studies from UK regulatory precedent that provide some detail on how the respective regulatory authority chose to account for the change in volume and the impact on costs. For each case study, the introductory section summarises the salient issues.

A1.1 Telecommunications

Over the last decade, BT experienced a trend of slowly declining volume of voice traffic (telephone calls) over its network. This created a challenge for the company, since one of the outputs used by Ofcom to assess BT's performance was based on the volume of calls. Although call volumes were declining, BT still required a similar level of expenditure to maintain its network. This situation was further complicated by the fact that BT was in the process of radically upgrading its network infrastructure to a newer standard. Acknowledging this, Ofcom, the regulator, noted that it is difficult to disentangle the effects of a reduction in volumes and the change in network technology from the increasing costs, as reported by BT.[17] Instead, it created a model to assess what the costs would be of a hypothetical network operator facing similar conditions (declining volumes and network technology change). The model suggested that BT's reported costs appeared to be similar to modelled costs; as such, Ofcom made a downward adjustment to the cost measure used for the performance to account for the likely impact of these factors.

Ofcom also considered whether declining volumes were likely to affect the estimate of the effects of economies of scale included in its adopted unit cost measure. Ultimately, it chose to use the estimate used in the previous price control review, since any new estimates would, in its view, be unreliable owing to changes in network technology.

The above issues, as well as a description of how Ofcom examined volume changes in other services provided by BT, are discussed in more detail below.

A1.1.1 Wholesale narrowband markets (BT's network costs)

In its price control reviews, Ofcom calculates unit costs as total *forecast* costs divided by total volumes (ie, number of circuits). The total costs were in turn a function of a number of variables including cost–volume elasticity (CVE), asset–volume elasticity (AVE), efficiency gain, and volume changes.

In its price control review for the 2009–13 period, Ofcom estimated the CVE to equal 0.25, highlighting substantial economies of scale.[18] It considered 'whether the CVEs used should be different from those used in the last charge control because of the projected decline in PSTN's volumes',[19] but concluded that the CVE should remain unchanged, given that the expected upgrading in network technology could render new estimates unreliable.

[17] Ofcom (2009), 'Review of BT's Network Charge Controls. Explanatory Statement and Notification of decisions on charge controls in wholesale narrowband markets', September 15th, para A2.46.
[18] The CVE was defined as the percentage change in costs for a 1% change in volumes. A CVE of less than 1 signifies the presence of economies of scale.
[19] Ofcom (2009), op. cit., paras 2.64–2.66.

A1.1.2 Openreach's local-loop unbundling and wholesale line rental services

Although economies of scale are mentioned as an efficiency driver, there does not appear to be an analysis of the impact of growth in volume metrics on efficiency forecasts.[20]

A1.1.3 Wholesale broadband access

Similarly, volume forecasts form a key component of cost estimates used in the first price control for segments of BT's wholesale broadband activities in the 2011–14 period.

Although BT's end-user volume is expected to decline (by 0.7%) as users shift to other providers, bandwidth per user is expected to increase (by 23% per year).

Ofcom did not undertake new analysis of CVE estimates for this price control review, instead using estimates from the 2004 PPC charge control, which equalled 0.24. These were in line with Ofcom's expectations that 'BT's economies of scale would mean that as volumes rise, unit costs would fall and vice versa'.[21]

A1.2 Postal services

The postal services sector faces major challenges in terms of volume decline reducing revenues while increasing unit costs.[22] To address this situation, Postcomm originally introduced a new volume-adjustment mechanism that was triggered if delivered volumes were more than 2% above or below the forecast cited in the price control review process. However, even this measure was deemed insufficient, and Ofcom later established a new regulatory framework, which came into effect in March 2012 and which effectively suspended[23] ex ante regulation for the next seven years.[24] Ofcom will still monitor Royal Mail's financial and operational performance, but the company has been granted more flexibility in setting prices, and more commercial and operational freedom. A more thorough discussion of the issues follows.

A1.2.1 Royal Mail

The volume of mail in the UK has fallen by around 20% in the last five years and further declines are expected at a rate of around 5% per year.[25] Furthermore, the revenue loss due to this volume decline has been compounded by customers moving from higher-value traditional products to lower-value services, such as bulk mail (post sent in high volumes typically by business customers). Together, these factors have meant that Royal Mail's revenues have fallen by more than 35% since 2006.[26]

According to Ofcom:

> as volumes have dropped, Royal Mail's average costs have increased. Unless Royal Mail can deliver efficiency gains that exceed the effect of volume decline, it will have to rely on increasing prices, which in turn is likely to exacerbate the decline in demand, further increasing unit costs, and putting additional upward pressure on prices.[27]

[20] Ofcom (2011), 'Charge control review for LLU and WLR services', Consultation Document, March 31st; and 'Charge control review for LLU and WLR services: Annexes', Consultation Document, March 31st.

[21] Ofcom (2011), 'Proposals for WBA charge control', January 20th, para 5.69.

[22] Although 16 billion letters were delivered to 28.8m addresses in 2010–11, with Royal Mail being responsible for 99% of these (see Ofcom (2012), 'Securing the Universal Postal Service: Decision on the new regulatory framework', March 27th, p. 1).

[23] Ex ante regulation for the majority of products has been removed. Ofcom will monitor performance and could reintroduce regulatory controls if Royal Mail is found to have earned high profits without making efficiency improvements.

[24] Ofcom (2012), op. cit., pp. 43–101.

[25] Royal Mail Holdings plc (2011), 'Annual Report and Financial Statements 2010-11', p. 3.

[26] Ofcom (2012), op. cit., p. 1.

[27] Ibid., p. 2.

A1.2.2 Volume downturn and risk mitigation

During the 2006–10 regulatory period, Postcomm (then regulator of postal services) considered that there was some evidence of a fall in volumes, but it was not clear whether this was a short-term effect or the start of a longer-term trend.[28] Nevertheless, it ensured that, if Royal Mail's volumes declined significantly, there would have been risk-sharing mechanisms in place for the company to recover an appropriate amount of additional revenue, recognising that its 'profits are sensitive to the volume of mail that it delivers, mainly because a large proportion of its costs are relatively fixed in the short term'.[29]

An automatic volume-adjustment mechanism was therefore introduced, which was triggered if delivered volumes were more than 2% above or below the forecast used to set the control.[30] In these circumstances, Royal Mail's revenues were adjusted by 40% of applicable downstream revenues. More precisely, it was:

– allowed to keep 60% of the total downstream revenue impact of actual mail volumes being higher than forecast, representing the *long-run marginal costs* associated with the higher mail volume, and had to forfeit 40% of the revenue associated with the higher mail volumes;
– compensated for 40% of the revenue associated with mail volumes being lower than forecast.

Among other concerns, Royal Mail considered that this overstated the cost reduction arising from a volume reduction, and therefore under-compensated the business for a given reduction in volume.[31]

A1.3 Airports

The effects of changes in output play an important part in regulatory price control reviews of airports in the UK and in Ireland, since the preferred measure of productivity adopted by both regulators is based on passenger numbers. The views of the two regulators on how the adopted productivity measure should be adjusted to account for changes in passenger numbers are presented below.

A1.3.1 The CAA's review of London airports

Heathrow, Gatwick and Stansted have demonstrated a steady trend of passenger increases over the past decade. All three are regulated by the Civil Aviation Authority (CAA), which uses 'passengers per man-year' (ie, the ratio of passengers to employee hours in a year) to assess the performance of the airports. This is a partial productivity measure based on the production function, since it is effectively a ratio of outputs (passengers) to inputs (employee hours).

In its analysis for the 2008–13 price control, the CAA observed that there were significant improvements in this partial productivity measure, even after taking into account various outsourcing initiatives that served to reduce reported employee hours (direct labour). It also noted, however, that improvements on this measure were mainly influenced by increasing passenger numbers. The CAA has stated that:

> as passenger numbers rise, the ratio of passengers to man-years will tend to increase as there is a proportion of posts (e.g. staff at BAA's corporate centre) that do not

[28] Postcomm (2005), 'Royal Mail Price and Service Quality Review: Final Proposals for Consultation', December; Postcomm (2006), ''Royal Mail's Price and Service Quality Review 2006-2010: Licence Modifications Proposals', March.
[29] Ibid., p. 100.
[30] Postcomm proposed the 2% corridor to reflect broadly the level of volumes at which Royal Mail's financial position could begin to be impaired.
[31] Royal Mail (2010), 'The proposed regulatory regime for 2011/12: Annex 4—A response to the Postal Services Commission's May 2010 consultation document', August.

increase with passenger numbers. Moreover, when an airport is operating below capacity, some staff may be underutilised. Together these represent a volume effect.[32]

In order to adjust for the effect of volume growth on the adopted productivity measure, the CAA included in its calculations 'an assumption about the elasticity of staff numbers to passenger numbers', designed to capture the likely economies of scale available to the regulated airports.

For the 2008–13 price control, the CAA estimated the elasticity of costs with respect to traffic levels to equal 0.3, highlighting that this elasticity was consistent with the range estimated by the Competition Commission for the previous price control review.[33]

A1.3.2 The Commission for Aviation Regulation's model for Dublin Airport

This section considers the approach taken by the Irish Commission for Aviation Regulation (CAR) in calculating the OPEX forecasts feeding into estimates of airport charges at Dublin Airport over the period 2010 to 2014. The results of the operating cost modelling were as follows:

– passenger numbers were estimated to decline in 2010, but increase from 2011 onwards;
– similarly, overall operating costs were estimated to decline in 2010, but increase from 2011;
– however, owing to the impact of economies of scale, operating costs per passenger increased in 2010, declining from 2011.

OPEX was forecast as follows.

– OPEX was calculated as the sum of staff costs and non-staff costs. The calculations were made separately for the existing terminal (T1) and the new terminal (T2).

– Staff numbers were estimated to decline as a result of efficiency savings—there was an underlying assumption that Dublin Airport could realise efficiency savings of 4% relative to its 2008 operations.

– The second impact on staff numbers came from their link to passenger numbers (pax). Growth in staff numbers was linked to passenger growth forecasts for each year of the regulatory period (see elasticities in Table A1.1 below). The change in pax was also assumed to have a second-order effect on some other costs (eg, overheads), which were assumed to move in line with changes in staff numbers.[34]

[32] Civil Aviation Authority (2006), 'Airports price control review: Initial proposals for Heathrow, Gatwick and Stansted', December, para C.18.
[33] Ibid.
[34] Commission for Aviation Regulation (2009), 'Determination on Maximum Levels of Airport Charges at Dublin Airport', December 9th, p. 79.

Table A1.1 Elasticities of staff numbers to passenger numbers

Activity	Is pax a driver of staff numbers?	Elasticity at T1	Elasticity at T2
Terminals	Yes	0.60	0.63
Airport Police Fire Service	Yes	0.33	0.64
Maintenance	Yes	0.15	0.30
Cleaning	Yes	0.30	0.30
Retail	Yes	0.30	0.30
Airfield Services & Facilities	No		
Airport Management (& Support)	No		
Car Parks	No		
Commercial	No		
Support Services	No		

Source: Commission for Aviation Regulation (2009), 'Determination on Maximum Levels of Airport Charges at Dublin Airport', December 9th, and associated spreadsheet.

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