Reckon LLP
Data analysis | Economic regulation | Competition law

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Productivity growth of GTS

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1 Introduction and summary

1.1 Energiekamer needs to set a series of price controls for the gas transmission system operator, GTS. For each price control, Energiekamer will set a value of X which is used in a CPI–X cap on average price increases.

1.2 At the time of writing this report, Energiekamer had not decided on its method for setting the X factor for each regulatory period. One method that Energiekamer told us that it might use would involve a calculation that takes an estimate of a total cost concept for GTS — which includes an allowance for profit and amortisation of the regulatory asset base (RAB) — for the start of the regulatory period and then rolls this forward for each year of the regulatory period by an annual adjustment factor. We call this annual adjustment factor Y. A positive Y implies costs rising relative to CPI.

1.3 Alternative methods are possible. For instance, Energiekamer may set the X factor for a regulatory period by taking an estimate of GTS's operating expenditure requirements at the start of the regulatory period and then rolling this forward by an annual adjustment factor. We call this annual adjustment factor Z. The resulting operating expenditure forecast would then be combined with separate allowances for amortisation and profit as part of the calculation used to set X.

1.4 The annual adjustment factors Y and Z relate to changes over time in GTS's costs, relative to the CPI. They could be positive or negative. Changes over time in GTS's costs will be affected by the productivity improvements that GTS achieves and by changes (relative to CPI) in the prices of its inputs, including labour.

1.5 These annual adjustment factors are not intended to take account of changes over time in the volume of GTS's outputs (e.g. expansion of capacity at particular entry points).

1.6 This report provides information that is relevant to regulatory decisions about Y and Z. We have carried out analyses of growth rates in output price indices, productivity measures and unit cost measures for different sectors of the Dutch economy using the EU KLEMS dataset. We have reviewed a number of studies relating to productivity and unit cost trends for gas transportation companies. We have carried out analyses of changes over time in operating expenditure per unit of output using data for gas transportation companies in the Netherlands, US, UK and Australia. We have also examined decisions made by regulators in a number of European countries, insofar as these concern annual adjustment factors that share similarities with Y and Z.

1.7 Table 1 provides summary information on the estimates we set out in the report which are most comparable to the adjustment factors Y or Z. The table must not be taken in isolation from the more detailed information, discussions and caveats provided in the report.

Table 1 Estimates for selected measures

Measure	**Estimates of growth rates**	**Most comparable to**
Output price indices for 30 sectors of the Dutch economy using data from EU KLEMS dataset (1970 to 2007)	Compound average growth rate (relative to CPI) for most sectors between –1.5% and 1.5% over 38-year period	**Y**
Estimates reported in a study on a measure of total cost (including profit element) for a sample of US gas transmission companies	Average annual growth rate (in constant dollars) over the period 1996 to 2004 of –5.9% or –2.9% depending on the output measure used	**Y**
A measure of the cost of labour and intermediate inputs per unit of output for 30 sectors of the Dutch economy using data from EU KLEMS (1970 to 2007)	Compound average growth rate (relative to CPI) for most sectors between –1.5% and 1.5% over 38-year period	**Z**
Measures of operating expenditure per unit of output for gas transportation companies in the Netherlands, US, UK and Australia	Estimates of compound annual growth rates, relative to consumer price inflation, between –7.1% and 4.0%	**Z**

1.8 The information set out in this report might be drawn on by Energiekamer to:

(a) Support an argument about a provisional value for Y or Z that could then be refined in light of other information — or arguments raised by interested parties.

(b) Identify cases where historical information is out of line with a proposed value of Y or Z, which might raise questions about the reasonableness of the proposed value.

1.9 If the information set out in this report is used as part of decisions about Z, we suggest that steps are taken to ensure that, as far as possible, any allowances for amortisation or capital expenditure are on a basis which is consistent with what is being assumed for operating expenditure. For instance, the measure relating to the costs of labour and intermediate inputs in table 1 is compatible with a hypothesis that such allowances would cover the asset replacement needed to keep the same amount and quality of services from capital assets (but no more) over the regulatory period.

1.10 Any comparison between GTS and a particular sector of the Dutch economy, or another company, will be vulnerable to criticism. There will be differences between GTS and that comparator that could affect the opportunities for productivity improvements and the input price inflation experienced.

1.11 We draw comparisons across a range of sectors of the Dutch economy that, taken together, does not seem unreasonable to compare with GTS. The EU KLEMS dataset we use allows for estimates to be made over a long period (1970 to 2007) and for 30 different sectors. The large sample size is good given the measurement problems that arise in the estimation of changes over time in output prices, productivity and measures of costs per unit of output.

1.12 Several estimates relating to gas transportation companies in other countries show a fast reduction in expenditure relative to an inflation index. This might reflect something special about the opportunities for productivity growth available to gas transmission companies, which would be relevant to the choice of a value for Y or Z for GTS. But it might be due to other factors that are not relevant to GTS. For instance, estimates of relatively rapid reductions in measures of total costs for gas transmission companies in the US may be due to a period of high productivity growth following regulatory reforms to introduce greater competition.

1.13 We suggest that in addition to familiarising itself with the information in this report, Energiekamer considers how the choice of values for Y or Z may affect different risks that arise in relation to the price control for GTS and makes decisions in light of which risks are most important to its regulatory objectives.

Structure of this report

1.14 The remainder of this document is structured as follows.

1.15 Section 2 sets out our understanding of potential methods that Energiekamer may use for setting the value of X for the GTS price controls.

1.16 Section 3 provides an overview of the information we have collected through different strands of this project, and discusses the potential implications of these for the GTS price control, in light of the potential methods described in Section 2.

1.17 Section 4 sets out our analysis of the EU KLEMS dataset, which includes estimates of the growth rates for output price indices, and a measure of labour and intermediate input costs (per unit of output), for different sectors of the Dutch economy.

1.18 Section 5 provides a review of some recent English-language studies that contain estimates of productivity growth and unit cost trends for gas transportation companies. We have drawn on this to identify methods, estimates or other data that may be relevant to the GTS price control.

1.19 Section 6 provides estimates of the changes over time in measures of operating expenditure, and operating expenditure per unit of output, that we have calculated using data relating to GTS and other gas transportation companies.

1.20 Section 7 discusses a number of recent regulatory decisions relating to price controls for gas transportation companies in a number of European countries, as well as recent price control decisions for a broader set of sectors from the UK. The focus is on aspects of these decisions that relate to the expected changes over time in regulated companies' costs, including assumptions about productivity growth and input price inflation, but excluding changes in costs driven by changes in the scale of the business or its outputs.

2 Possible methods for setting X for GTS

2.1 Energiekamer needs to set a series of price controls for the gas transmission system operator, GTS. For each price control, Energiekamer will set a value of X which is used in a CPI–X cap on average price increases.

2.2 At the time of writing this report, Energiekamer had not decided on its method for setting the X factor for each regulatory period. This section identifies two methods that Energiekamer might use. These stem from discussions we have had with Energiekamer. Each of these methods involves an annual adjustment factor, which we refer to as Y or Z in subsequent sections of the report.

Requirements for the X factor

2.3 Energiekamer will set a value of X for each regulatory period. A regulatory period might last for three, four or five years.

2.4 X is used in a CPI–X cap on average price increases, where the average price increase is defined as the increase in the revenue that would result from the application of the tariffs for two successive years to the same set of notional entry and exit capacities.

2.5 A single value of X must be set for all the years in each regulatory period — there is no possibility to impose a special increase or decrease of prices (sometimes called a P_0) in the first year of the regulatory period.

The overarching cost concept

2.6 Given the requirements for X set out above, and the fact that X must be set in advance before volumes or costs are known, it is not possible to match actual revenue in each year with any notions of cost and/or reasonable profit in that year.

2.7 Subject to these limitations, Energiekamer's overarching principle is to link expected revenue with the sum of:

(a) operating expenditure;

(b) a return on assets, calculated by multiplying a weighted average cost of capital (WACC) estimate with a regulatory asset base (RAB) amount; and

(c) amortisation of the RAB.

2.8 Ideally, instead of drawing on GTS's operating expenditure, amortisation, or assets, the objective of Energiekamer is to set X in a way that is consistent with the operating expenditure, amortisation or assets that an efficient operator would use. But lack of information or lack of information might mean that GTS's data are used for part of the calculations.

The regulatory asset base (RAB)

2.9 For the new method decisions, Energiekamer will determine the regulatory asset base as part of a process separate from the estimation of productivity or efficiency improvement.

2.10 Energiekamer's regulatory practice works with a "real" weighed average cost of capital (WACC). Energiekamer will apply the CPI inflation index when rolling forward the value of the RAB. At the time of writing, Energiekamer had not yet decided what amortisation periods to use in the calculations for the RAB.

Exclusion of network expansion or enhancements

2.11 In respect of network expansion or enhancements, the method decisions allowed for an increase in tariffs during a price control period. The rules for any such adjustment in the new method decisions are outside the scope of our work. We focus on the price controls for GTS on the basis that it is to provide a constant scale (and quality) of outputs to customers.

Method based on a single annual adjustment factor — Y

2.12 Energiekamer has told us that one possible method to set X for each regulatory period would involve the following process.

2.13 For a year near the beginning of the price control period, Energiekamer would estimate operating expenditure plus amortisation plus WACC on RAB. Let us call this the "base year". It might be the first year of the period, the year immediately before the start of the period, or the most recent year for which data are available at the time of setting price controls.

2.14 The calculation of operating expenditure plus amortisation plus WACC on RAB in the base year would use GTS data. Let us call the annual revenue estimate for the base year E.

2.15 If suitable international benchmarking information is available, the result of the calculation would be adjusted to remove the effect of any apparent relative inefficiency of GTS. This is not expected to be achievable as part of the current process for setting GTS price controls. If it were done, it would lead to an adjustment to the value of E that would reflect a view on the efficient costs and profits in the base year.

2.16 E relates to the overarching cost concept in the base year. Energiekamer would set X with the aim of matching, in the final year of the regulatory period, the expected revenue allowed under the price control to the overarching cost concept. To do this, it is necessary to extrapolate from E, in a year near the beginning of the regulatory period, to the equivalent cost concept in the final year of the regulatory period.

2.17 Energiekamer would use a rate of change in the overarching cost concept relative to CPI in order to make this extrapolation. Let us call this amount Y, expressed in logarithms. For ease of comparisons with the estimates in this report, we express Y as the rate of growth in the overarching cost concept, relative to CPI. Y may be a positive number (faster increases than CPI) or a negative number (a reduction relative to CPI).

2.18 Once E and Y have been determined, it becomes possible to calculate target revenue for the last year of the price control period at base year prices and at constant volume, by applying a factor of exp(Y) to E as many times as there are years between the base year and the last year of the price control period. Let us call the result T. In algebraic terms, T = E*exp([number of years]*Y).

2.19 For example if E were 100 Euros, the price control period three years and Y set at 2 per cent, then T would be calculated as 100*exp(3*0.02), which is 106.18 Euros. Similarly, if E were 100 Euros, the price control period three years and Y set at –2 per cent, then T would be calculated as 100*exp(3*–0.02), which is 94.18 Euros.

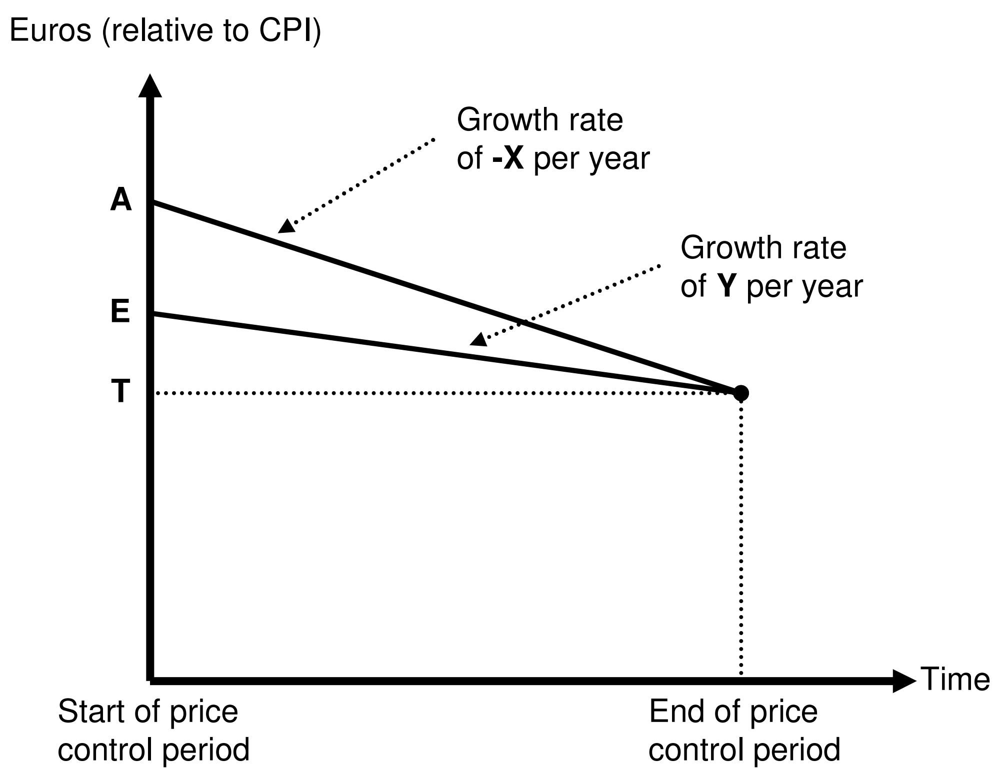
2.20 To determine the X factor by reference to T, it is necessary to estimate what revenue GTS's prices or price limits in the year immediately before the price control period would raise if applied to volumes in the base year. Let us call this amount A. In the case where the base year is the year immediately before the price control period, then A is GTS's revenue in that year.

2.21 Energiekamer wants to determine the X factor for the regulatory period by solving the following equation:

$$A^*(1-X/100)^{[\text{years in price control}]} = T.$$

2.22 This formula reflects the objective that, if volumes did not change, the price control set by reference to X would lead to revenues in line with target revenues in the last year of the price control period.

Figure 1 Illustration of relationship between Y, X, A, E and T



2.23 The annual adjustment factor Y relates to changes over time in the overarching cost concept, relative to the CPI. This will be affected by the productivity improvements that GTS achieves and by changes (relative to CPI) in the prices of its inputs, including labour.

2.24 Whilst Y relates to the growth in the overarching cost concept relative to the CPI, X is not a growth rate but a rate of reduction. A positive value of Y indicates growth in the overarching cost concept relative to CPI. A positive value of X in the CPI–X formula means that prices are set to decrease relative to the CPI.

Treatment of capital expenditure

2.25 The method presented above does not involve any forecast of capital expenditure, either for asset replacement or for network expansion. An allowance for amortisation of the RAB would be made for the base year as part of the determination of E. The annual adjustment factor Y would be used to roll-forward E for each year of the price control.

Methods based on annual adjustment factor for operating expenditure — Z

2.26 The method set out above involves the application of an annual adjustment factor (Y) to a cost concept that includes operating expenditure and financial allowances for amortisation of the RAB and profit.

2.27 Alternative methods are possible. In particular, Energiekamer may set the X factor for a regulatory period by taking an estimate of GTS's operating expenditure requirements at the start of the regulatory period and then rolling this forward by an annual adjustment factor. The resulting operating expenditure forecast would then be combined with separate allowances for amortisation and profit as part of the calculation used to set X.

2.28 We use the term Z to refer to annual adjustment factors that are applied to roll forward a measure of operating expenditure in the base year of the price control. Such adjustment factors relate to changes over time in GTS's operating expenditure relative to the CPI. These changes will be affected by the productivity improvements that GTS achieves and by changes (relative to CPI) in the prices of the inputs that feature within operating expenditure, including labour. As discussed below, they may also be affected by capital expenditure.

2.29 The exact nature of Z may vary according to whether it applies to total operating expenditure or some subset of operating expenditure. For instance, some regulators apply adjustment factors to a subset of operating expenditure that is deemed "controllable". The nature of Z may also depend on the way in which the allowances for capital expenditure elements of the price control are made.

Interactions between operating expenditure and capital expenditure

2.30 If a method involving separate operating expenditure and amortisation or capital expenditure elements is to be used, care is needed if these elements are to be combined in a coherent way.

2.31 Changes in the amount of labour inputs may be driven not only by total factor productivity improvements but also by a process of capital substitution, through which a greater volume (or quality) of services from capital assets allows the same outputs to be produced using less labour. This may be possible if GTS delivers the same outputs or services to network users using a greater amount of capital assets or by using higher-quality capital assets.

2.32 A process of capital substitution may lead to reductions in operating expenditure that are not attributable to productivity improvements, or changes in input prices, but instead reflect changes in the balance of labour and intermediate inputs compared to capital inputs.

2.33 There is a risk of inconsistency in the calculation of the price control if a value of Z is chosen which would only be achievable through the purchase of additional capital assets for which no allowance is made in the calculation of the price control. For example, this risk may arise if a value for Z is chosen based on historical operating expenditure reductions from companies that have experienced substantial capital substitution, but the allowances for amortisation and profit are not compatible with this scale of capital substitution.

2.34 There are also risks that the opportunities for productivity growth are double-counted if historical information on changes over time in costs, or productivity, is used to produce separate allowances relating to operating expenditure and capital expenditure.

Constant capital hypothesis as a means to address risks of inconsistency

2.35 We have identified a possible method to mitigate the risk of inconsistency highlighted above. This involves making calculations for the separate elements of the price control (e.g. operating expenditure, amortisation of the RAB and allowance for profit) that are each compatible with a hypothesis that the volume of services from capital are constant over the regulatory period. Under this hypothesis, price limits are set as if all productivity improvements were to take place though changes in the amount of labour and intermediate inputs used relative to the volume of output.

2.36 As an example, the constant capital hypothesis could be applied as follows:

(a) Make an estimate of GTS's operating expenditure requirements in the base year of the price control.

(b) Apply an annual adjustment factor (Z) to this estimate of operating requirements to obtain a forecast of operating expenditure requirements for each year of the price control period. This annual adjustment factor should be compatible with the hypothesis that all the productivity growth that is available to GTS will be experienced through changes to the volume of labour and intermediate inputs, and that the volume and quality of services from GTS's capital assets will remain constant over the price control period.

(c) Calculate allowances for other elements of the price control, including amortisation of the RAB and profit, for each year of regulatory period. These allowances should be compatible with the hypothesis that GTS will keep the same amount and quality of services from capital assets (but no more) over the regulatory period.

2.37 Under this method, the focus is not on what GTS's actual operating expenditure will be in each year of the regulatory period — which may depend on its capital expenditure — but on what GTS's operating expenditure would be if it were to operate with a constant volume of services from capital inputs. Whilst somewhat artificial, this provides a way to combine operating expenditure and RAB amortisation elements in a coherent way.

2.38 This is not the only conceivable way to addresses the risks of inconsistency. For instance, it might be possible to use a hypothesis about a certain rate of change in the volume of services that GTS receives from capital assets (e.g. taken from capital expenditure forecasts for GTS) and then to set allowances for operating expenditure and RAB amortisation that are both compatible with that hypothesis. We do not develop such an approach in this report.

Comparison between methods involving Y and Z

2.39 The choice of method to calculate the price controls for GTS is beyond the scope of this report. We make some observations below that Energiekamer might take into account as part of any choices it makes between a method involving an annual adjustment factor of the nature of Y or an annual adjustment factor of the nature of Z. We recognise that Energiekamer may choose a method that does not involve either Y or Z.

Regulatory precedent

2.40 Section 7 provides a summary of recent decisions made by economic regulators in a number of European countries insofar as these concern annual adjustment factors that share similarities with Y and Z. This is intended to provide an update of the summaries of regulators' decisions in Reckon's 2008 report for Energiekamer.[1]

2.41 The majority of the regulatory decisions that we have covered use an approach to setting price controls more similar to the method involving Z than the method involving Y. This reflects, to some degree, the relatively large number of decisions by UK regulators amongst those that we have covered. We have identified regulatory decisions from the UK, Italy, Portugal and France which involve the use of an annual adjustment factor (or factors) to determine an allowance for operating expenditure over the price control period. The composition of the operating expenditure element to which the adjustment factor is applied varies.

[1] Reckon (2008) "The productivity growth of GTS", available from http://go.reckon.co.uk/a15680, accessed on 11 March 2011.

2.42 There are some examples of regulators that have used approaches not too dissimilar to the use of Y to set the prices. For example, regulators in Germany and Spain have applied an annual adjustment factor to prices or allowed revenues, rather than to individual cost categories such as operating expenditure. The nature of the annual adjustment factor varies.

Compatibility with "total cost" comparisons

2.43 The type of an annual adjustment factor used (if any) might be driven by the type of assessment of GTS's costs, or expenditure requirements, that Energiekamer carries out as part of the work to set the X factor for GTS's price controls.

2.44 Some possible methods for setting GTS's price controls may not involve a separate estimate of operating expenditure requirements in the base year. For instance, our understanding is that the most recent method decisions for TenneT were based on an estimate of a "total cost" measure for the base year, which is similar to the overarching cost concept for GTS descried above. This estimate was taken from comparative analysis of measures of "total cost" across TenneT and electricity transmission companies in other countries. The method involving an annual adjustment factor Y seems compatible with this type of approach.

2.45 If the comparisons of costs between companies are limited to measures of "total costs" and no separate operating expenditure element is examined, then it may not be possible to use methods involving an annual adjustment factor Z.

Compatibility with capital expenditure forecasts

2.46 Methods involving the application of an annual adjustment factor Z to a separate operating expenditure element may provide more flexibility in the way that allowances for capital expenditure and profit are included in the price control calculation.

2.47 In some circumstances, the regulator may make capital expenditure forecasts over the regulatory period (e.g. drawing on submissions from the regulated company, and subjecting these to review). For example, suppose that because of the age profile of network assets, a large increase in capital expenditure is needed over the regulatory period for the purposes of asset replacement. If the regulator wants to provide the company with a reasonable opportunity to earn a fair rate of return on the RAB over the price control period, then it may be important to allow for that increase in capital expenditure through the calculation of the price control.

2.48 The use of capital expenditure forecasts will be more straightforward under a method involving the application of an annual adjustment factor to an operating expenditure element. For instance, the price control could be calculated by combining the following elements for each year of the regulatory period:

(a) An allowance for operating expenditure made by rolling forwards an estimate of GTS's operating expenditure requirements in the base year by an annual adjustment factor Z.

(b) Allowances for RAB amortisation and profit elements set by reference to forecasts of GTS's capital expenditure for each year of the regulatory period.

Availability and reliability of historical estimates

2.49 We discuss in Section 3 which of the historical estimates we have collected are comparable to Y and which are comparable to Z. We also identify issues and problems that arise in seeking to draw comparisons between the historical information and Y or Z.

2.50 If historical information relating to changes over time in measures of costs and productivity is to be drawn on for regulatory decisions about an annual adjustment factor, the availability and reliability of this information may depend on the choice between methods involving Y and methods involving Z.

Consistency between operating expenditure and capital elements

2.51 As highlighted above, there are potential risks of inconsistency in the price control calculation if an annual adjustment factor Z is applied to an operating expenditure element and this is combined with separate capital or amortisation elements. We suggested above one way in which these risks might be mitigated. This involves efforts to ensure that each of the different elements is compatible with a common hypothesis about capital assets. These specific risks do not arise in the case of an annual adjustment factor Y applied to the overarching cost concept that includes amortisation of the RAB and profit.

3 Relevance of the information collected in this report

3.1 This section provides an overview of the information we have collected through different strands of this project, and discusses the potential implications of these for the GTS price control, in light of the possible methods described in Section 2.

Overview of the information collected

3.2 Energiekamer asked us to provide a broad body of evidence to support the analysis. We collected a wide body of information from a range of different sources. Table 2 provides an overview of the information collected.

Table 2 Overview of information collected

Category	Estimates calculated using data collected for the study or estimates taken from published reports or papers
Changes over time in the prices of goods and services	• Estimates of the growth in output price indices for 30 sectors of the Dutch economy
Changes over time in the costs of labour and intermediate inputs	• Estimates of the growth in a measure of the cost of labour and intermediate inputs for 30 sectors of the Dutch economy • Estimates of the growth in a measure of labour costs for 30 sectors of the Dutch economy • Estimates of the growth in a measure of GTS operating expenditure per unit of output • Estimates of the growth in measures of operating expenditure per unit of output for oil and gas pipeline companies in the US, for gas transmission in Britain, and for gas distribution in Australia
Changes over time in concepts of total costs (including profit element)	• Estimates of the rate of the reduction in a measure of total cost (including profit element) for a sample of US gas transmission companies
Changes over time in measures of productivity	• Estimates of total factor productivity growth for 30 sectors of the Dutch economy • Estimates of productivity growth for labour inputs and for labour and intermediate inputs (with adjustment for capital substitution effects) for 30 sectors of the Dutch economy • Estimates of partial productivity growth for labour inputs, and for labour and intermediate inputs, for 30 sectors of the Dutch

Category	Estimates calculated using data collected for the study or estimates taken from published reports or papers
	economy • Estimates of multi-factor productivity growth for the US oil and gas pipeline industry • Estimates of total factor productivity growth for a set of recently-privatised gas distribution companies in Australia

3.3 We provide further details of this information in Sections 4, 5 and 6. In addition to the information in table 2, we provide in Section 7 a review of a number of recent regulatory decisions relating to price controls for gas transportation and other utilities in some Western European countries.

The potential contribution to regulatory decisions

3.4 There are important differences between the historical estimates presented in this report and the annual adjustment factors Y and Z which are introduced in Section 2.

3.5 Most of the historical estimates are derived from data relating to companies other than GTS. They relate to the growth rates in categories of costs or other measures that differ, to varying degrees, from the cost concepts to which Y and Z apply. They also apply to different periods: Y concerns changes over the regulatory period of a GTS price control (e.g. 2010 to 2013) and the future can be different from the historical periods over which our estimates are taken.

3.6 In this context, the estimates that we have produced or collated cannot be used to determine what the "right" value of Y or Z is, or to "prove" that a particular value for Y or Z would be inappropriate. Instead, the information set out in this report might be drawn on by Energiekamer to:

(a) Support an argument about a provisional value for Y or Z that could then be refined in light of other information — or arguments raised by interested parties.

(b) Identify cases where historical information is out of line with a proposed value of Y or Z, which might raise questions about the reasonableness of that proposal.

3.7 In either case, other sources of information, such as any business plan forecasts prepared by GTS, submissions by other interested parties or any directly relevant regulatory precedent, may also be relevant to regulatory decisions about Y and Z.

3.8 We summarise below the potential implications of the information we have collected for Y and then, in a separate section, the potential implications of the information we have collected for Z. We then discuss the potential impacts of restricting the information used to set GTS price controls to that based on data up to 2005. Finally, we highlight the need for regulatory judgement, and identify a number of risks that may have a bearing on regulatory decisions about the value of Y or Z.

Potential implications for the choice of Y

Output price indices for sectors of the Dutch economy

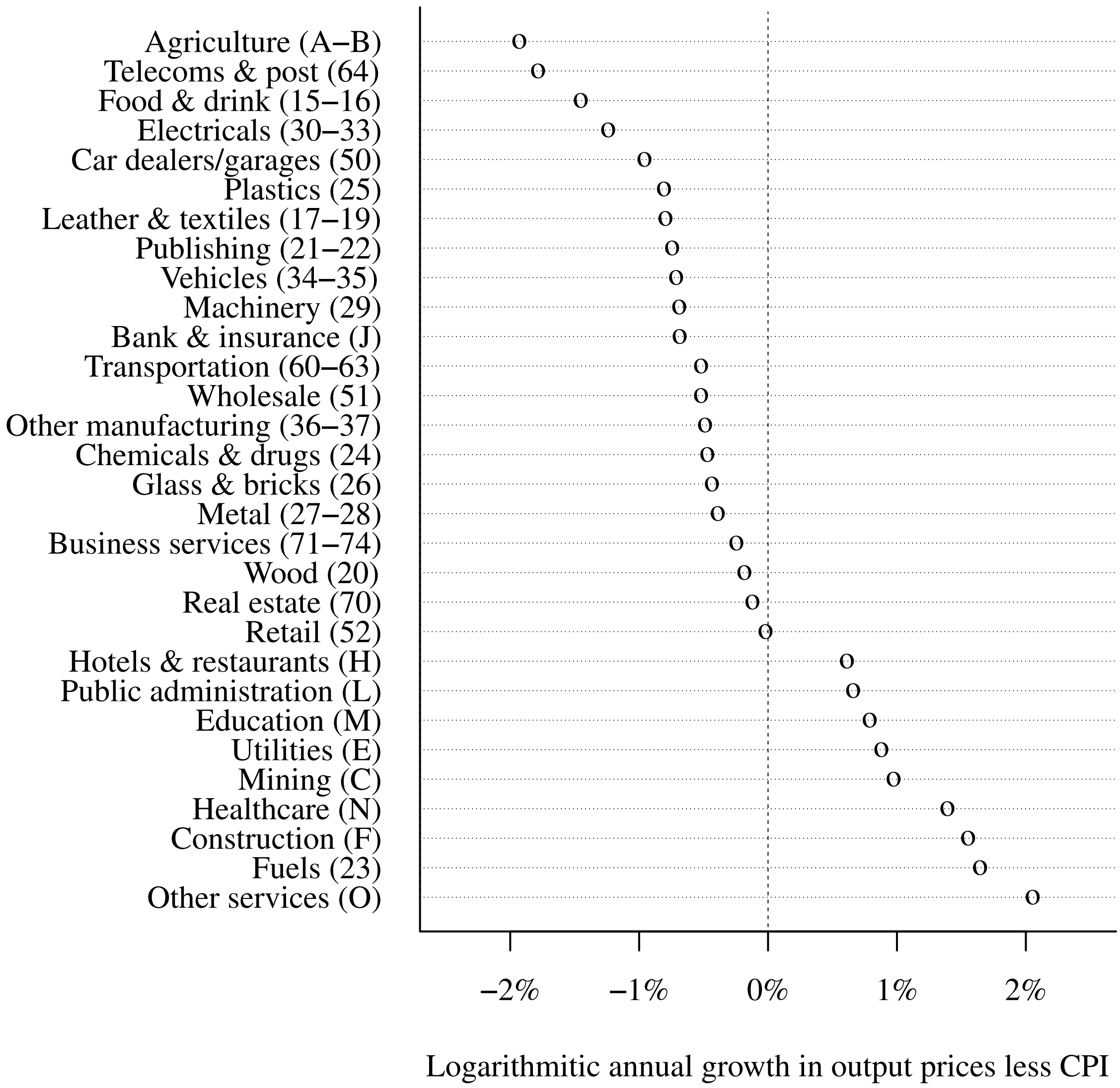
3.9 There are grounds to make comparisons between Y and the historical growth rates in output price indices relative to CPI. Changes over time in the prices of the goods and services produced by companies within an industry will reflect changes over time in their costs of production and in the rate of profits. These will, in turn, reflect the productivity growth achieved by these companies and the changes in the prices of the inputs that these companies use (relative to the CPI).

3.10 Any comparison between GTS and a particular sector from the EU KLEMS dataset will be vulnerable to the criticism that it attempts to extract spurious precision out of a comparison between things that are fundamentally quite different. For this reason, we draw comparisons between Y and the output price indices across a range of sectors of the Dutch economy that, taken together, do not seem unreasonable to compare with GTS.

3.11 For instance, it is straightforward to argue that differences between GTS and companies operating in another sector of the Dutch economy (e.g. construction) may mean that GTS will experience different cost trends to those companies. It is not straightforward to argue that differences between GTS and all other sectors of the Dutch economy are such that GTS can be expected to experience cost trends that lie outside the range of cost trends experienced by these sectors.

3.12 Figure 2 shows estimates for the annualised growth rate, over the period 1970 to 2007, in the output price index (relative to the CPI) for 30 sectors of the Dutch economy. A negative number indicates a sector for which, over the period, the price index for the industry's outputs has increased at a slower rate than the CPI. We provide more details on each of these sectors in Section 4. For presentational purposes, we order the sectors according to the growth rate.

Figure 2 Growth in output price index relative to CPI (Netherlands, 1970 to 2007)

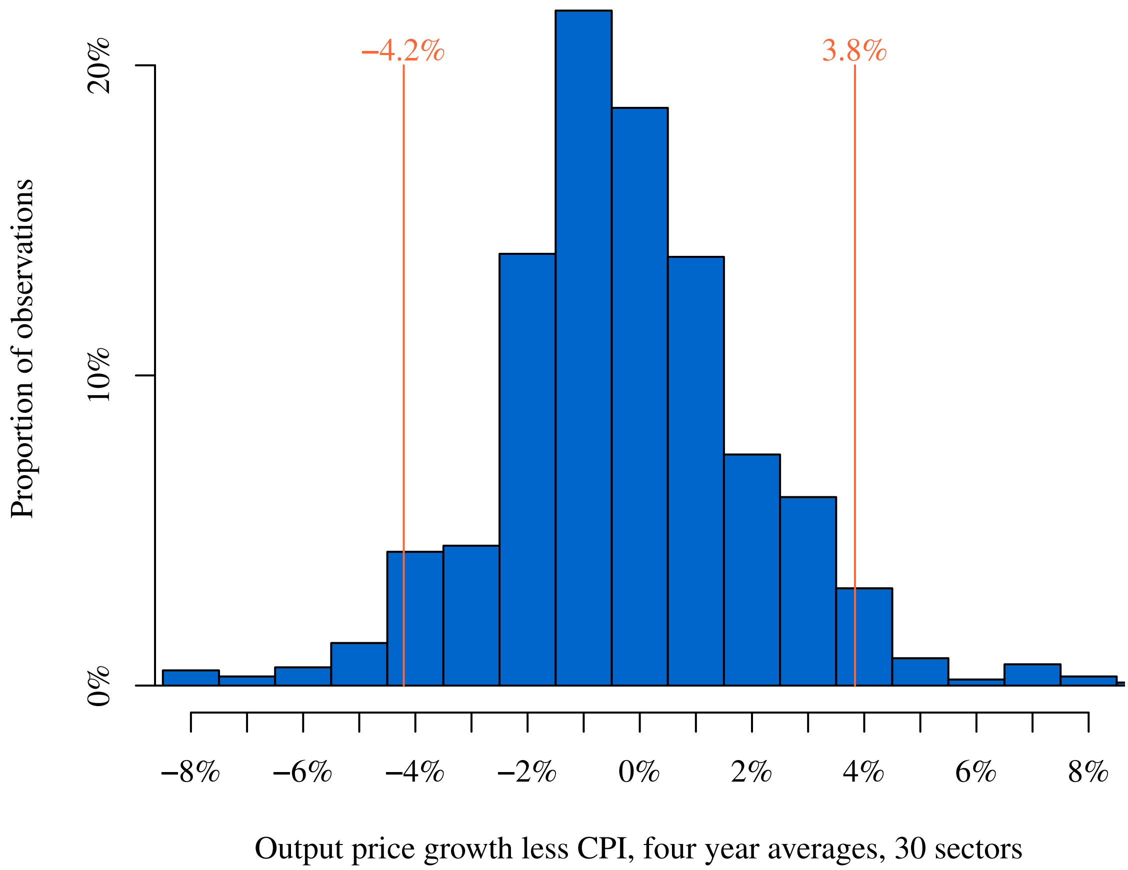


3.13 Over the period 1970 to 2007, output price indices (relative to CPI) for most sectors of the Dutch economy have experienced a growth rate of between –1.5 per cent and 1.5 per cent per year.

3.14 In some cases, the year-on-year changes in output price indices are well outside this range. In general, the shorter the time period over which the average annual growth rates are taken, the more variation there is.

3.15 Figure 3 provides a histogram that helps convey the variance in the growth rates for output price indices, looking across all sectors.

Figure 3 Distribution of annual rates growth rates for output price indices relative to CPI (four-year averages between 1970–2007, all sectors)



3.16 The histogram shows the frequency distribution of the 1,020 observations corresponding to each combination of a sector (there are 30 sectors) and a period of four consecutive years (there are 34 such periods between 1970 and 2007). For each observation, the annual average growth in output prices less CPI is calculated, and is placed in the "pot" corresponding to the nearest integer percentage value. The height of each bar on the histogram is proportional to the proportion of the 1,020 observations that in the relevant pot.

3.17 The logic for the four-year average is based on the possible length of regulatory periods for GTS. These need to be between three and five years. Energiekamer has told us that it is considering a length of the regulatory period of four years.

3.18 The vertical lines in the histogram enclose 90 per cent of the observations. In 90 per cent of cases for which we have data, the average growth rate of the output price index over a four-year period was between –4.2 per cent and 3.8 per cent.

3.19 Whilst the histogram helps show the variance in growth rates over relatively short periods of time, similar to regulatory periods, there is still merit in looking at the average growth rates over the full period of the data. A long data period is good because of the measurement problems that arise in the production of output price indices. On this basis, a value of Y of less than –1.5 per cent or a value of Y of more than 1.5 per cent might seem to conflict with the historical information on long-term output price trends from the EU KLEMS dataset (i.e. the growth rates over the full period of our sample).

3.20 If Y is set outside that range, we suggest that Energiekamer provides an explanation of why such a value of Y is reasonable despite the apparent conflict with the estimates of the growth in output prices across different sectors of the Dutch economy. Such an explanation may take different forms. For instance, it may be possible to argue that comparisons between Y and the output price indices are not reasonable. Alternatively, it may be possible to find alternative information that could be seen to support a Y outside the range above and which can be argued to be more relevant to GTS than output price indices for different sectors of the Dutch economy (e.g. estimates that are focused on gas transmission companies).

Potential limitations of output price comparisons

3.21 Comparisons with output price indices might be criticised because Y is to be applied to a regulatory construct: the sum of GTS operating expenditure, allowed return on RAB and amortisation (and perhaps some other elements). The growth rate in this regulatory construct might differ from the growth rate in the prices of goods and services that are sold on markets that are not subject to price control regulation.

3.22 The price control for GTS might be seen to comprise two main elements:

(a) An allowance for operating expenditure (excluding depreciation or amortisation of the RAB).

(b) Financial allowances for RAB amortisation and profit (and potentially other financial adjustments).

3.23 There is an argument that the growth rate in the sum of (a) and (b) may not be comparable to the growth rate in output price indices for sectors of the Dutch economy if the balance between elements (a) and (b) for GTS is very different to that for the other sectors.

3.24 At the time of writing, information was not available on the relative scale of the operating expenditure, RAB amortisation and profit elements for the next set of GTS price controls. More information on this may become available as Energiekamer progresses its work on the GTS price controls.

3.25 We have used the EU KLEMS data to calculate the expenditure on labour and intermediate inputs as a proportion of gross output, for the different sectors of the Dutch economy. For the last year of our data (2007), the average share across the 30 disaggregated sectors was 85 per cent. All sectors apart from real estate and mining have a share of at least 69 per cent. The value for the "electricity, gas and water supply" sector is 78 per cent. These shares can be taken as approximations of the proportion of revenue in each sector that is attributable to operating expenditure (excluding depreciation).

3.26 Once Energiekamer has made decisions about the allowances for operating expenditure (excluding depreciation and amortisation of the RAB) and financial allowances for RAB amortisation and profit, it might be worth comparing the mix between elements (a) and (b) above that this implies with the mix in other sectors. If differences in that respect are a concern, it might be worth considering an alternative method for setting the price controls for GTS. We identified in Section 2 that rather than applying a single annual adjustment factor (Y) to a cost concept that includes amortisation and profits, an annual adjustment factor (Z) could be applied to the operating expenditure element, with a separate regulatory treatment of the amortisation and profit elements.

3.27 We discuss the relevance of historical information to an adjustment factor based on Z further below. The next sub-sections proceed on the basis that the issues above do not prevent comparisons between Y and data from other sectors.

Estimates of total factor productivity growth

3.28 We have identified a study which provides estimates of the growth in (gross output) multi-factor productivity growth for the oil and gas pipeline transportation industry in the US over the period 1987 to 2004.[2] This industry classification includes intra- and inter-state transmission pipelines. The annual average growth rate in multi-factor productivity is 1.2 per cent. More information on this study is provided in Section 5.

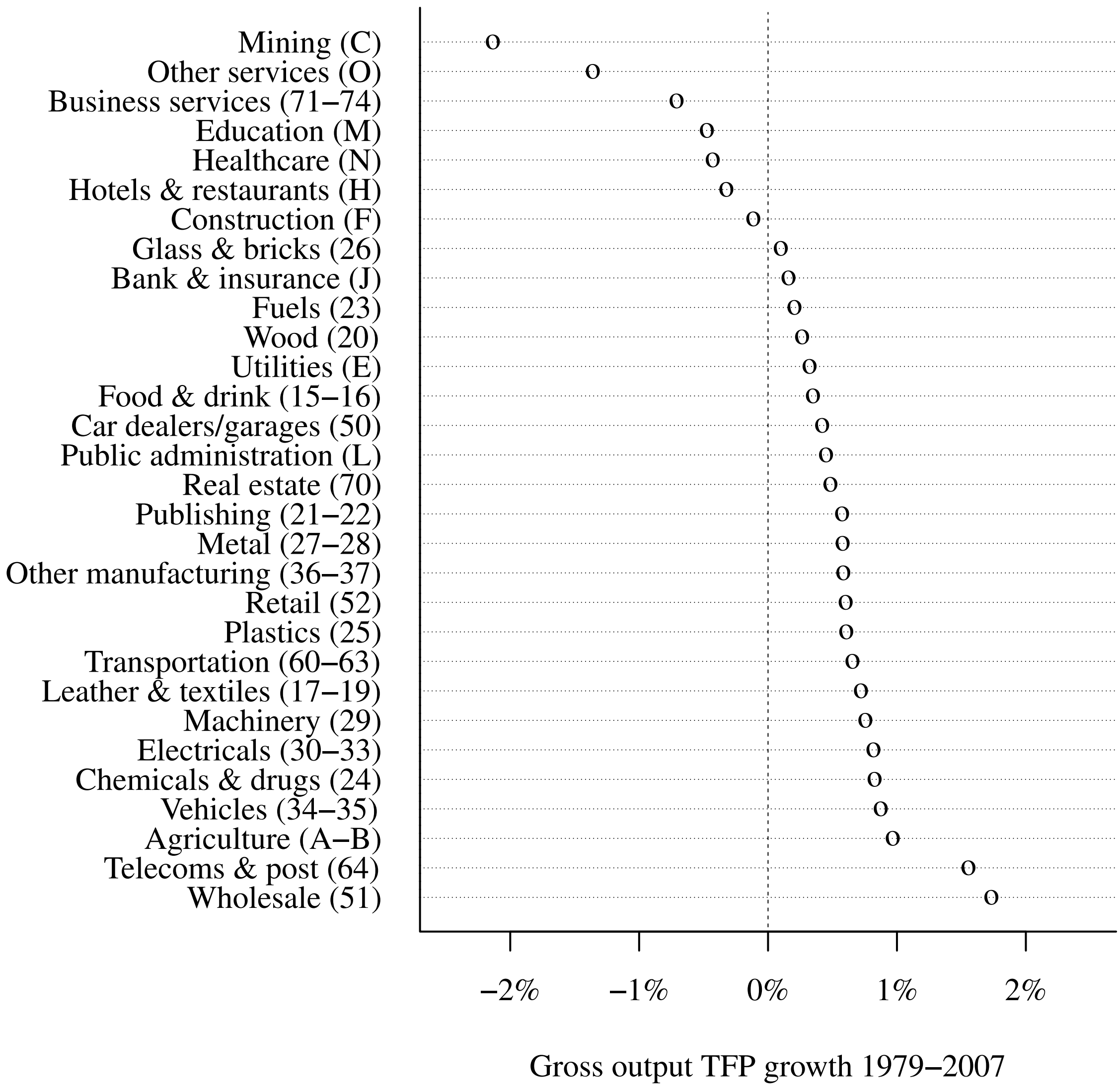
3.29 This estimate of multi-factor productivity growth for the US oil and gas pipeline industry is relatively high compared to the estimates from the EU KLEMS dataset for total factor productivity growth for the various sectors of the Dutch economy.

3.30 Whilst there are differences in method, both the multi-factor productivity estimate and the total factor productivity estimates from EU KLEMS cover a range of inputs including capital, labour, energy and other intermediate inputs. In both cases, the productivity growth represents growth in the volume of outputs that is not attributed to growth in the volume of inputs.

[2] Lawrence, M and J Skolnik (2008) "Estimating Multifactor Productivity (MFP) in Pipeline Transportation, 1987-2004", *Transportation Research Board, 87th Annual Meeting 2008*, Washington, DC.

3.31 Figure 4 shows estimates of gross output productivity growth for sectors of the Dutch economy over the period of the EU KLEMS data for which we can estimate productivity (1979 to 2007).

Figure 4 Gross output total factor productivity growth (Netherlands)



3.32 Figure 4 highlights that few of the sectors have productivity growth as high as 1.2 per cent per year.

3.33 We find that there is a negative correlation between the estimate of total factor productivity growth for a sector and the growth in the output price index for that sector. This is what we would expect. All else equal, we would expect a greater rate of productivity improvement to restrain the rate of output price increases. Because of other differences between sectors, such as different rates of input price growth, this correlation will not be perfect.

3.34 Out of the 30 sectors, 15 have a total factor productivity growth above 0.5 per cent. Out of these 15 sectors, the range of output price growth is –1.9 to 0.2.

3.35 There is an argument that any value of Y significantly greater than 0 would conflict with the historical information on output price indices and on productivity growth for gas pipelines and other sectors. If the productivity improvements in the US oil and gas pipeline industry are seen as representative of those achievable by GTS, then it would not be reasonable to compare Y with the output price indices for sectors which have experienced much lower rates of total factor productivity growth than the US oil and gas pipeline industry. The only sectors with output price growth (relative to the CPI) much above 0 per cent are estimated to have experienced much lower rates of total factor productivity growth than the US oil and gas pipeline industry.

3.36 However, this argument can be criticised in a number of ways:

(a) The companies within the oil and gas pipeline industry in the US will differ from GTS in ways that may affect the productivity growth they achieve and the input price inflation that they experience.

(b) The fact that the estimate of multi-factor productivity growth for oil and gas pipelines in the US is relatively high compared to the estimates of total factor productivity growth for sectors of the Dutch economy may be due to differences in the methods used to compute these estimates rather than reflective of the oil and gas pipeline industry achieving relatively high productivity growth. The multi-factor productivity growth estimate for the US oil and gas pipeline industry is made using a different method to that for the sectors of the Dutch economy from the EU KLEMS dataset. For instance, the volume measure for labour inputs in the method for oil and gas pipelines is based on the number of employees whilst the labour volume measure in the EU KLEMS dataset is based on a measure of hours worked adjusted for changes in the composition of the workforce. These differences mean that the estimates of productivity growth relate to slightly different things and this limits the power of comparisons between them.

(c) The estimates of gross output total factor productivity for sectors of the Dutch economy from the EU KLEMS dataset appear vulnerable to measurement problems that cast some doubt on their reliability. A number of sectors are shown to have experienced total factor productivity growth that is close to zero or even negative. This feature is not limited to sectors involving a large proportion of public sector provision, such as education and health and social work, for which productivity measurement issues are well-known. We do not believe that there have been no significant productivity improvements in the Netherlands between 1979 and 2007 amongst companies in sectors such as construction, financial intermediation and hotels and restaurants. The estimates of gross output total factor productivity growth rates for these sectors, and perhaps others, are likely to be affected by measurement issues (see Section 4 for more discussion of potential measurement issues with the EU KLEMS data).

Estimates for a measure of total costs per unit of output for US gas transmission

3.37 We have identified a study which provides estimates which relate to the rate of change in a measure of the total costs (including a profit element) per unit of output for a sample of 39 regulated US inter-state gas transmission pipelines.[3] The most relevant results from that study are estimates of an average annual rate of reduction in the cost measure (in 2004 US dollars) over the period 1996 to 2004 of 2.9 per cent or 5.9 per cent, depending on which output measures are used in the method. More information on this study is provided in Section 5.

3.38 The estimates seem to be on a comparable basis to Y and, for the purposes of the GTS price control, have the benefit of being focused on gas transmission companies. If the

[3] Jamasb T, Pollitt M and Triebs T (2008) "Productivity and efficiency of US gas transmission companies: a European regulatory perspective", *Cambridge Working Paper in Economics 0812,* Faculty of Economics, University of Cambridge.

results of this study were simply taken and applied to the GTS price control, this could imply a value of Y of between –3 and –6.

3.39 However, the estimates from this study appear as outliers when compared with the estimates from the EU KLEMS dataset, such as the output price indices for different sectors of the Dutch economy (see the histogram above). This might reflect something special about the opportunities for productivity growth available to gas transmission companies, which would be relevant to the choice of a value for Y for GTS. But it might be due to other factors that are not relevant to GTS. In this context, we suggest caution in seeking to draw inferences for the GTS price control from this study alone.

3.40 We suspect that the differences between the estimates from the study on US gas transmission companies and the estimates for the output price indices for different sectors of the Dutch economy are not simply indicative of greater opportunities available for gas transmission companies for ongoing productivity improvements and below-CPI cost reductions.

3.41 For instance, the estimates from the study on US gas transmission companies are based on a much shorter data period than the estimates from EU KLEMS. The authors of the study highlight a "regulatory push for more competition" in 1992 and suggest that this might have led to a period of relatively high increases in efficiency over the data period used in the study.

Comparisons between Y and estimates of total factor productivity growth

3.42 It does not make sense to compare estimates of total factor productivity growth directly with Y. Y concerns changes over time in a cost concept, and these changes will be driven not only by total factor productivity growth but also by changes in the prices of the inputs, which cannot be relied on to grow in line with the CPI.

3.43 A comparison of Y could be made against a measure which is calculated as the sum of two components:

(a) An estimate of the growth in total factor productivity (on a gross output basis).

(b) An estimate or forecast of an appropriate input price index (relative to the CPI).

3.44 For instance, a weighted average input price index could be based on estimates of the changes in the prices (relative to the CPI) for different categories of inputs used by GTS (e.g. labour, energy, other intermediate inputs and capital assets), with weights given by the share of overall GTS costs (and profits) attributed to each input category.

3.45 If such an approach were used, it would be important to ensure that the estimates of productivity growth relate to comparable inputs to those for which the input price index applies. We feel that this raises a problem in the context of productivity estimates from the EU KLEMS dataset.

3.46 For instance, the EU KLEMS dataset uses measures of the volume of labour inputs that are based on hours worked adjusted for changes in the composition of the workforce (e.g. using a measure of educational attainment and age, which is taken as a proxy for work experience).[4]

3.47 The average annual growth in a price index of this labour measure implied in the EU KLEMS dataset over the period 1979 to 2007 for the aggregated "total industries" category is 0.1 per cent per year (relative to CPI). This is low compared to the figures that we are familiar with for the annual growth rate in wages or annual earnings from employment. At least over long time periods, we would expect these to rise relative to CPI. We suspect that this difference reflects the special nature of the data on the volume of labour input that are used in the EU KLEMS dataset and which are used in the calculation of total factor productivity growth.

3.48 Because of this feature of the EU KLEMS dataset, it does not seem straightforward to combine an estimate of total factor productivity growth with an input price index that is based on estimates of the growth in wages from another source.

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[4] O'Mahony, M and M P Timmer (2009) "Output, input and productivity measures at the industry level: the EU KLEMS database", *The Economic Journal*, Vol 119 No 538, page F379

Potential for a lower or more negative value of Y

3.49 The apparent conflict between a value of Y of less than –1.5 and the information on output prices does not arise if there are grounds to believe that GTS will experience a period of particularly high productivity growth because of changes in the regulatory or institutional arrangements.

3.50 The rapid reductions in the measure of total costs for gas transmission companies in the US, highlighted above, may be explained by a period of high productivity growth following the regulatory reforms to introduce greater competition.

3.51 Similarly, recent estimates of total factor productivity growth for several gas distribution companies in Australia range between 1.9 per cent and 3.3 per cent. The authors of these studies highlight that the data cover the period following privatisation and suggest that such high rates of productivity growth should not be expected in the future.

3.52 In the UK, it seems probable that electricity distribution companies and water and sewerage companies experienced a temporary period of relatively high productivity growth following privatisation and the introduction of incentive regulation. This view seems to have been reflected in the price controls set by regulators in the UK. In the previous rounds of price control decisions, UK regulators tended to set out expectations that utility companies could achieve significant reductions in operating expenditure relative to the retail price index. More recent price control decisions for these companies seem to be based on a view that there is now less opportunity for operating expenditure reduction relative to the RPI. We provide a summary of recent regulatory decisions in the UK in Section 7.

3.53 If Energiekamer expects GTS to experience a period of relatively high productivity growth, comparisons with other sectors of the Dutch economy which have experienced more modest productivity growth will not be so relevant. In this case, a value of Y below –1.5 might be justified despite the apparent conflict with the estimates relating to changes in output price indices for other sectors of the Dutch economy.

3.54 We have not considered in this study whether there are any grounds for expecting such a period of relatively high productivity growth from GTS for the regulatory period over which Energiekamer needs to set price controls for.

Estimates relating to operating expenditure for gas transportation companies

3.55 As part of our study, we have produced a number of estimates of the changes over time in measures of operating expenditure for various gas transportation companies.

3.56 These growth rates relate to categories of costs that exclude capital elements (such as depreciation and profits). They are not directly comparable to Y. We discuss their potential relevance to the choice of Z below.

Potential implications for the choice of Z

Comparisons with Z

3.57 We identified in Section 2 that Energiekamer may set the X factor for a regulatory period by taking an estimate of GTS's operating expenditure requirements at the start of the regulatory period and then rolling this forward by an annual adjustment factor. The resulting operating expenditure forecast would then be combined with separate allowances for amortisation and profit as part of the calculation used to set X. We use the term Z to refer to annual adjustment factors that are applied to roll-forward a measures of operating expenditure as part of the price control calculations.

3.58 Two main categories of estimates reported in this study can be compared with Z:

(a) Changes over time in the LEMS cost measure, relative to the CPI.

(b) Changes over time in measures of operating expenditure per unit of output, relative to the CPI (or similar inflation index).

3.59 We discuss below the estimates under each of these headings. In each case, the basis for comparisons with Z may depend on what concept or measure of operating expenditure Z would be applied to. We also discuss below the potential for comparisons between Z and the labour cost measure described in Section 4.

LEMS cost measure

3.60 We set out estimates of what we call the LEMS cost measure in Section 4. These estimates are calculated for 30 sectors of the Dutch economy, using the EU KLEMS data.

3.61 The LEMS cost measure captures labour costs and expenditure on intermediate inputs and excludes the purchases of capital by a sector. This seems similar, in some ways, to the concept of operating expenditure (excluding depreciation). However, there are several reasons why changes over time in the LEMS cost measure are not the same as measure of changes in operating expenditure. This is discussed further in the section on “Potential measurement issues” in Section 4.

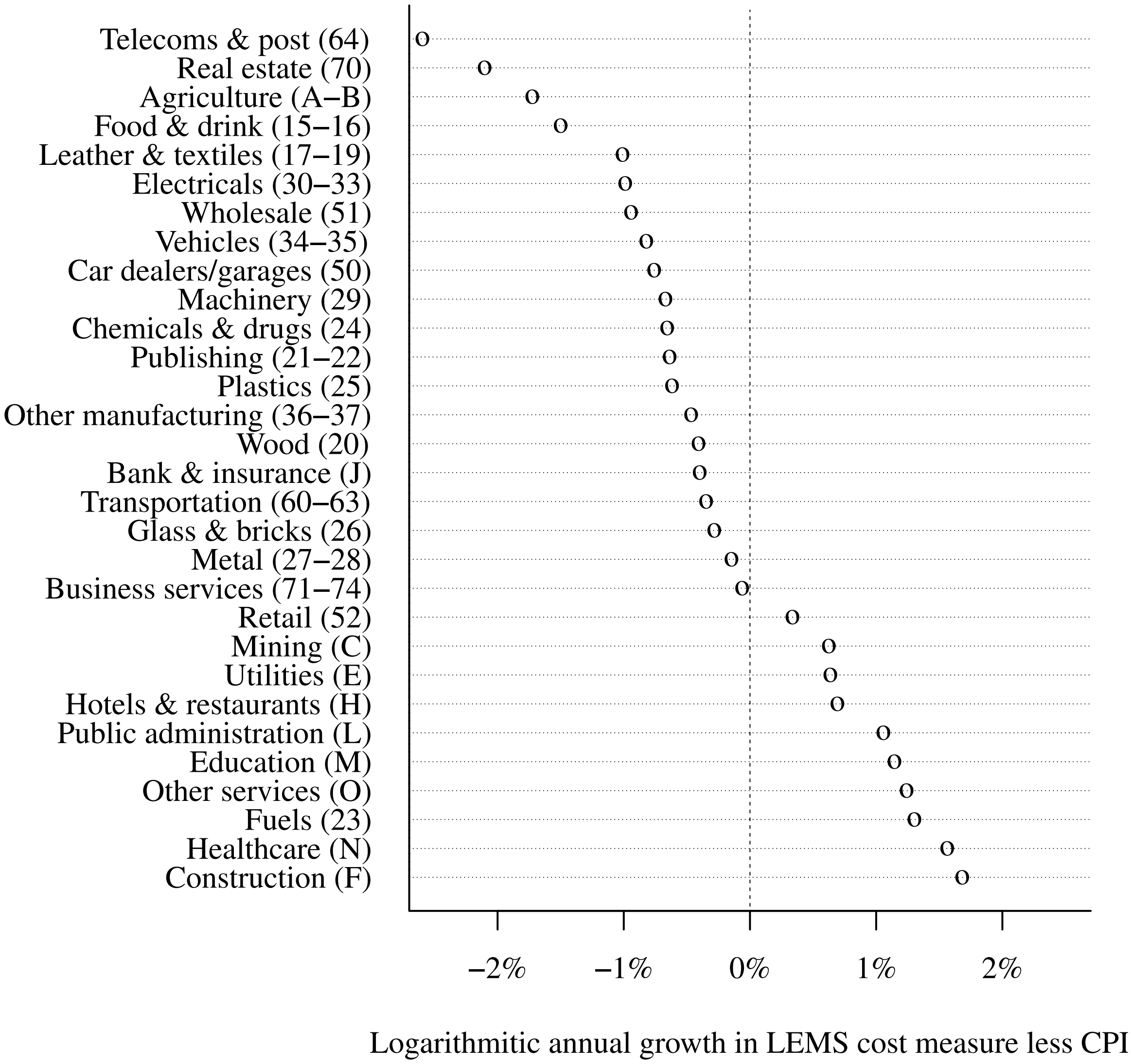
3.62 The LEMS cost measure is designed to be comparable to an annual adjustment factor Z that would be applied to operating expenditure under a hypothesis that the volume of services from capital assets remains constant over the regulatory period (see discussion in Section 2 for more information on this constant capital hypothesis).

3.63 As far as we are aware, the growth rate in the LEMS cost measure is the most comparable thing to the growth rate in operating expenditure per unit of output (under a constant capital hypothesis) that can be calculated from the EU KLEMS dataset. But the growth in the LEMS cost measure for a sector should not be taken as a perfect guide to changes in operating expenditure for companies in that sector.

3.64 The estimates for the LEMS cost measure should reflect the impact of productivity growth in each sector and of changes, relative to the CPI, in the prices of labour inputs and of intermediate inputs (e.g. the prices of materials and energy used for production).

3.65 Figure 5 shows estimates for the annualised growth, over the period 1970 to 2007, in the LEMS cost measure relative to the CPI. A negative number indicates a reduction in costs relative to the CPI. The industries in figure 5 are ordered in a way that helps to convey the spread of the growth in the LEMS cost measure across different industries and to highlight those with relatively low or high growth rates.

Figure 5 Growth in LEMS cost measure relative to CPI (Netherlands, 1970 to 2007)

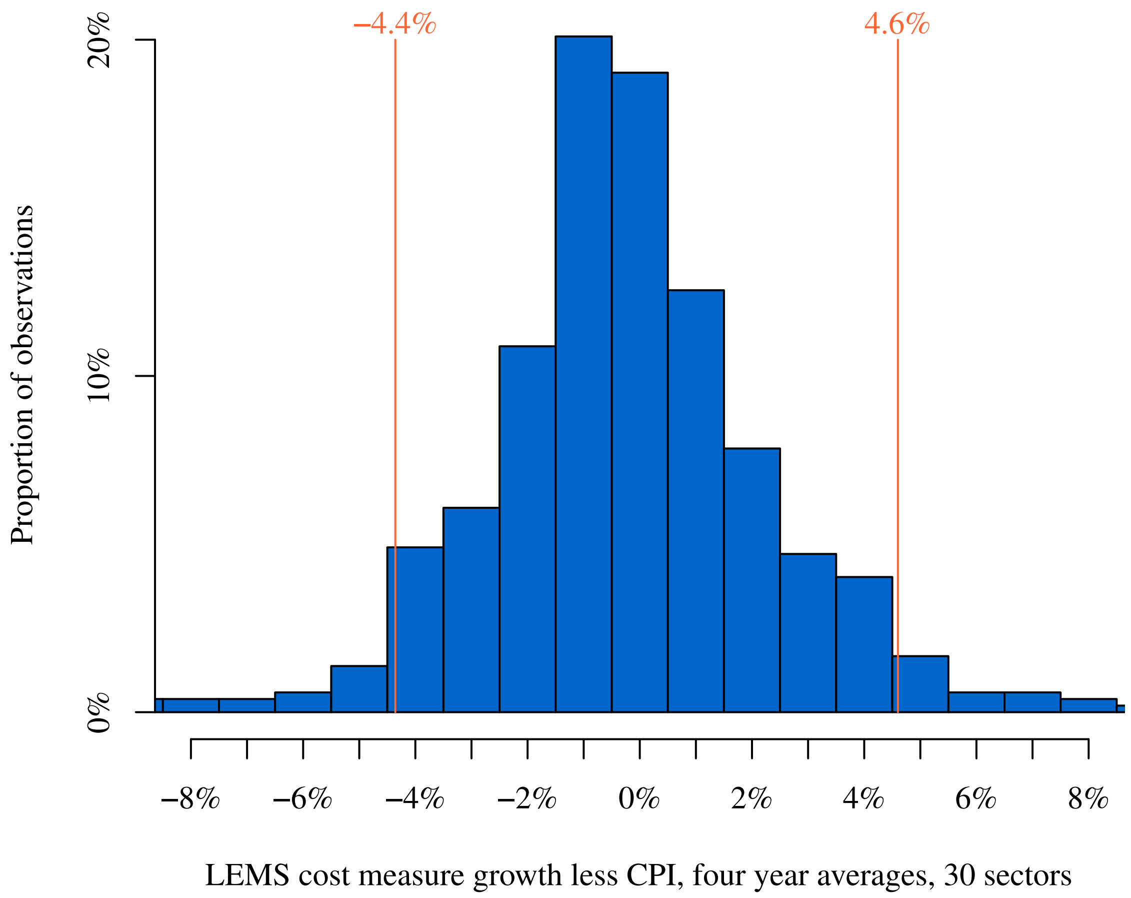


3.66 As with the estimates for the output price indices, we find that for most sectors the average growth rate in the LEMS cost measure, relative to CPI, over the period 1970 to 2007 lies in the range –1.5 per cent to 1.5 per cent.

3.67 Figure 6 provides a histogram which indicates the variance in the growth rates of the LEMS cost measure over shorter time periods (four-year averages). This is done on the same basis as the histogram for the output price indices shown earlier.

3.68 The vertical lines in the histogram enclose 90 per cent of the observations. In 90 per cent of cases for which we have data, the average growth rate of the LEMS cost measure relative to CPI was between –4.4 per cent and 4.6 per cent.

Figure 6 Distribution of annual rates growth rates for LEMS cost measure relative to CPI (four-year averages, all sectors)



3.69 As highlighted above, the LEMS cost measure is designed for comparisons with Z under the constant capital hypothesis discussed in Section 2. If an alternative view about capital substitution is used for the operating expenditure element of the GTS price controls, comparisons with the LEMS cost measure may not be valid.

Estimates relating to operating expenditure for gas transportation companies

3.70 We have produced and collated a number of estimates of the changes over time in measures of operating expenditure per unit of output for gas transportation companies. These are summarised in table 3.

Table 3 Estimates for measure of gas transportation operating expenditure

Measure	**Compound annual growth rate**
GTS — total operating expenditure plus incidental, adjusted for changes in measures of outputs, relative to Dutch CPI (2005–2009)	–7.1%
GTS — total operating expenditure plus incidental less energy, nitrogen and flexibility costs, adjusted for changes in measures of outputs, relative to Dutch CPI (2005–2009)	1.5%
Labour and intermediate input (including natural gas) expenditure per unit of output relative to US CPI-U for US oil and gas transmission pipelines (1987–2004)	–1.3%
Operating expenditure for gas transmission company in Great Britain relative to the UK CPI (2005–2009) — range calculated using different output measures	–0.4% to 4%
Measure of "controllable operating expenditure" for gas transmission company in Great Britain relative to the UK CPI (2006– 2009) — range calculated using different output measures	–5.8% to 3%
Operating and maintenance expenditure per unit of output for three Australian gas distribution companies relative to Australian CPI (1998–2007)	–4.2%

3.71 Comparisons between the estimates in the table above and a value of Z are possible, but these are complicated by the possibility of capital substitution. The growth rates in these measures of operating expenditure may reflect both productivity growth and capital substitution. As discussed in Section 2, there are some risks of inconsistency if a value of Z is chosen based on historical changes in operating expenditure without consideration of the interactions between operating expenditure and capital assets.

3.72 Any comparisons between these estimates and Z should also take account of the coverage of the operating expenditure measure used. Ideally, there would be consistency between the operating expenditure measure to which Z would be applied and that used for the historical estimates. For example, there are differences in the estimates reported in table 3 as to whether the costs of energy are included or excluded.

3.73 We now make some comparisons between the estimates in table 3 and the estimates for the LEMS cost measure. The LEMS measure is not an operating expenditure measure — rather it is an approximation of an operating expenditure measure based on sector-level data from National Accounts. Unlike the estimates in table 3, the LEMS cost measure is adjusted so as to be compatible with the constant capital hypothesis discussed in Section 2.

3.74 Of the estimates in the table above, the estimate for the US oil and gas transmission pipeline sector is calculated over the longest time period (1987–2004). The estimated growth rate is –1.3 per cent (relative to a US consumer inflation measure). This does not appear at odds with the estimates for the LEMS costs measure. This estimate might suggest a lower value of Z than the LEMS estimates taken in isolation. However, some caution is needed. The estimate of relatively low growth in operating expenditure (per unit of output) for US oil and gas pipelines might also be due to other factors. The companies within the oil and gas pipeline industry in the US will differ from GTS in ways that may affect the operating expenditure trends and productivity growth they experience.

3.75 Some of the other estimates in the table above appear as outliers compared to the estimates of the LEMS measure (e.g. see the histogram at figure 6). Some of these estimates may be affected by transitory effects. For example, the substantial reductions in operating and maintenance expenditure per unit of output for the Australian gas transportation companies may reflect a period of relatively high productivity growth following privatisation, which is not sustainable.

Comparisons between labour unit cost measure and Z

3.76 In Section 4, we also present estimates for a labour cost measure using EU KLEMS data (see Section 4 for more information on this measure).

3.77 The labour cost measure is not directly comparable with Z. If the EU KLEMS data are to be used for comparisons with Z, the LEMS cost measure — or a variant of this involving a different assumption on the rate of capital substitution — would be more relevant.

3.78 It might be possible to construct a weighted average that would enable the labour cost measure to be used in a comparison with Z. For instance, Z might be compared against a weighted average calculated as the sum of:

(a) The growth rate in the labour cost measure (relative to CPI), with a weight based on the proportion of domestic labour contributing to GTS's operating expenditure (including the labour of GTS' subcontractors and suppliers).

(b) The growth rate in a price index (relative to CPI) for the non-labour elements of GTS's operating expenditure (e.g. reflecting the prices of raw materials or imports used by GTS). The weight for this price index would be one minus the weight used for (a).

3.79 However, there will be uncertainty about the weights and the price index needed for (b), and we do not see this calculation bringing benefits compared to comparisons with the LEMS cost measure.

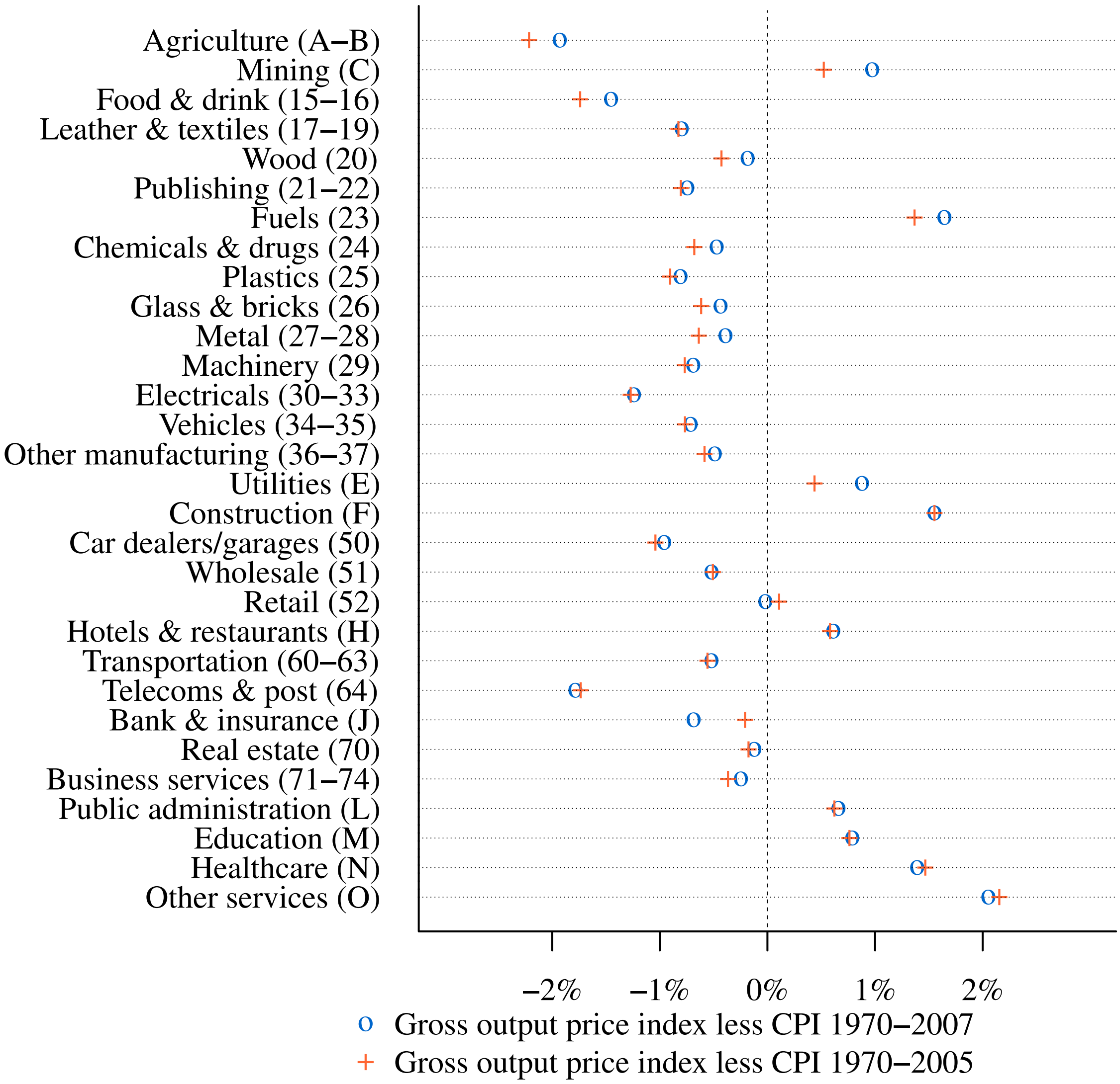
Impact of excluding data from periods beyond 2005

3.80 Energiekamer needs to set a series of price controls for GTS, including retrospective price controls for regulatory periods from 2006. Energiekamer has told us that it may be necessary to set price controls for certain regulatory periods by reference to data for years up to and including 2005, and ignoring more recent data.

3.81 We have considered what the impact of this data restriction would be for the estimates discussed in this section.

3.82 We have carried out analysis of the EU KLEMS dataset using data for the period 1970 to 2005. Figure 7 shows the compound annual growth rate for the output price indices for the period 1970 to 2005 and for the period 1970 to 2007. There is little difference. This is not surprising given the large overlap in the data period covered in the two cases.

Figure 7 Output price indices relative to CPI (impact of different data periods)



3.83 We have carried out a similar comparison for the LEMS cost measure. Again, the impact of a restriction to a data period of 1970 to 2007 is limited. We provide a corresponding chart for the LEMS cost measure in Section 4.

3.84 There are two main areas where a restriction to use data only up to 2005 would have an impact:

(a) A substantial part of the data used in our analysis in Section 6 on GTS and National Grid in the UK relates to years after 2006.

(b) The studies we describe in Section 5 relating to gas distribution companies in Australia are based on data periods that go slightly beyond 2005. Similarly, the estimates we provide in Section 6 of changes over time in operating and maintenance expenditure for these companies use data for 2006 and 2007.

3.85 The estimates we report for these companies should not be used if there is a requirement to ignore data from 2006 onwards.

3.86 Some of the information we have collected would not be affected at all by an exclusion of data for years after 2005. In particular, the two studies we discuss in Section 5 relating to gas pipelines in the US use data up to 2004.

The need for regulatory judgement

3.87 Energiekamer will need to exercise regulatory judgement in any choices it makes about Y or Z. As part of this, we think that it will be important for Energiekamer to take account of any relevant submissions from GTS and other interested parties.

3.88 We also suggest that Energiekamer considers how the choice of Y and Z may affect different risks that arise in relation to the price control for GTS, and that it chooses a value in light of a consideration of which risks are most important to Energiekamer's regulatory objectives.

3.89 As an illustration, we have sought to identify a number of risks that might be affected by the choice of Y or Z:

(a) **Risk that investors are denied a fair return on capital**. If Y (or Z) is too low then the investors in GTS may not be able to earn a fair rate of return on their capital. Setting a higher value of Y or Z reduces the risk that GTS does not generate sufficient profit to provide a fair return on capital.

(b) **Risk of prices being too high.** A possible regulatory objective is that Energiekamer may wish that the prices customers pay for gas transportation services are no higher than necessary to cover the costs efficiently incurred by

GTS and to provide a reasonable return on capital to investors. This risk might be reduced by choosing a lower (or more negative) value of Y or Z.

(c) **Risks of GTS inefficiency from easy profits**. There are possible theories that the level of the price control may affect the extent to which GTS retains, or reduces, its expenditure over the price control period. For instance, if the revenues that GTS can collect under the price control are high in relation to costs, GTS may be able to earn a reasonable return on capital without much effort or innovation on the part of its managers. If managers are comfortable achieving such a level of profit, rather than chasing the maximum profit available, then GTS could miss opportunities for productivity improvements and cost reductions. This risk might be reduced by choosing a value of Y or Z that is relatively low, provided that it is within a plausible range. We do not know whether this hypothetical risk is relevant to GTS.

(d) **Risks of corner-cutting to maintain profits**. If GTS's costs rise at a faster rate than the revenues it can collect under its price control, the profits made by GTS could be suppressed. There is a risk that, in these circumstances, GTS management seeks to achieve a reasonable profit by introducing cost reductions that reduce quality of service, lead to greater risks of asset failure in the future, or lead to higher capital expenditure requirements in the future. These risks might be reduced by choosing a higher value of Y or Z. The scale of this risk depends on other elements of the regulatory framework, such as the safeguards on quality of services, and on the way that GTS's management behaves.

3.90 If some of these risks are taken as priorities then small adjustments to the choice of Y or Z may not provide an effective way to address them. For instance, if prioritisation is given to the risks that investors are denied a fair return on capital over the regulatory period and, subject to that, the risks that prices over the regulatory period are too high, then this might point to a regulatory method which involves regulatory scrutiny of forecasts prepared by GTS of its capital expenditure and operating expenditure requirements over the price control period; this does not fit with the method that would involve a single Y as set out in Section 2.

4 Information from EU KLEMS data

Introduction

4.1 This section presents our analysis of the EU KLEMS dataset. It provides estimates of several different measures which relate to changes over time in productivity and costs (per unit of output) for different sectors of the Dutch economy. It is structured as follows:

(a) An introduction to the data sources used.

(b) A description of the measures that we examine.

(c) A discussion of some potential vulnerabilities and measurement issues.

(d) Some introductory statistics for the sectors covered.

(e) Results for the different measures.

Data sources

4.2 The main data source for the estimates in this section is the EU KLEMS dataset (November 2009 release). We have combined this with data on the consumer price index from Statistics Netherlands (CBS). Unless otherwise stated, we use the full period of time for which the necessary data for the Netherlands are available from EU KLEMS. This is 1970 to 2007 for output price indices and unit cost measures, and 1979 to 2007 for productivity measures.

Description of the measures

4.3 We provide estimates for a number of different measures that can be seen to relate to changes over time in productivity and the costs of production. We describe these below.

Output price index

4.4 One of the main measures that we examine is the growth rate (relative to CPI) in the variable "GO_P" from the EU KLEMS dataset, which is described as "Gross output, price indices, 1995 = 100". For a particular sector of the Dutch economy, this measure represents an index of the prices of the goods and services supplied by that sector.

4.5 The outputs to which these indices apply cover both goods and services for final consumption by households or Government, and outputs used by other businesses (i.e. outputs that are then taken as intermediate inputs).

4.6 The growth rate in the gross output price index for a particular sector of the economy can be seen to represent the combined impact of changes in productivity and changes in the prices of the inputs that are used in production. Changes over time in the prices of the goods and services produced by companies within an industry will reflect changes over time in their costs of production and in the rate of profits. These will, in turn, reflect the productivity growth achieved by these companies and changes in the prices of the inputs that these companies use (relative to the CPI).

4.7 This price index also plays an important role in the calculation of the productivity and LEMS measures described below. For example, a necessary ingredient to calculate total factor productivity on a gross output basis is a measure of the volume of gross output produced by a sector. A measure of the volume of gross output can be obtained by dividing the nominal value of the gross output of that sector by the price index for that sector. In this way, the rate of change (as a natural logarithm) in the volume of gross output can be seen as the rate of change in the value of gross output minus the rate of change in the price index.

Gross output total factor productivity measure

4.8 We have calculated estimates of the growth in gross output total factor productivity. These relate to the growth rate in the volume of gross output relative to the growth rate in the volume of inputs.

4.9 The growth in gross output total factor productivity can be seen as an estimate of the increase in the annual volume of gross output that might be obtained from a constant volume of labour, services from capital and intermediate inputs. It can also be seen as the growth rate in the volume of gross output that is not attributed to growth in the volume of inputs used.

4.10 We have chosen not to report estimates for total factor productivity growth based on an alternative measure of output — gross value added. Estimates of total factor productivity growth on a "value added" basis are frequently cited in macroeconomic studies. In this context, when the term TFP growth, or total factor productivity growth, is used, it tends to refer to estimates of total factor productivity on a value added basis rather than on a gross output basis.

4.11 For the purposes of this study, we have not found a role for estimates of total factor productivity on a value added basis. The underlying reason is that value added refers to a combination of labour costs, capital amortisation and profits, but excluding materials and services. Even if it is useful in growth accounting, it is not suited to be reconciled with accounting or business concepts such as operating expenditure.

4.12 We focus on gross output total factor productivity estimates. Gross output total factor productivity estimates are more common in microeconomic studies, especially ones that focus on the productivity improvements for specific companies. The studies that we review in Section 5 focus on gross output measures of total factor (or multi-factor) productivity growth.

LEMS cost measure and labour cost measure

4.13 We also examine two cost measures that we call the LEMS costs measure and the labour cost measure. Each of these relates to a sub-set of costs.

(a) **LEMS cost measure**. This is an estimate of the increase in the cost of labour and intermediate inputs (energy, materials and services) that might be expected from past productivity and input price trends, if there was to be a constant volume of gross output and a constant volume of services from capital.

(b) **Labour cost measure**. This is an estimate of the increase in the cost of labour that might be expected from past productivity and input price trends, if there was to be a constant volume of gross output, and constant volume of intermediate inputs, and a constant volume of services from capital.

4.14 We use the term "LEMS" because the cost measure covers four of the five input categories from which the term "KLEMS" is derived: labour (L), energy (E), materials (M) and services (S). The cost measure does not cover capital inputs (K). The data provided in EU KLEMS takes energy, materials and services as a single category, which is called intermediate inputs. So the LEMS cost measure covers labour and intermediate inputs but not capital inputs.

4.15 Table 4 highlights the main features of the LEMS and labour cost measures.

Table 4 Comparison of unit cost measures

	LEMS cost measure	**Labour cost measure**
Source	Based on measure reported in our report for Ofwat (2008), but adapted because most recent EU KLEMS data for the Netherlands do not report certain data on taxes and subsidies[5]	Measure reported in our previous report for Energiekamer on GTS productivity growth (2008)[6]
Cost coverage	Labour compensation (including wages, the self-employed and taxes on labour) Expenditure on intermediate inputs (expenditure on goods and services not attributed to the purchase of capital)	Labour compensation (including wages, the self-employed and taxes on labour)
Output measure	Volume index of gross output	Volume index of value added
Treatment of changes in capital	Adjustment to exclude the impact on costs that is attributed to changes in the volume of capital employed	Adjustment to exclude the impact on costs that is attributed to changes in the volume of capital employed
Interpretation	The growth (relative to CPI) in labour costs and expenditure on intermediate inputs if there had been: • A constant volume of outputs • A constant volume of capital	The growth (relative to the CPI) in labour costs if there had been: • A constant volume of outputs • A constant volume of capital • A constant volume of intermediate inputs

[5] Reckon (2008) "PR09 Scope for efficiency studies", available from http://go.reckon.co.uk/a79315 accessed on 10 March 2011.

[6] Reckon (2008) "The productivity growth of GTS", available from http://go.reckon.co.uk/a15680, accessed on 10 March 2011.

	LEMS cost measure	Labour cost measure
Link to productivity and input prices	Calculation takes account of: • Total factor productivity growth • An estimate of what would have happened if that total factor productivity growth had only been manifest through reductions in the volume of labour and intermediate inputs • Wage growth and changes in the prices of intermediate inputs	Calculation takes account of: • Total factor productivity growth • An estimate of what would have happened if that total factor productivity growth had only been manifest through reductions in the volume of labour • Wage growth

4.16 As indicated in the table, for both of these measures an adjustment is made to exclude the impact on costs that is attributed to changes in the volume of capital employed

LEMS productivity measure and labour productivity measure

4.17 Each of the costs measures above is calculated by combining an input price index for the relevant categories of inputs (e.g. labour and intermediate inputs) with a productivity measures. These productivity measures are:

(a) **LEMS productivity measure (at constant capital)**. This is an estimate in the decrease in the volume of labour and intermediate inputs (energy, materials and services) that might be expected from past productivity trends, if there was to be a constant volume of gross output and a constant volume of services from capital. This is calculated by taking an estimate of gross output total factor productivity growth achieved and making an estimate of what would have happened if that total factor productivity growth had only been manifest through reductions in the volume of labour and intermediate inputs.

(b) **Labour productivity measure (at constant capital)**. This is an estimate in the reduction in the volume of labour that might be expected from past productivity trends, if there was to be a constant volume of gross output, and constant volume of intermediate inputs, and a constant volume of services from capital. This is calculated by taking an estimate of value added total factor productivity growth achieved and making an estimate of what would have happened if that total factor productivity growth had only been manifest through reductions in the volume of labour employed.

4.18 We report estimates of these measures alongside estimates for the LEMS cost measure and labour cost measure to provide an indication of how the former may be decomposed into productivity and input price effects.

Relationships between the different measures

4.19 There is a relationship between each productivity index and the corresponding price index (all indices and measures are expressed in logarithms):

[Output price index] = [Input price index for labour, intermediate inputs and services from capital] – [Gross output total factor productivity measure]

[LEMS cost measure] = [Input price index for labour and intermediate inputs] – [LEMS productivity measure]

[Labour cost measure] = [Wage index] – [Labour productivity measure]

4.20 Although they might superficially appear to relate to a subset of factors of production, the LEMS productivity measure and labour productivity measure defined above are based on total factor productivity measures. They are not partial factor productivity measures. This is because the cost increase or volume reduction in the labour input, or labour and intermediate inputs, is estimated on the assumption that the other factors of production are kept constant in volume terms relative to output volume.

4.21 The three productivity measures are related as follows:

[LEMS productivity measure] = [Gross output total factor productivity measure]/([Value of labour and intermediate inputs]/[Value of gross output])

[Labour productivity measure] = [Gross output total factor productivity measure]/([Value of labour]/[Value of gross output])

Or equivalently:

[Gross output total factor productivity measure]*[Value of gross output]

= [LEMS productivity measure]*[Value of labour and intermediate inputs]

= [Labour productivity measure]*[Value of labour]

Potential measurement issues

Gross output productivity and unit cost measures

4.22 Whilst gross output is a straightforward concept to understand when it applies to a single company, complications arise for the large aggregations of organisations captured by the industries and sectors for which the EU KLEMS data are available.

4.23 A productivity or unit cost measure based on gross output is most meaningful when it relates to data for a single company. Total factor productivity on a gross output basis for the company can be calculated as the growth in a measure of the volume of outputs produced by the company minus a weighted-average of the growth in the volume of inputs used by the company (e.g. labour inputs, materials inputs and capital employed).

4.24 The data available from EU KLEMS is not provided for individual firms. It is provided for various sectors or industries, and for further aggregations of these sectors. If we calculate total factor productivity on a gross output basis for one of the sectors in the EU KLEMS database, we obtain an estimate of the weighted average total factor productivity growth achieved by companies in the sector. The weights used for the weighted average relate to each company's share of gross output. In a simple case, a company's gross output is its turnover.

4.25 If total factor productivity growth is calculated on a gross output basis, the following features apply:

(a) Total factor productivity growth will be sensitive to the organisation of enterprises within a sector — in particular, the extent of vertical integration. This feature may limit the reliability of comparisons of total factor productivity growth over time, between sectors and between countries. For instance, if the extent of vertical integration changes over time through a greater use of subcontractors rather than in-house production, this will affect the measure of total factor productivity growth.

(b) The contribution of each company's total factor productivity growth to the productivity growth for the sector will depend on each company's share of gross output. The gross output of a company within a sector gives no reliable indication of the relative importance of the company to the sector, in terms of using labour and capital inputs to take things produced by other sectors (and imports) and transform them into the sector's output.

4.26 The extent to which measures of gross output total factor productivity growth can be affected by vertical integration depends on the level of aggregation of the sector. This is recognised by researchers involved in the EU KLEMS project:[7]

> "MFP measures [also known as TFP measures] can be derived at various levels of aggregation. Gross output decompositions are most meaningful at the lowest level of aggregation, viz., establishments. As soon as aggregates of gross output are decomposed, one runs into problems of comparability over time and across countries, depending on differences in the vertical integration of firms. Ideally, decomposing gross output should be done on a sector output measure which excludes intra-sectoral deliveries of intermediates (Gollop, 1979). […] Therefore, we present gross output decompositions only at the lowest possible industry level, depending on the level of detail of outputs and inputs, and do not show any industry aggregates. In the current database we also present the decompositions of value added growth, which is insensitive to the intra-industry delivery problem."

4.27 In this light, we only report estimates for gross output total factor productivity growth and the LEMS and labour cost measures (which are both derived from estimates of gross output total factor productivity growth) for the most disaggregated sectors available from the EU KLEMS dataset. This means, for example, that we report

[7] O'Mahony, M and M P Timmer (2009) "Output, input and productivity measures at the industry level: the EU KLEMS database", *The Economic Journal*, Vol 119 No 538, page F395

estimates for various different categories of manufacturing industries rather than for manufacturing overall.

Evidence of measurement problems

4.28 As reported further below, the estimates we have made using the EU KLEMS data show gross output total factor productivity growth for some sector, over the full period of data, which are close to zero or even negative. This feature is not limited to sectors involving a large proportion of public sector provision, such as education and health and social work, for which productivity measurement issues are well-known.

4.29 We do not believe that there have been no significant productivity improvements in the Netherlands between 1970 and 2007 amongst companies in sectors such as construction, financial intermediation and hotels and restaurants.

4.30 Instead, we suspect that these results are more likely to reflect measurement issues that cast some doubts over the reliability of the results for the gross output total factor productivity and LEMS productivity estimates and, perhaps to a lesser degree, the LEMS cost measure.

4.31 The estimates of low or negative total factor productivity growth do not, by themselves, imply any vulnerability in the output price indices.

Exclusion of mining and quarrying sector from charts

4.32 In the case of the mining and quarrying sector, the measurement problems appear to be particularly severe. This might be explained by the difficulty of producing a reliable measure of the volume of capital employed in this sector combined with the relatively small proportion of the value of the sector which is attributed to labour and intermediate inputs (for which the measures of the volume of inputs used may be more reliable). In some of the charts below we exclude the mining and quarrying sector.

Gross output and own-account capital formation

4.33 At face value, the growth in the LEMS cost measure described above provides an approximation to the growth in operating expenditure. It captures the data reported for labour compensation and consumption of intermediate inputs and excludes the purchases of capital by a sector. This seems similar to the concept of operating expenditure (excluding depreciation).

4.34 However, the growth in the LEMS cost measure is not the same as measure of changes in operating expenditure (even leaving aside the adjustment we make for constant capital).

4.35 Some of the expenditure included in the LEMS cost measure may relate to expenditure to create things that could be capitalised and excluded from operating expenditure in a company's accounts (e.g. if a company's own employees create a new capital asset for the company to use, such as a new IT system for its own use). Our understanding is that this would be treated as follows in the datasets on which the EU KLEMS data are based:

(a) The labour used to create the capital asset would contribute to labour costs. The labour costs reported in EU KLEMS would include some costs that would not be classified as operating expenditure.

(b) The creation of the capital would be treated as "own account capital formation" and the value of the capital formed would be added to reported turnover (sales) as part of the calculation of its gross output. The volume of gross output reported would increase even there was no increase in the supply of goods and services to customers.

4.36 These impacts work in opposite directions — the first increases the LEMS cost measure and the second decreases it. We have not identified a reason for them to cancel out exactly. We do not expect the likely scale of this issue to be sufficient to detract from the relevance of the LEMS cost measure to the potential operating expenditure trends for GTS.

Statistics about the sectors covered

4.37 In the charts that follow we use short names for each of the sectors, rather than the names from the EU KLEMS dataset. This is partly for presentational purposes, but also because in some cases the names from EU KLEMS can give a misleading picture of what the sector comprises. The letter or number in brackets is the NACE code for the sectors (or NACE codes where it applies to an aggregation of sectors). We have chosen our sector names based on a review of what sub-sectors each sector comprises. Table 5 shows the mapping of short names to EU KLEMS sectors.

Table 5 Short names that we use for EU KLEMS sectors

EU KLEMS description	Short name
Agriculture, Hunting, Forestry And Fishing	Agriculture (A-B)
Mining And Quarrying	Mining (C)
Food , Beverages And Tobacco	Food & drink (15-16)
Textiles, Textile , Leather And Footwear	Leather & textiles (17-19)
Wood And Of Wood And Cork	Wood (20)
Pulp, Paper, Paper , Printing And Publishing	Publishing (21-22)
Coke, Refined Petroleum And Nuclear Fuel	Fuels (23)
Chemicals And Chemical	Chemicals & drugs (24)
Rubber And Plastics	Plastics (25)
Other Non-Metallic Mineral	Glass & bricks (26)
Basic Metals And Fabricated Metal	Metal (27-28)
Machinery, Nec	Machinery (29)
Electrical And Optical Equipment	Electricals (30-33)
Transport Equipment	Vehicles (34-35)
Manufacturing Nec; Recycling	Other manufacturing (36-37)
Electricity, Gas And Water Supply	Utilities (E)
Construction	Construction (F)
Sale, Maintenance And Repair Of Motor Vehicles And Motorcycles; Retail Sale Of Fuel	Car dealers/garages (50)
Wholesale Trade And Commission Trade, Except Of Motor Vehicles And Motorcycles	Wholesale (51)
Retail Trade, Except Of Motor Vehicles And Motorcycles; Repair Of Household Goods	Retail (52)
Hotels And Restaurants	Hotels & restaurants (H)
Transport And Storage	Transportation (60-63)
Post And Telecommunications	Telecoms & post (64)
Financial Intermediation	Bank & insurance (J)
Real Estate Activities	Real estate (70)

EU KLEMS description	Short name
Renting Of Machinery and Equipment And Other Business Activities	Business services (71-74)
Public Admin And Defence; Compulsory Social Security	Public administration (L)
Education	Education (M)
Health And Social Work	Healthcare (N)
Other Community, Social And Personal Services	Other services (O)
Total	Whole economy

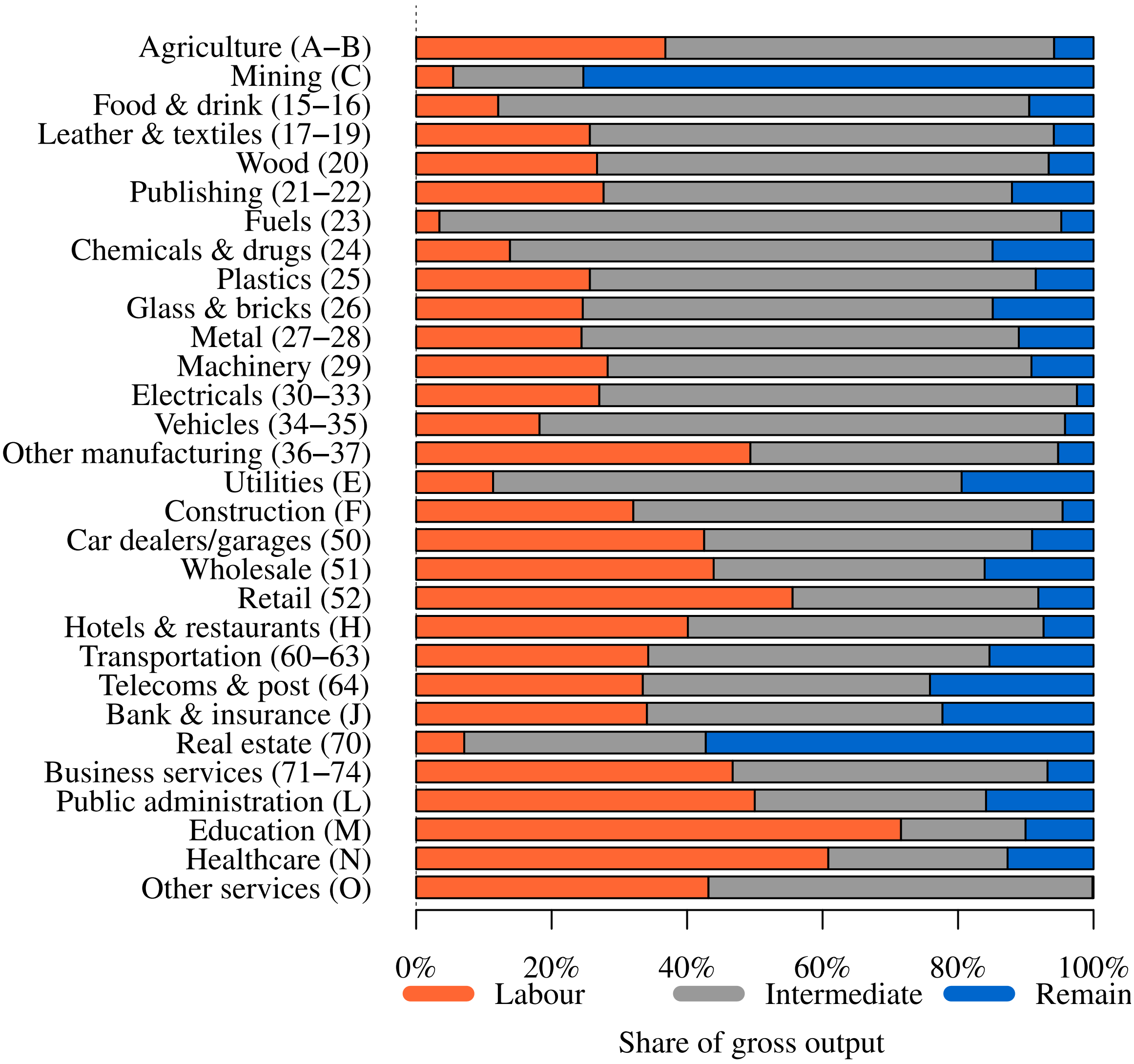
4.38 Before turning to the main estimates, we provide some introductory information on the various sectors covered. Table 6 reports the figures from EU KLEMS for gross output and value added for the most recent year of data, 2007. Value added represents the value of gross output of a sector minus its expenditure on intermediate inputs (inputs other than capital and labour).

Table 6 Gross output and value added by industry (Netherlands, 2007)

Sector	Gross output in 2007 (EUR billion)	Value added in 2007 (EUR billion)
Agriculture (A-B)	26	10
Mining (C)	21	15
Food & drink (15-16)	55	13
Leather & textiles (17-19)	4	1
Wood (20)	3	1
Publishing (21-22)	20	8
Fuels (23)	31	3
Chemicals & drugs (24)	54	11
Plastics (25)	7	2
Glass & bricks (26)	7	2
Metal (27-28)	27	8
Machinery (29)	22	7
Electricals (30-33)	21	4
Vehicles (34-35)	16	3
Other manufacturing (36-37)	10	5
Utilities (E)	35	10
Construction (F)	79	28
Car dealers/garages (50)	16	8
Wholesale (51)	71	41
Retail (52)	29	17
Hotels & restaurants (H)	18	9
Transportation (60-63)	53	23
Telecoms & post (64)	25	12
Bank & insurance (J)	62	30
Real estate (70)	60	42
Business services (71-74)	123	70
Public administration (L)	62	34
Education (M)	27	21
Healthcare (N)	60	44
Other services (O)	37	16
Whole economy	*1,081*	*503*

4.39 Figure 8 shows, for each industry, labour costs and the expenditure on intermediate as a proportion of gross output. It shows the average shares over the period 1970 to 2007. The remainder of gross output includes depreciation and profits as well as other elements such as taxes on production and production subsidies.

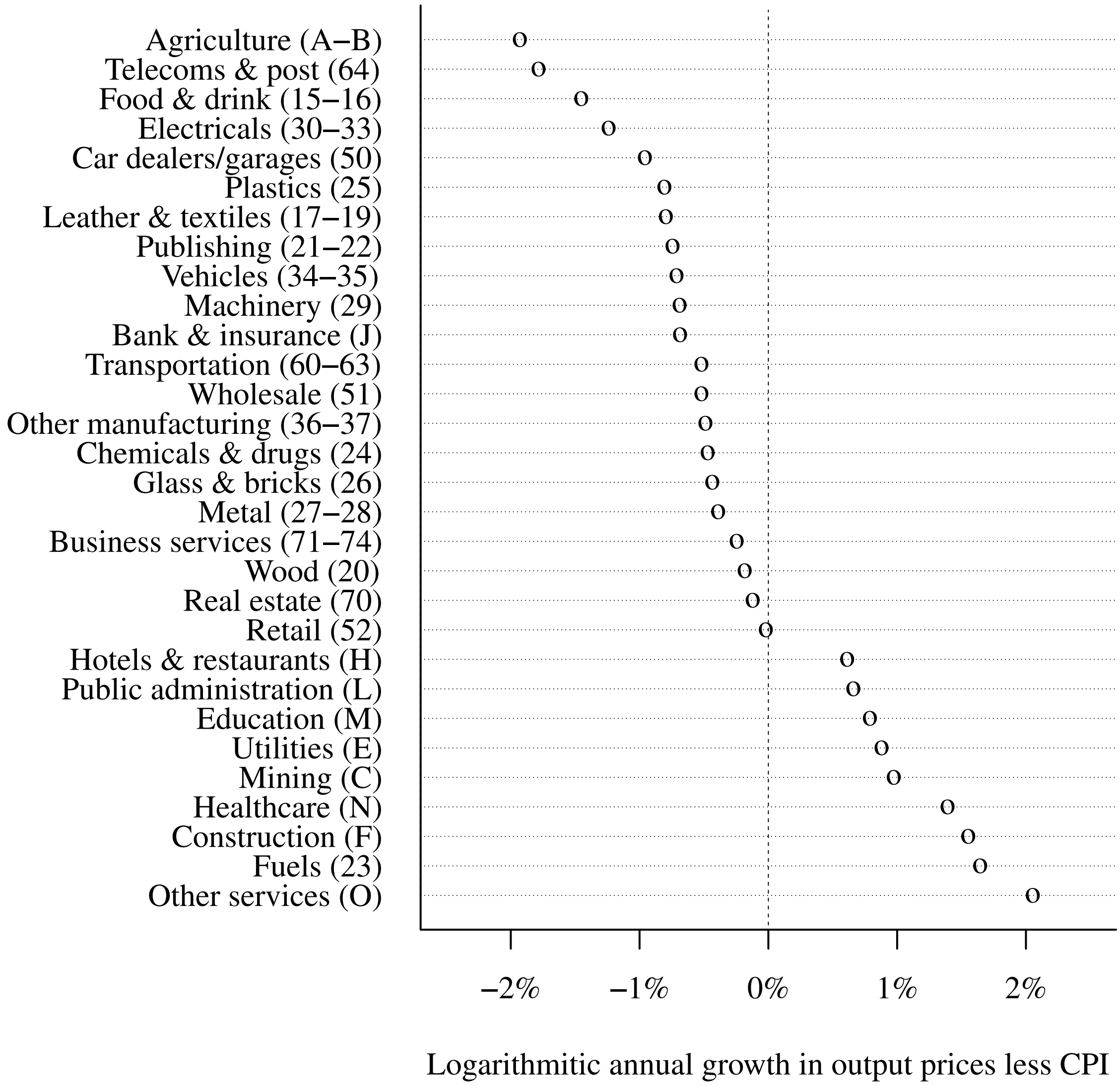
Figure 8 Average labour and intermediate inputs share of gross output (Netherlands, 1970 to 2007)



Output price indices

4.40 Figure 9 shows estimates for the annualised growth, over the period 1970 to 2007, in the output price index for each of the sectors covered, relative to the CPI. A negative number indicates a sector for which, over the period, the price index for the industry's outputs has increased at a slower rate than CPI.

Figure 9 Growth in output price index relative to CPI (Netherlands, 1970 to 2007)

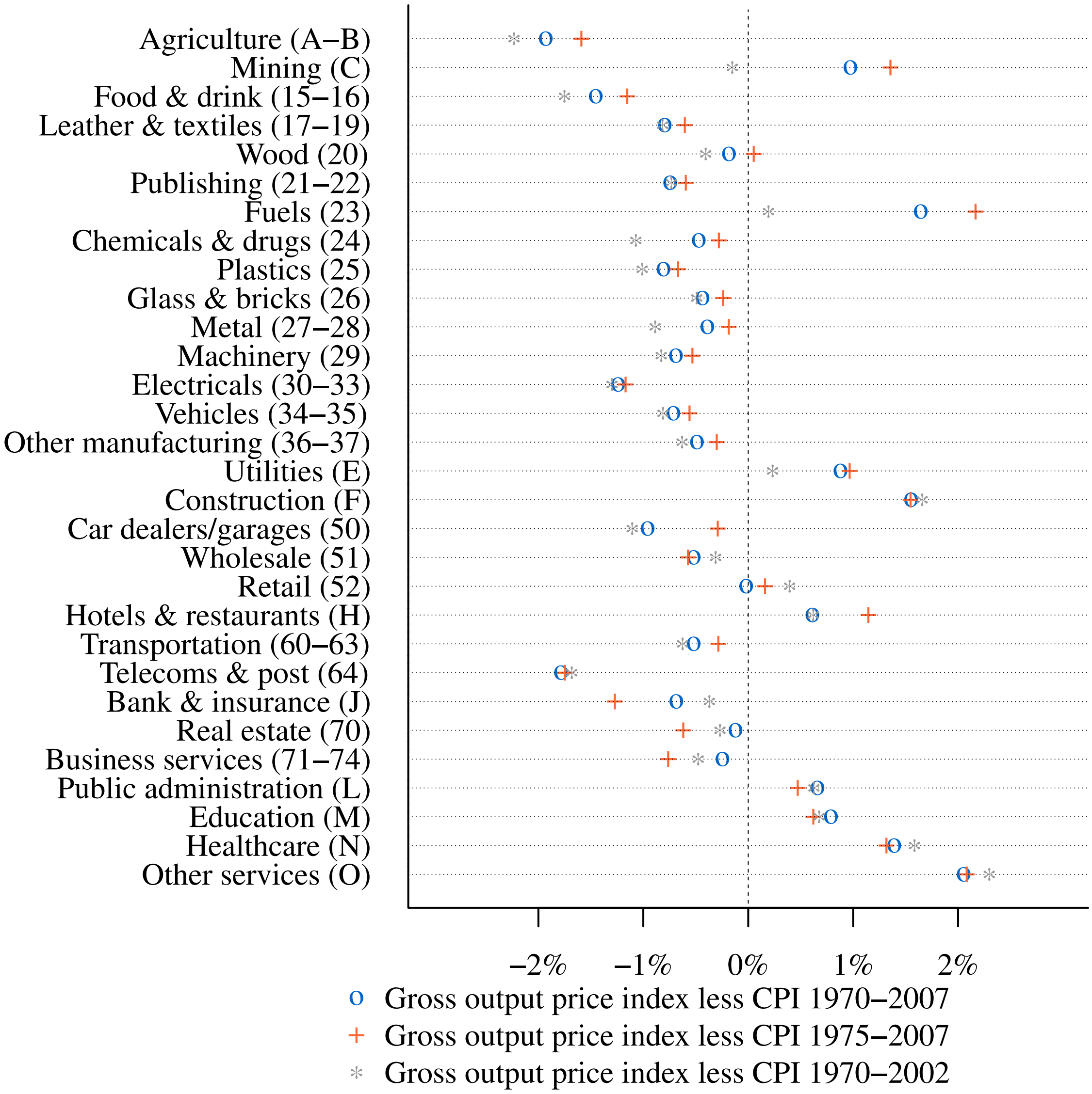


4.41 The prices of outputs supplied on a market will tend to be affected by both the productivity growth of companies supplying that market and changes in the prices of the inputs (e.g. wages) that these companies use to supply services on the market.

4.42 Similarly, changes over time in the output price index for an industry will reflect the impact of productivity growth in that industry and changes in the prices of labour inputs and of intermediate inputs. Changes in the output price will also reflect changes in the rate of profits earned on capitals employed in the industry. It is possible to see this from the opposite perspective too: changes in the rate of profits reflect the combined effect of changes in output prices, input prices and productivity.

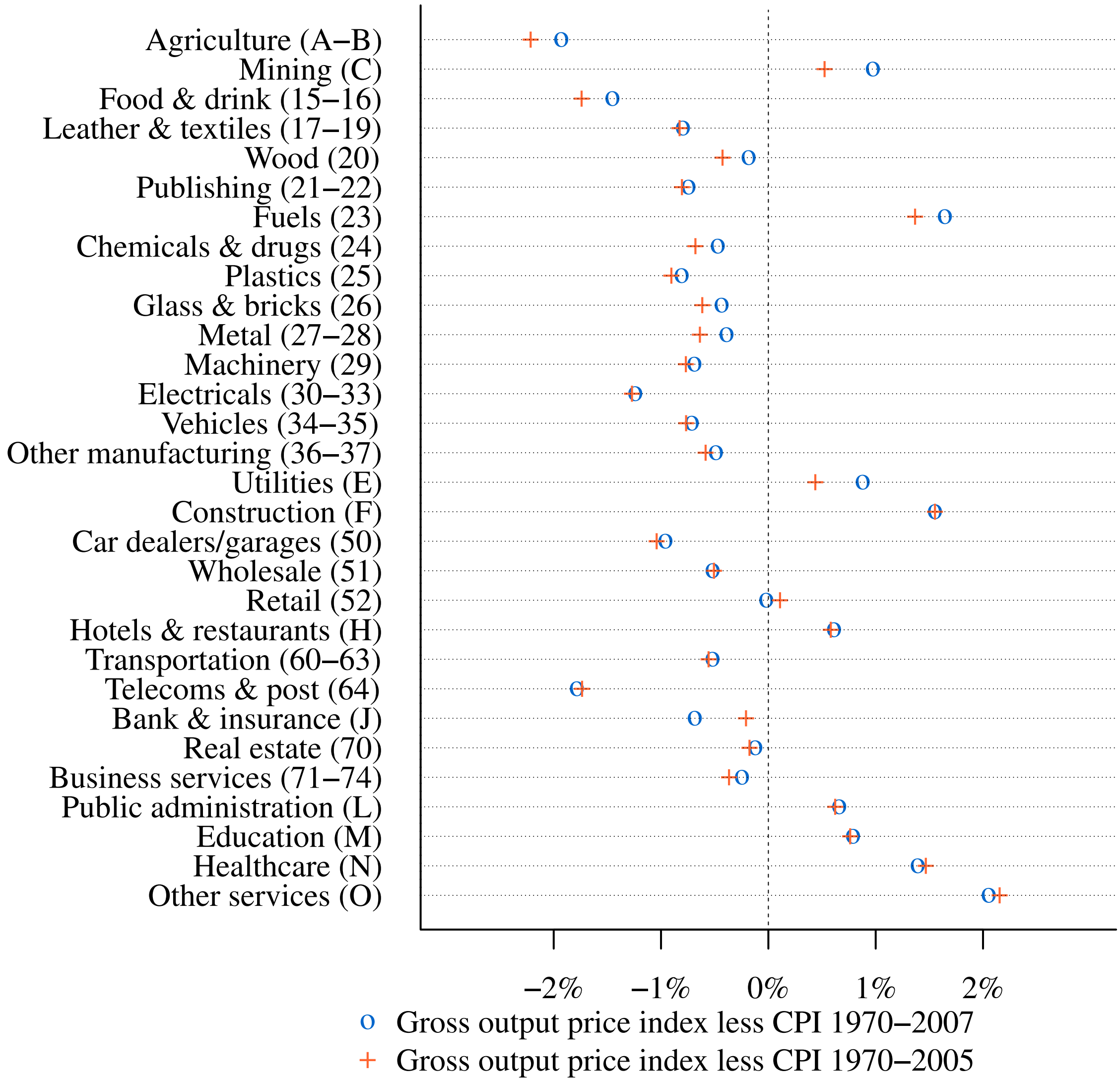
4.43 The growth rates in the output price indices are sensitive to the time period over which the calculations are made. Figure 10 reproduces the growth rates for the period 1970 to 2007, and compares them to a growth rate for a period which excludes the first five years (1975 to 2007) and to a growth rate for a period which excludes the last five years (1970 to 2002).

Figure 10 Growth in output price index relative to CPI for different data periods (Netherlands, 1970 to 2007)



4.44 We understand that Energiekamer is considering an approach in which it sets the GTS price controls for the period from 2006 only in light of data that relates to years up to 2005. On this basis, figure 11 shows estimates for the growth in output price indices (relative to CPI) for the period 1970 to 2005, and compares these to corresponding estimates over the full period of data, 1970 to 2007.

Figure 11 Growth in output price index relative to CPI for different data periods (Netherlands, 1970 to 2007)

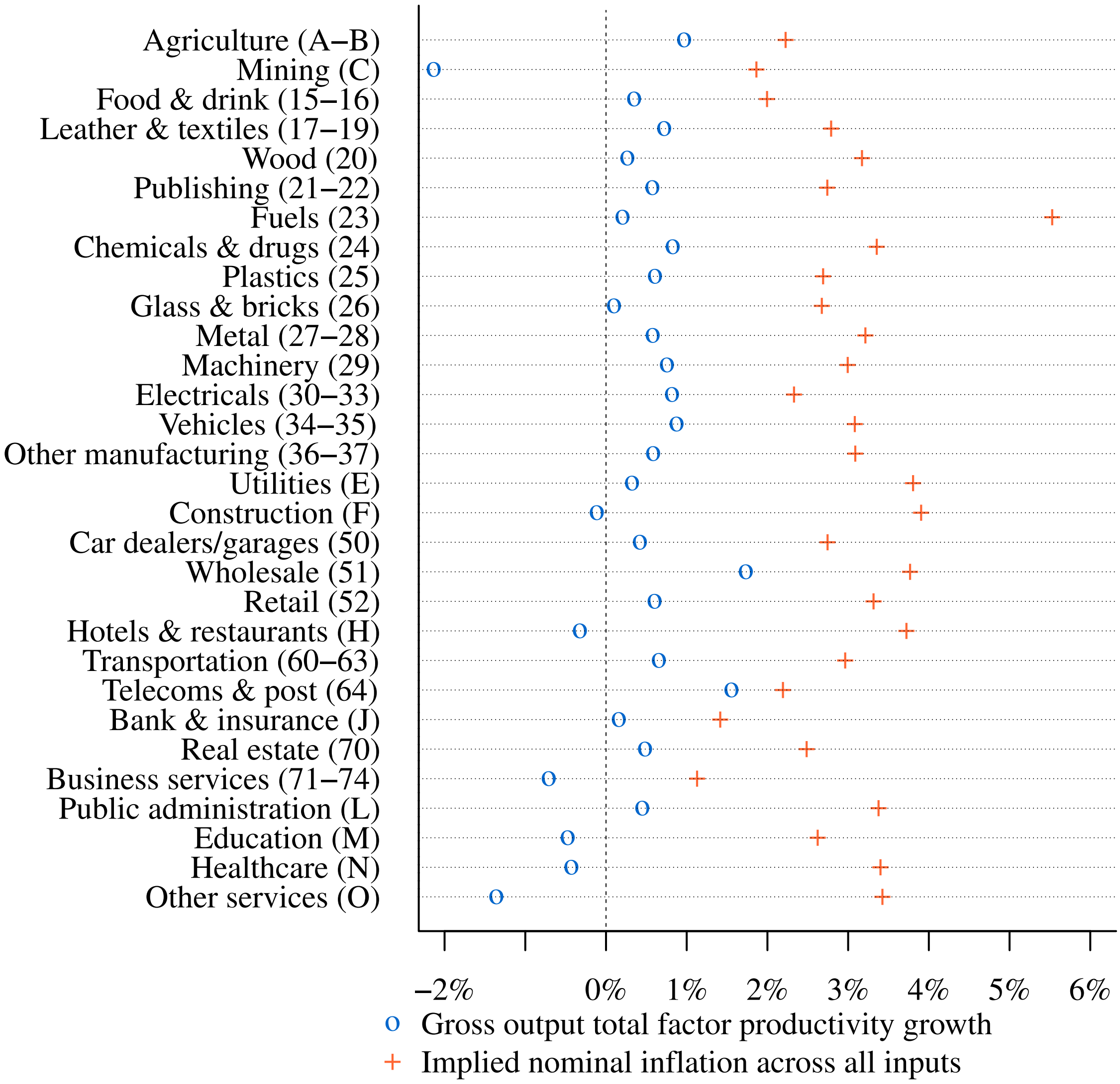


Gross output total factor productivity growth

4.45 Figure 12 shows an estimate of total factor productivity growth for each industry (on a gross output basis) over the period 1979 to 2007.

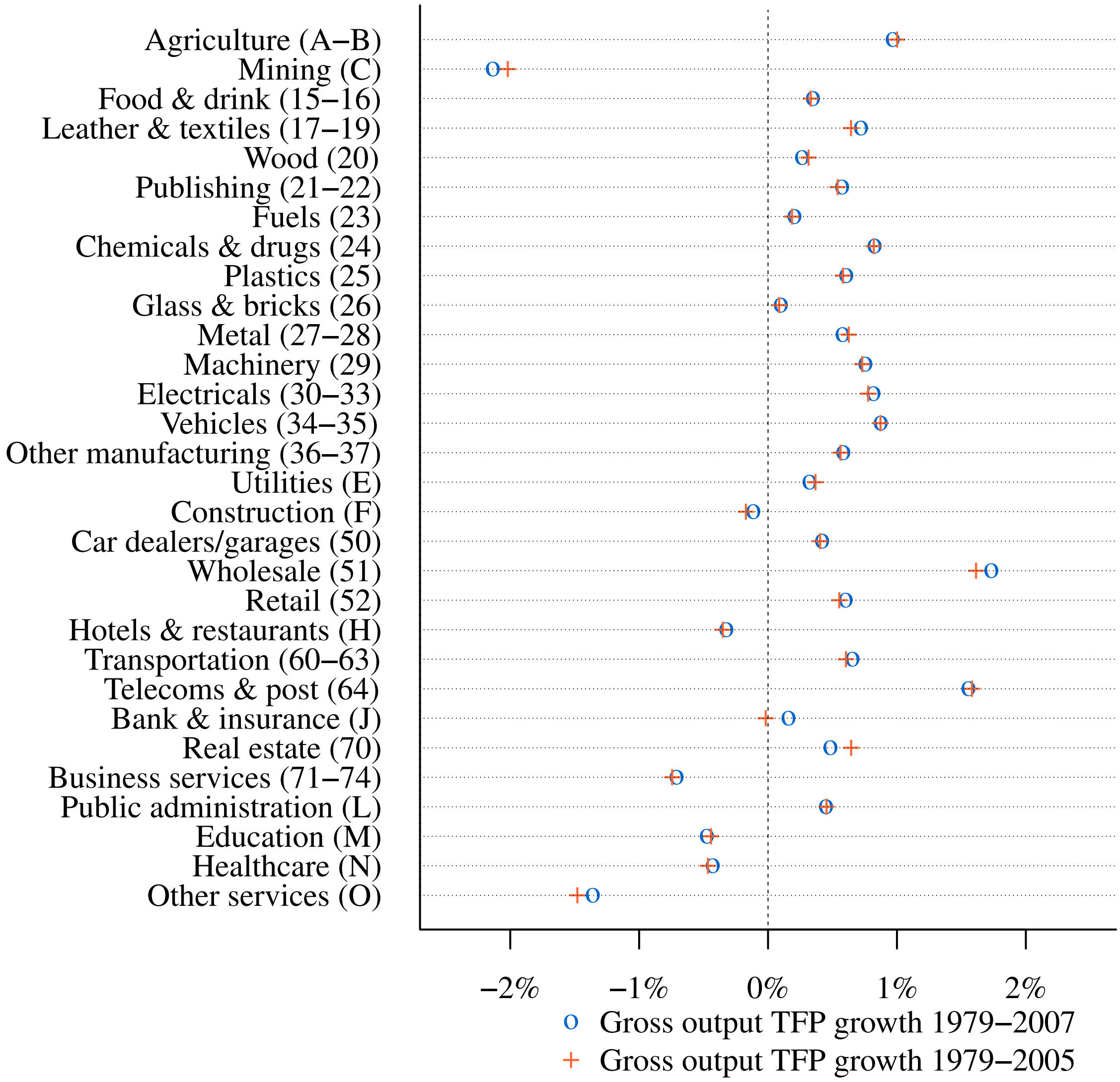
4.46 It is useful to keep in mind the relationship between output price growth and total factor productivity: output price growth can be seen as the combined effect of total factor productivity growth and the growth in the prices of the various inputs used (including capital and profit). Figure 12 also shows, for each industry, the implied inflation across all inputs taken together. This is simply calculated as the sum of the growth in total factor productivity plus the growth in output prices. This reflects changes in the “price” per unit of each input category, including wages, the prices of intermediate inputs and the rate of profit per unit of capital employed. For clarity of exposition, we show this implied input price growth in nominal terms, rather than relative to the CPI.

Figure 12 Growth in gross output total factor productivity and implied nominal input price inflation (Netherlands, 1979 to 2007)



4.47 Figure 13 shows estimates for the growth in gross output total factor productivity for the period 1979 to 2005, and compares these to corresponding estimates over the full period of data, 1979 to 2007.

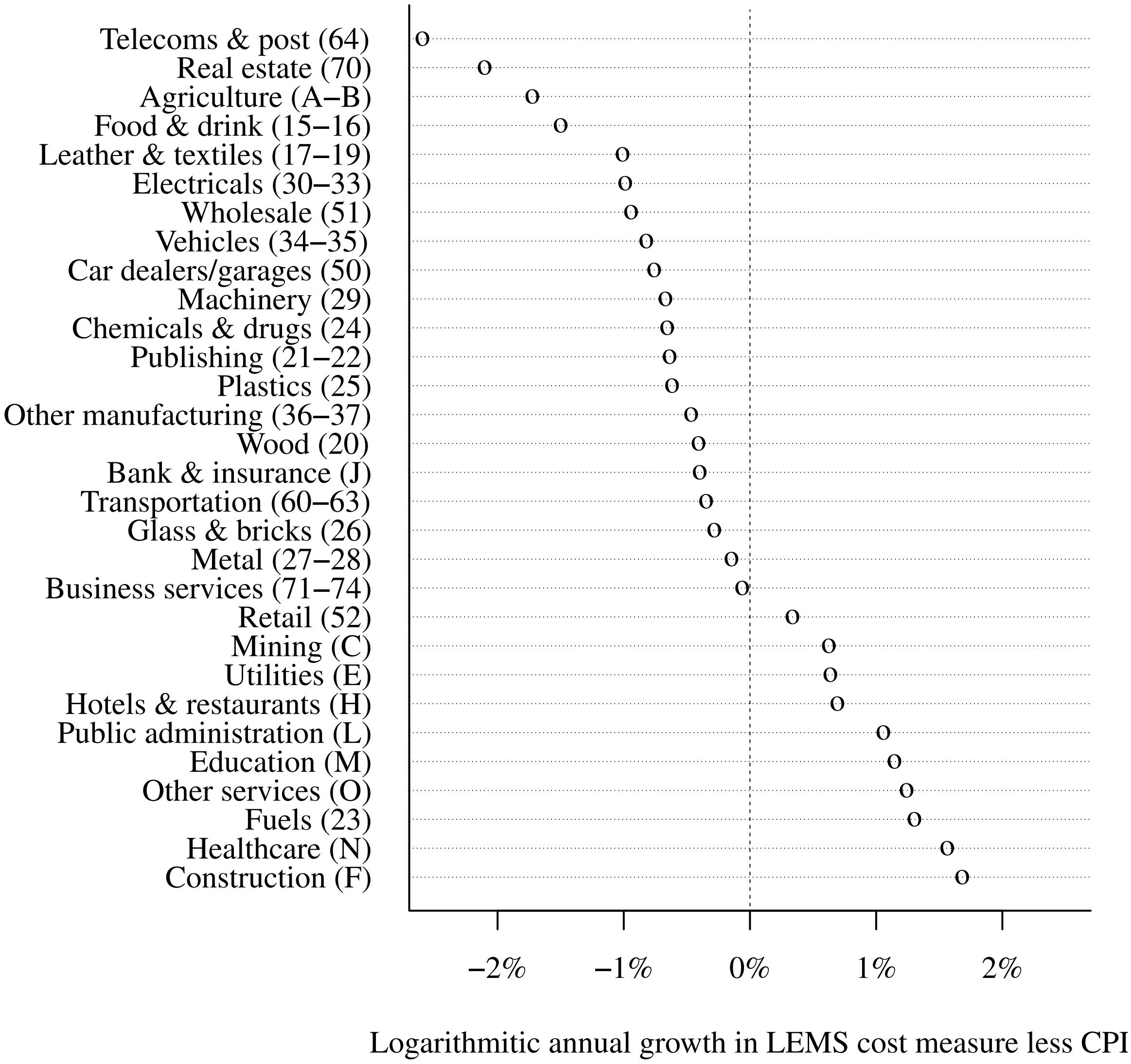
Figure 13 Growth in gross output total factor productivity for different data periods (Netherlands, 1979 to 2007)



LEMS cost measure

4.48 Figure 14 shows estimates for the annualised growth, over the period 1970 to 2007, in the LEMS cost measure relative to the CPI. A negative number indicates a reduction in costs relative to the CPI. The sectors in figure 14 are ordered in a way that helps to convey the spread of the growth in the LEMS cost measure across different industries and to highlight those with relatively low or high growth rates.

Figure 14 Growth in LEMS cost measure relative to CPI (Netherlands, 1970 to 2007)

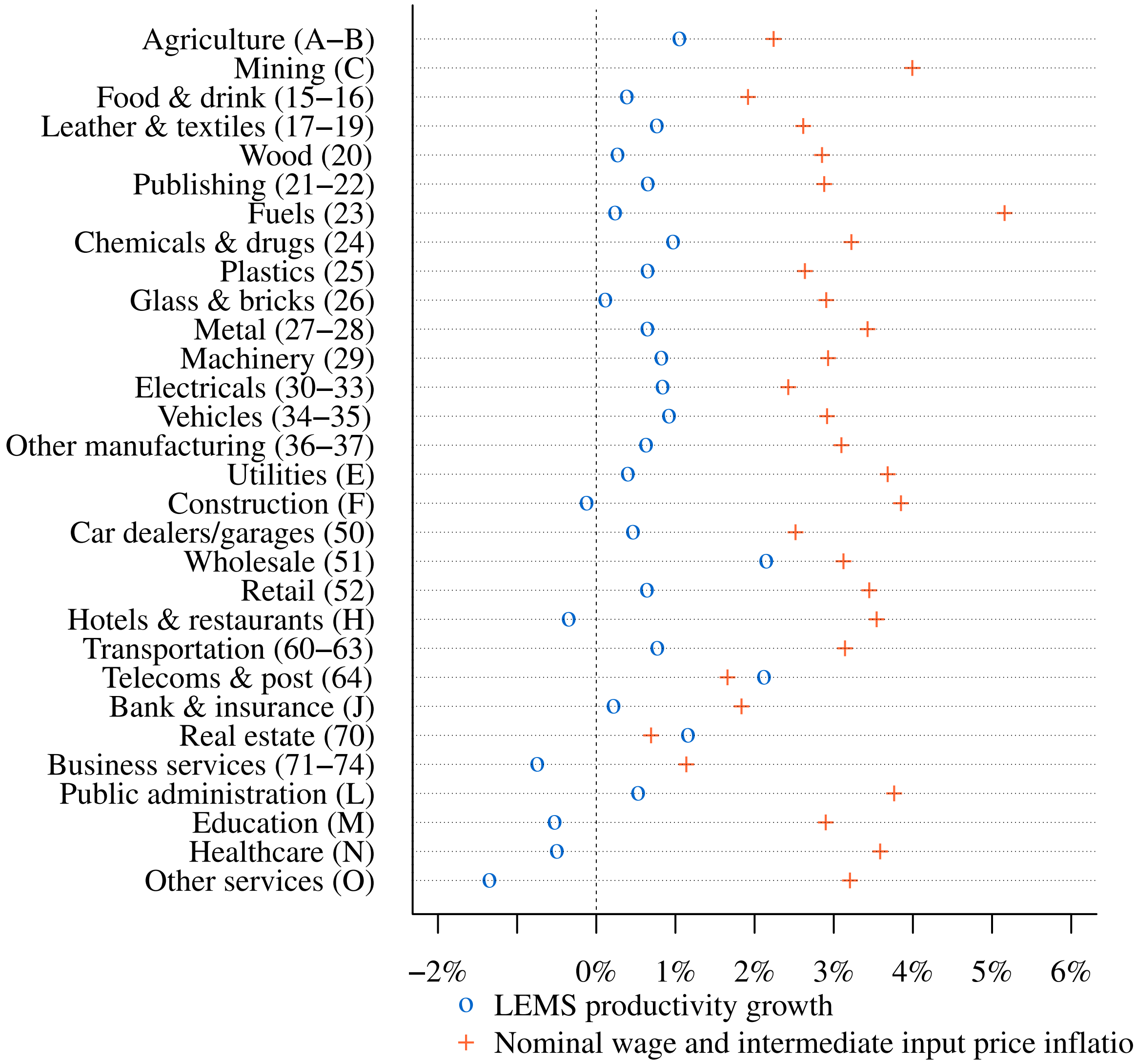


4.49 The estimates for the LEMS cost measure shown above reflect the impact of productivity growth in each sector and of the changes, relative to the CPI, in the prices of labour inputs and of intermediate inputs (e.g. the prices of materials and energy used for production). The prices of labour inputs relate to wages and salaries (and bonuses) of employees and also the compensation of the self-employed. We use the term wage inflation as a short-hand in the charts and in the discussion below.

4.50 Figure 15 provides a decomposition of the productivity and input price elements. The productivity growth estimate corresponding to the LEMS cost measure is an estimate of the rate of reduction in the volume of labour and intermediate inputs used for a given level of output and a given volume of capital employed. In the description of measures provided above, we called this the LEMS productivity measure (at constant capital).

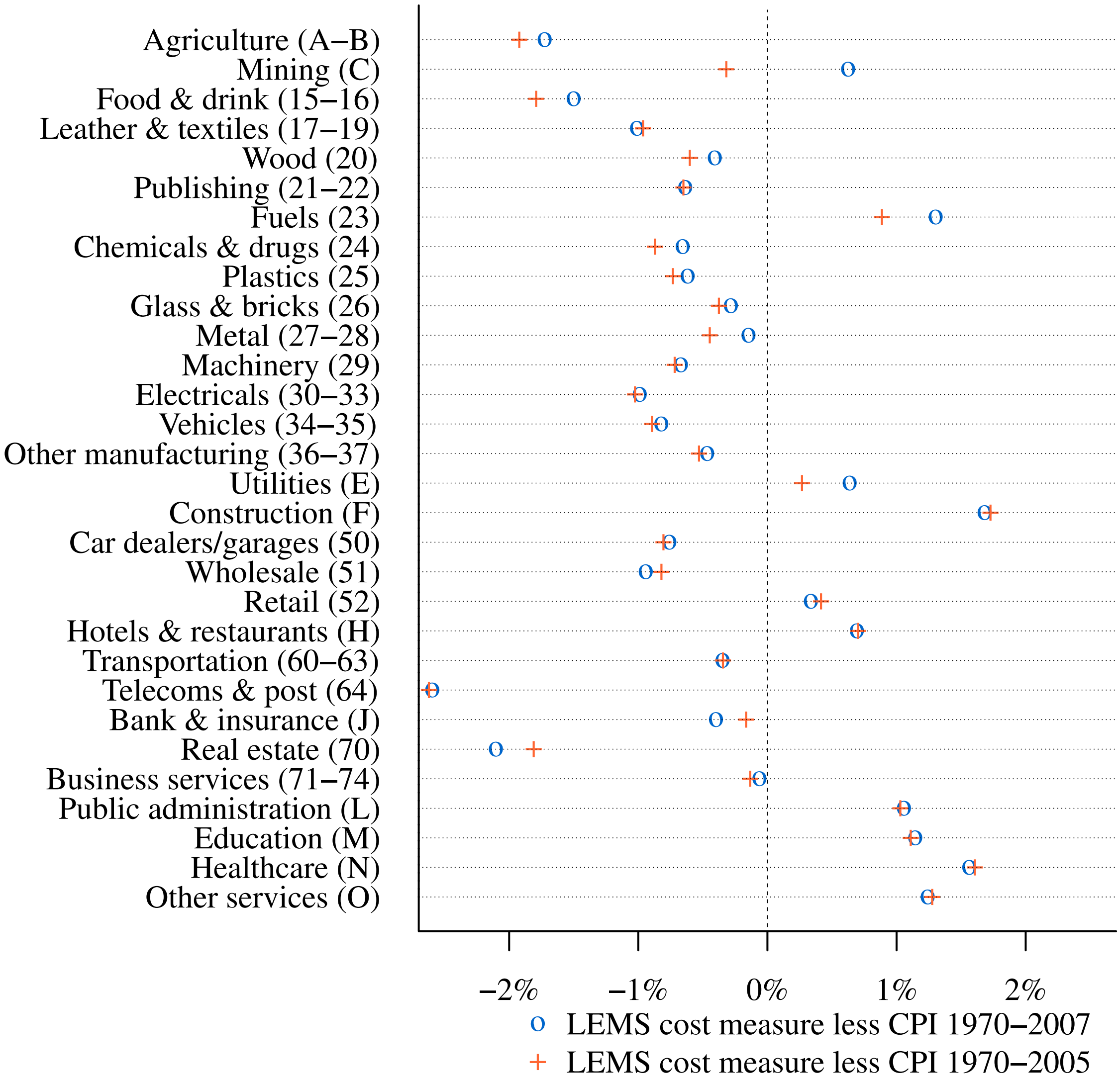
4.51 For clarity of exposition, we show input price growth in nominal terms, rather than relative to the CPI. The annualised growth in LEMS cost measure (in nominal terms) can be calculated by subtracting the growth in the LEMS productivity estimate from the wages and input price inflation.

Figure 15 Growth in LEMS productivity and nominal input prices (Netherlands, 1979 to 2007)



4.52 Figure 16 provides estimates of the growth in the LEMS cost measure for the period 1970 to 2005 and compares these to estimates over the full period of data, 1970 to 2007.

Figure 16 Growth in LEMS cost measure relative to CPI for different data periods (Netherlands, 1970 to 2007)

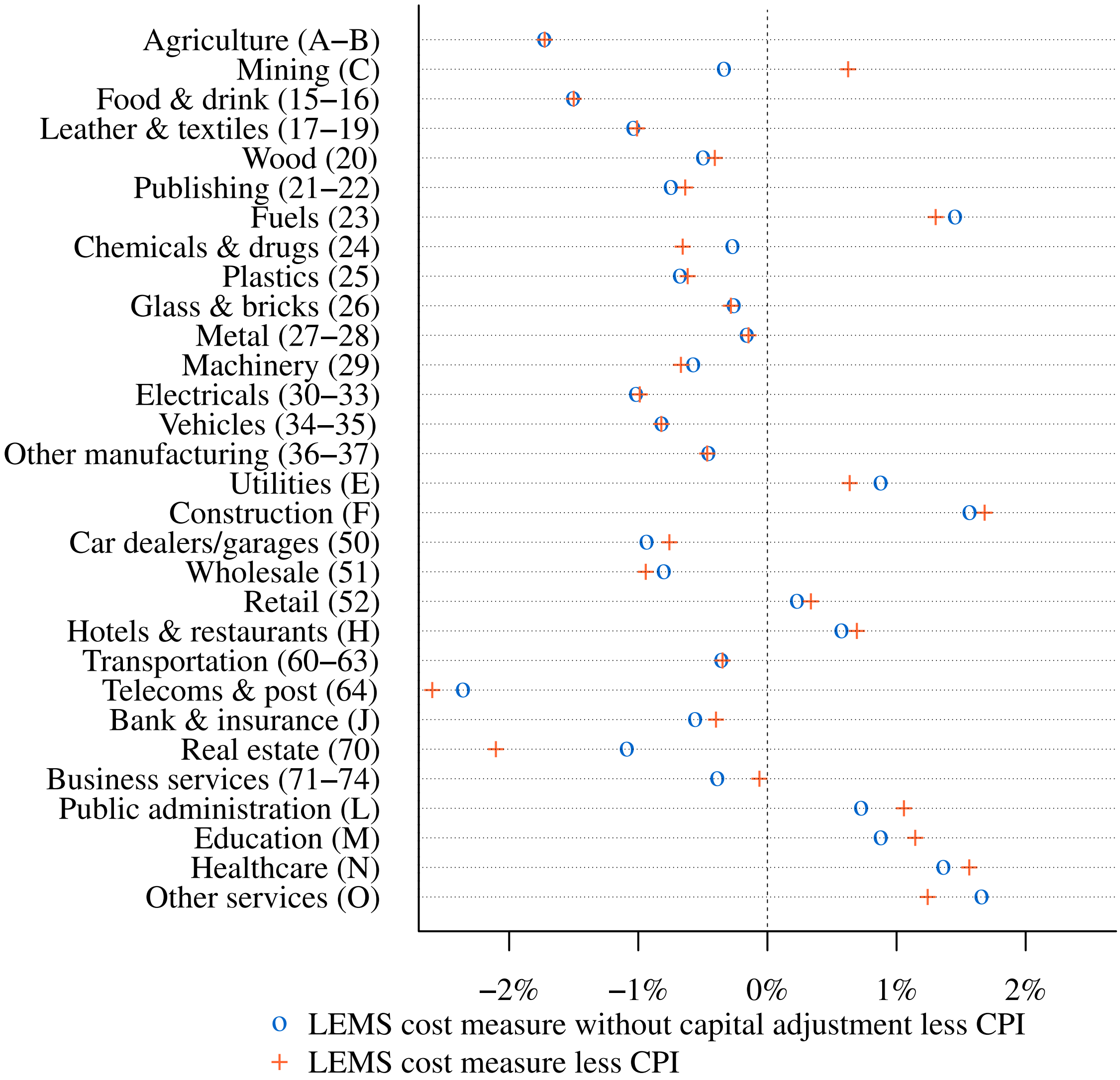


4.53 The growth in the LEMS cost measure is a measure of the change in the costs per unit of output that is not attributed to changes in the volume of capital employed. It is not a direct estimate of the changes over time in labour costs and expenditure on expenditure per unit of output.

4.54 The LEMS measure is useful, for instance, if we are interested in the changes over time in costs that are driven by total factor productivity growth and input price inflation, and not in the changes in costs that are driven by substitution between inputs that are included in the cost measure (e.g. labour) and inputs that are not (e.g. capital).

4.55 Figure 17 illustrates the effect of the calculation we use to strip out the impact on costs of changes in the volume of capital employed. For a particular industry, the impact will be greater the larger has been the increase, or decrease, over the period, in the volume of capital employed in the industry per unit of output (i.e. the extent to which the volume of capital employed has increased or decreased at a different rate to the volume of output produced).

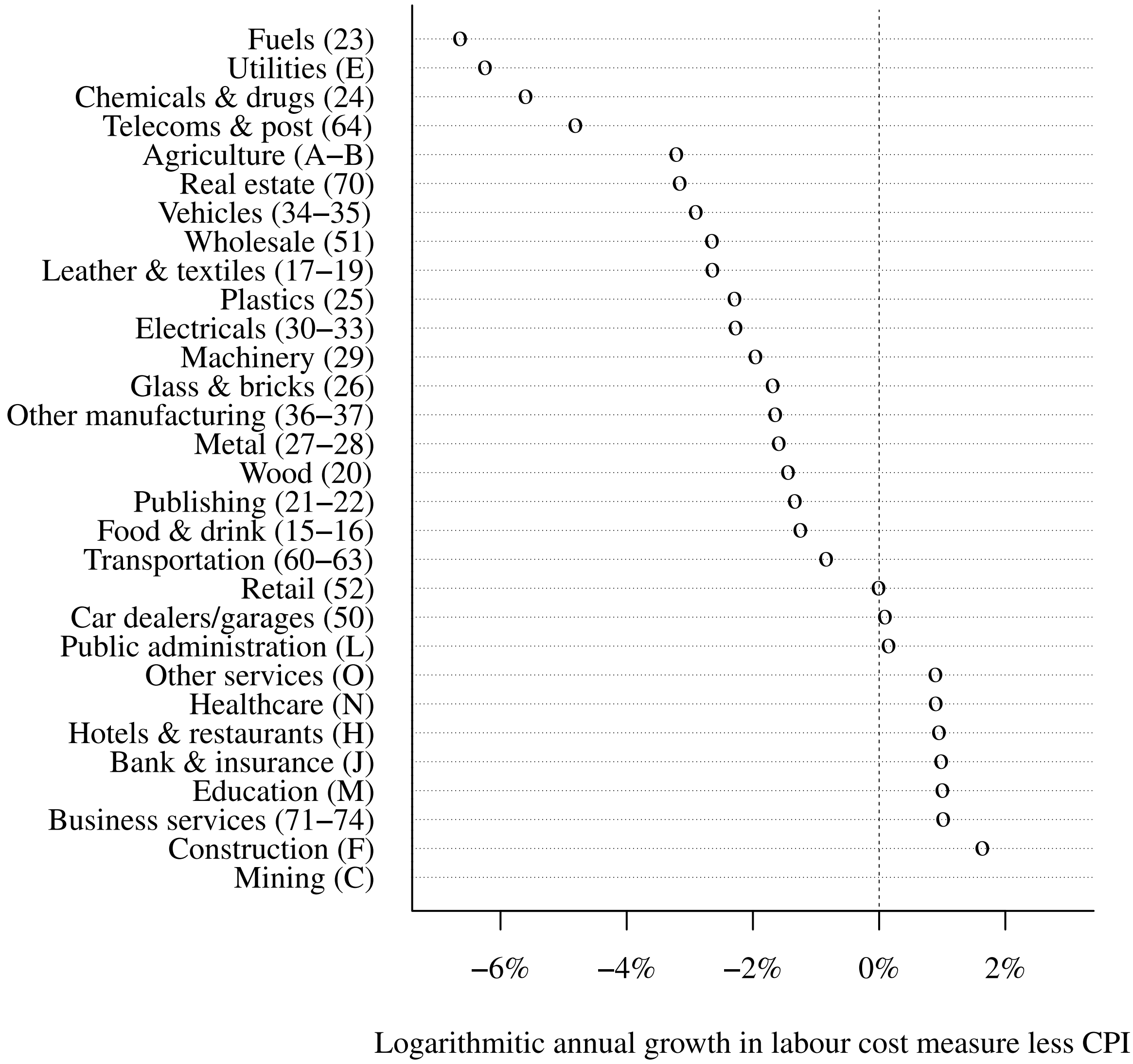
Figure 17 Growth in LEMS cost measure relative to CPI with and without the capital substitution adjustment (Netherlands, 1970 to 2007)



Labour cost measure

4.56 Figure 18 shows estimates of the annualised growth, over the period 1970 to 2007, in the labour cost measure relative to the CPI. A negative number indicates a reduction in costs relative to the CPI

Figure 18 Growth in labour cost measure relative to CPI (Netherlands, 1970 to 2007)

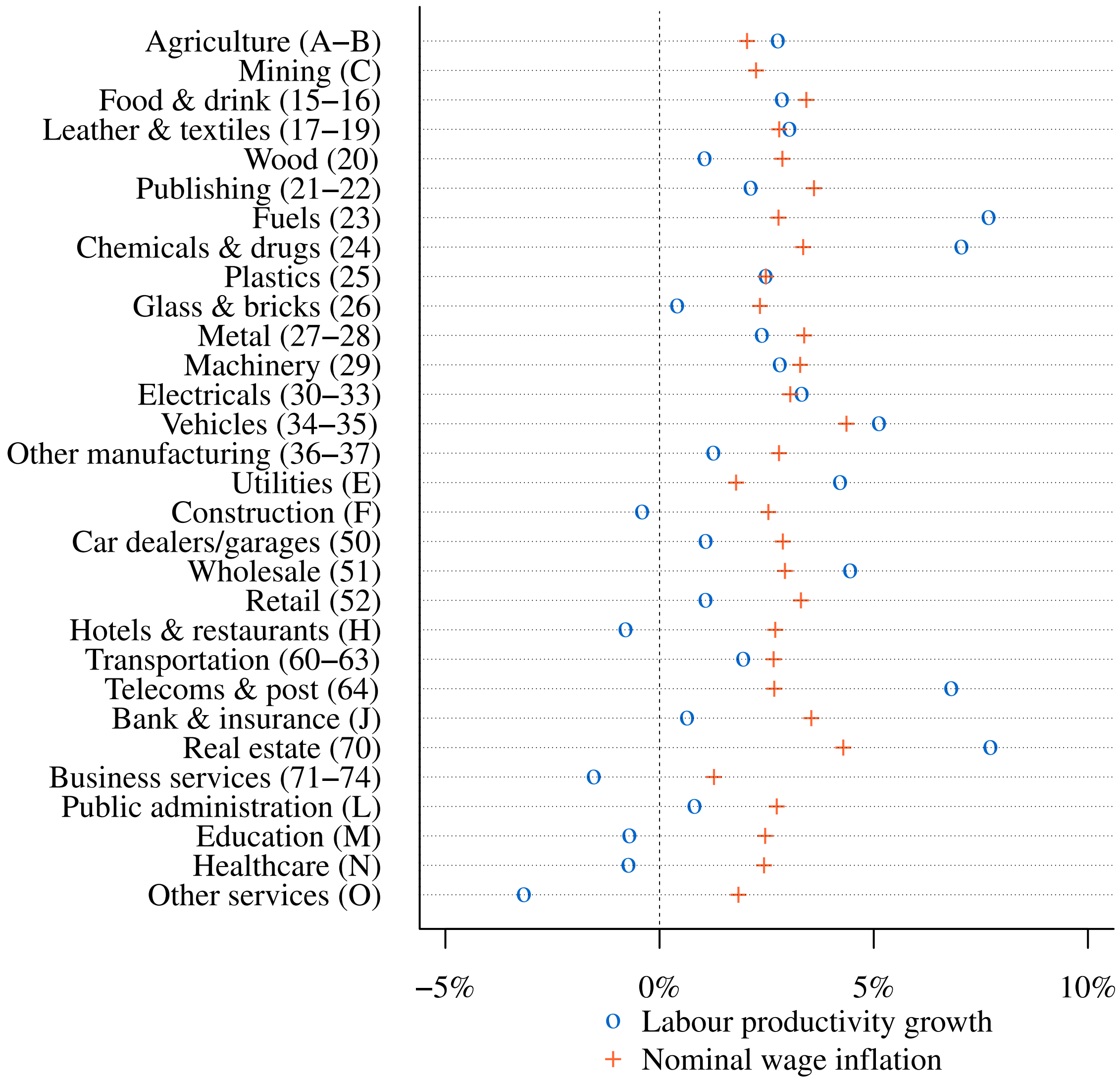


4.57 The estimates of the labour cost measure reflect the impact of productivity growth in each sector and changes, relative to the CPI, in the price of labour inputs. The price of labour inputs relates to wages and salaries (and bonuses) of employees and also the compensation of the self-employed. We use the term wage inflation as a short-hand in the chart.

4.58 Figure 19 provides a decomposition of the productivity and input price elements. The productivity growth estimate corresponding to the labour cost measure is an estimate of the rate of reduction in the volume of labour inputs used for a constant level of output, a constant volume of intermediate inputs and a constant volume of capital employed. In the description of measures provided above we called this the labour productivity measure (at constant capital). This measure should not be confused with what other studies call labour productivity growth.

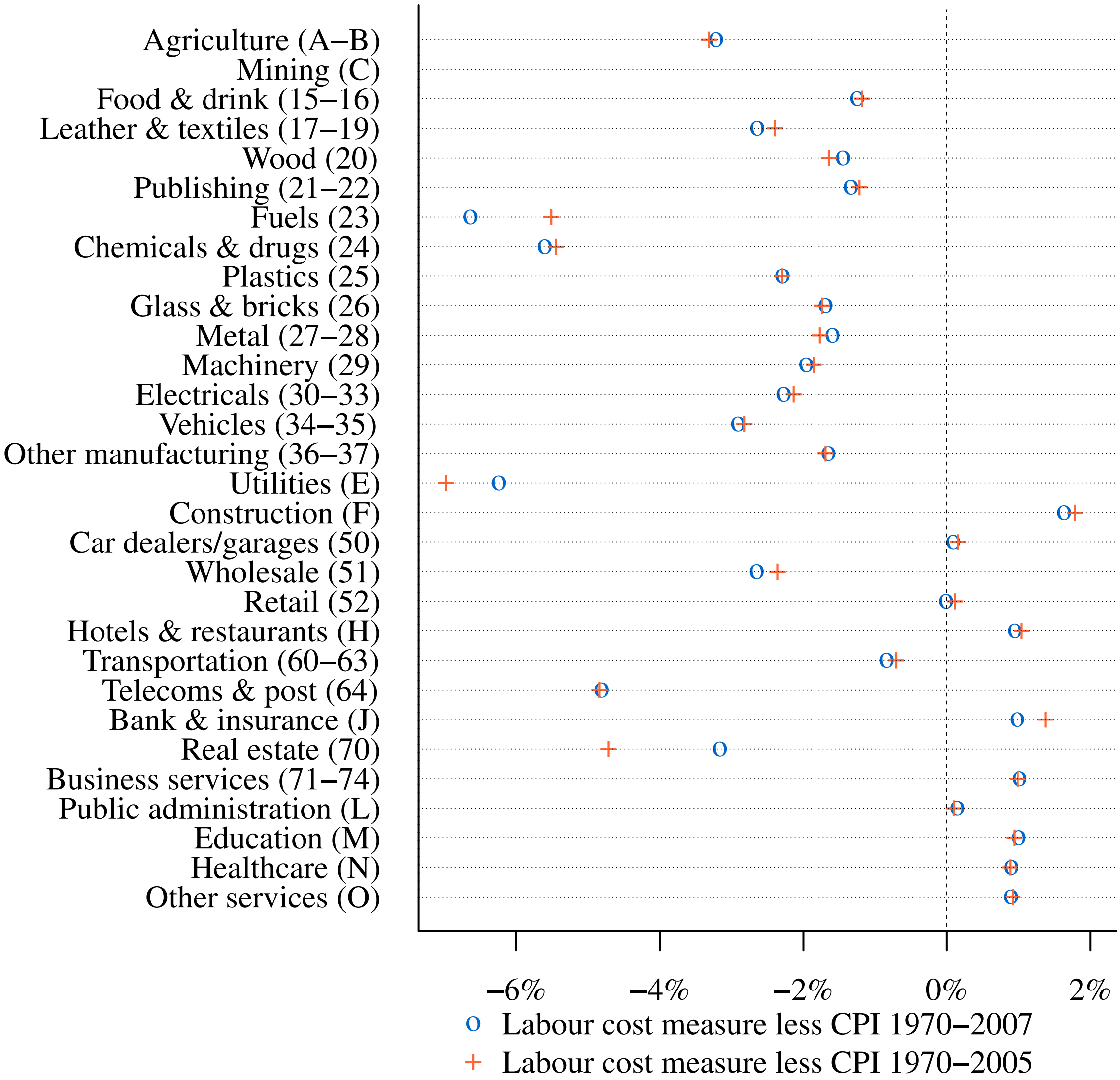
4.59 For clarity of exposition, we show wage growth in nominal terms, rather than relative to the CPI. The annualised growth in the labour cost measure (in nominal terms) can be calculated by subtracting the growth in the labour productivity estimate from the wage inflation.

Figure 19 Growth in labour productivity (at constant capital and intermediate inputs) and in labour input prices ("wages") (1979 to 2007)



4.60 Figure 20 shows estimates for the annualised growth in the labour cost measure (relative to CPI) for the period 1979 to 2005, and compares this to corresponding estimates over the full period of data, 1979 to 2007.

Figure 20 Growth in labour cost measure relative to CPI for different data periods (Netherlands, 1970 to 2007)



Methods to calculate statistics based on EU KLEMS data

4.61 This technical part describes the methods that we have used to derive the statistics presented earlier in this section.

Data source

4.62 Our calculations were based on data for the Netherlands from the November 2009 release of the EU KLEMS dataset, downloaded from http://www.euklems.net/.

Use of logarithms in growth rates

4.63 Except where otherwise specified, we use natural logarithms for the measures of rates of change that we have calculated. For example, if a variable X changes from 105 to 110 then its growth, gX, will be defined as ln(110/105) = 4.65%.

4.64 This convention enables growth rates over a period to be calculated as a simple arithmetic average of the annual growth rates.

4.65 To convert a logarithmic growth rate into an annual rate of reduction, the conversion formula is:

[percentage rate of reduction] = 100*(1 – exp(–g))

4.66 For example, a productivity rate of 4.65 per cent in terms of logarithms, if applied to an input volume with a first-year value of 100 (and constant output), implies a rate of reduction of 4.54 per cent a year, calculated as 100*exp(–0.0465).

4.67 Further adjustments might be necessary to convert between logarithm measures of growth rates and any non-logarithmic measures relative to CPI used in price control calculations.

Output price growth

4.68 The EU KLEMS dataset includes a series (GO_P) of output price indices.

4.69 Output price growth between year t–1 and year t is calculated as:

$$gGOP = \ln(GO\_P_t / GO\_P_{t-1})$$

LEMS cost measure

4.70 The annual growth in the LEMS cost measure is defined as follows:

$$gLEMS = gGOP + ((gKQ + gGOP)*K/GO - dK/GO) / (1 - K/GO)$$

where

gLEMS is the logarithmic growth in LEMS costs in a sector.

gGOP is the logarithmic growth in a gross output price index for the sector.

gKQ is the logarithmic growth in the quantity of services from capital used in the sector.

K/GO is the proportion of gross output value accounted for by services from capital. (We used the midpoint of the ratios in the two years.)

dK/GO is the year-on-year change in value of services from capital, expressed as a proportion of the value of gross output. (We used the midpoint of the gross output value in the two years.)

4.71 Expressing the logarithmic growth in the value of gross output, gGO, as the sum of gGOP and the logarithmic growth in the volume of gross output, which we denote gGOQ, then the above formula can be rearranged into the following identity:

$$gGO = (gGOQ + gLEMS)*(1 – K/GO) + dK/GO – (gKQ – gGOQ)*K/GO$$

4.72 This can be interpreted as a decomposition of growth in the value of gross output price into:

(a) A LEMS cost effect, gGOQ + gLEMS, weighted by the proportion of LEMS cost in gross output, which is 1 – K/GO. The growth in the volume of gross output appears in this term because gLEMS is defined as the growth in LEMS costs at constant volume of gross output.

(b) An effect associated with the change in the value of services from capital relative to the value of gross output, dK/GO.

(c) An adjustment associated with the change in the volume of services from capital per unit of gross output, gKQ – gGOQ, weighted by the proportion of the value of services from capital in gross output, which is K/GO.

4.73 Adjustment (c) ensures that gLEMS is measured at constant volume of services from capital. gLEMS is the growth in the cost of non-capital inputs which would be consistent with the observed growth in the value of output assuming constant volume of services from capital per unit of gross output.

4.74 In cases where the value of services from capital is, and remains, positive, a price index for services from capital can be defined as the difference between the logarithmic growth in the value of services from capital and the logarithmic growth in the quantity of services from capital.

4.75 Let us denote by gKP the price index for services from capital. Then:

$$dK/K = gKP + gKQ$$

4.76 A relationship between the output price index and gLEMS can be obtained by deducted output volume growth from both sides of the above relationship between gGO and gLEMS. This gives:

$$gGOP = gLEMS*(1 – K/GO) + gKQ/GO – gKQ$$

4.77 In the EU KLEMS dataset for the Netherlands, there are many instances where the value of services from capital is shown as a negative number, which means that gKP is not defined. We used the formula stated at the beginning of this section, which does not depend on a positive value of services from capital, in order to calculate the growth in the LEMS measure in all sectors and years.

Gross output measure of total factor productivity growth

4.78 The gross output measure of total factor productivity growth is defined as:

$$gTFPGO = gGOQ – K/GO*gKQ – L/GO*gLQ – II/GO*gIIQ$$

where

gTFPGO is the gross output measure of total factor productivity growth.

gKQ is the logarithmic growth in the quantity of services from capital used in the sector.

K/GO is the proportion of gross output value accounted for by services from capital.

gLQ is the logarithmic growth in the quantity of labour used in the sector.

L/GO is the proportion of gross output value accounted for by labour.

gIIQ is the logarithmic growth in the quantity of intermediate inputs used.

II/GO is the proportion of gross output value accounted for by intermediate inputs.

LEMS productivity at constant services from capital

4.79 The LEMS cost measure can be decomposed into productivity and input price growth elements by using a variable which we call growth in LEMS productivity at constant services from capital, defined as:

$$gLEMSPcK = gTFPGO / (1 – K/GO)$$

where

gLEMSPcK is the growth in LEMS productivity at constant services from capital.

gTFPGO is the gross output measure of total factor productivity growth.

K/GO is the proportion of gross output value accounted for by services from capital.

4.80 The relationship between gLEMS and gLEMSPcK is:

$$gLEMS = L/(II+L)*gLP + II/(II+L)*gIIP – gLEMSPcK$$

where

L is the value of labour.

II is the value of intermediate inputs.

gLP is the growth in wages.

gIIP is the growth in intermediate input prices.

4.81 This relationship is obtained by combining:

(a) the definitions of gTFPGO, gLEMSPcK and gLEMS;

(b) the fact that gross output is the sum of the value of labour, intermediate inputs and services from capital; and

(c) the fact that changes in the value of each of labour, intermediate inputs and services from capital can be decomposed between a price effect and a volume effect.

Labour cost measure

4.82 The labour cost measure is defined in the same way as the LEMS cost measure, but treating intermediate inputs (energy, materials and services) in the same way as services from capital, rather than in the same way as labour.

4.83 This gives:

gLabM = gGOP + ((gKQ + gGOP)*K/GO + (gIIQ + gGOP)*II/GO – dK/GO – dII/GO) / (1 – K/GO – II/GO)

where

gLabM is the logarithmic growth in the labour cost measure.

gGOP is the logarithmic growth in a gross output price index for the sector.

gKQ is the logarithmic growth in the quantity of services from capital used in the sector.

K/GO is the proportion of gross output value accounted for by services from capital. (We used the midpoint of the ratios in the two years.)

dK/GO is the year-on-year change in value of services from capital, expressed as a proportion of the value of gross output. (We used the midpoint of the gross output value in the two years.)

gIIQ is the logarithmic growth in the quantity index for intermediate inputs.

II/GO is the proportion of gross output value accounted for by intermediate inputs.

dII/GO is the year-on-year change in value of intermediate inputs, expressed as a proportion of the value of gross output.

4.84 Note that the denominator in the above equation, 1 – K/GO – II/GO, is equal to the proportion of gross output accounted for by labour, since in the KLEMS framework gross output is decomposed into labour, intermediate inputs, and services from capital (which capture the residual surplus or shortfall).

4.85 A rate of growth in labour productivity at constant intermediate inputs and constant capital can be defined as:

gLPcK = gTFPGO/(1 – K/GO – II/GO)

where

gLPcK is the growth in labour productivity at constant capital.

gTFPGO is the gross output measure of total factor productivity growth.

4.86 The link between the labour cost measure and labour productivity at constant intermediate inputs and constant capital is gLabM = gLP – gLPcK, where gLP is the growth in wages (the price of labour).

4.87 A simpler-looking formula for gLabM can be derived through this relationship. However, that formula cannot be implemented directly on EU KLEMS data for the Netherlands in the 1970s, as these do not include labour volume or wage data. The formula given earlier for gLabM can be used on the EU KLEMS data for the Netherlands throughout 1970–2007.

5 Information from studies on gas transportation productivity and unit costs

Introduction

5.1 This section provides a review of some recent English-language studies that contain estimates of productivity growth and unit cost trends for gas transportation companies. We have drawn on this to identify methods, estimates or other data that may be relevant to the GTS price control.

Overview of studies covered

5.2 There have been a number of studies relating to changes over time in the productivity and efficiency of gas transmission or pipeline companies in the US. We focus on two relatively recent studies, which adopt different methods of analysis.

5.3 We have also identified a number of studies that estimate growth rates for total factor productivity (TFP) for gas distribution companies in Australia. These studies have been carried out in the context of debates about potential changes to the methods for regulation that would place emphasis on adjusting price controls according to historical changes in estimates of industry-wide total factor productivity growth. We summarise the results from three different studies below. Table 7 provides a summary of estimates from the studies reviewed.

Table 7 Summary of studies covered

Study	Companies examined	Productivity growth estimates	Rate of reduction in unit cost measure
Lawrence M and Skolnik J (2008) Estimating multi-factor productivity in pipeline transportation, 1987-2004	US oil and gas inter-or intra-state pipeline or transmission companies 1987 to 2004	Estimates of multi-factor productivity growth over period imply compound annual growth rate of 1.2%	–
Jamasb T, Pollitt M and Triebs T (2008) Productivity and efficiency of US gas transmission companies: a European regulatory perspective	39 US interstate gas transmission pipeline companies 1996 to 2004	–	Estimate of average annual rate of decrease in the total costs of US gas transmission pipelines (relative to CPI) per unit of output: 2.9% or 5.9%, depending on output measure used
Pacific Economics Group (2008) Commissioned by the Essential Services Commission in Australia	Three gas distribution companies in Victoria, Australia: Envestra, Multinet and SP AusNet 1998 to 2007	Estimate of annual TFP growth rate of 2.85% for companies taken together	–
Meyrick and Associates (2007) Commissioned by Envestra, Multinet and SP AusNet	Three gas distribution companies in Victoria, Australia: Envestra, Multinet and SP AusNet 1998 to 2006	Estimate of annual TFP growth rate of 2.7% for companies taken together	–
Economic Insights (2009) Commissioned by Jemena Gas Networks (NSW)	A gas distribution company in New South Wales, Australia (Jemena Gas Networks) 1999 to 2009	Estimate of annual TFP growth rate of 1.9%	–

5.4 It is essential to recognise that the estimates provided in Jamasb, Pollitt and Triebs (2008) do not relate to a comparable productivity growth concept as the other studies. To emphasise this, we have used different columns in the table to report results.

Study on oil and gas pipeline productivity in the US

5.5 Lawrence and Skolnik (2008) provides a study on multi-factor productivity (MFP) for the oil and gas pipeline transportation industry in the US over the period 1987 to 2004.[8] The paper was published by the Transportation Research Board (TRB) of the US.

5.6 The industry classification studied covers intra- and inter-state transmission pipelines. It excludes pipelines used for the collection and distribution of crude oil and gas in the field, which are classified as part of the mining sectors. It also excludes the local distribution of natural gas to final consumers, which is classified as part of the utilities sector.

5.7 The growth in multi-factor productivity is calculated using estimates of the growth in the volume of industry output and the growth in the volumes of different categories of inputs.

5.8 As with the total factor productivity indices provided in the three studies on Australian gas distribution, discussed below, the intention is to take account as far possible of all inputs to production — labour, capital and intermediate inputs. The methods are however different.

5.9 In this paper, volume measures for five different categories of inputs were developed. Separate volume measures were calculated for:

(a) Labour inputs.

(b) A measure of the amount of land inputs used. The land volume measure drew on data on the length of pipelines and the average width of pipeline corridors and the value of land inputs drew on "detailed land price information" (page 6).

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[8] Lawrence, M and J Skolnik (2008) "Estimating Multifactor Productivity (MFP) in Pipeline Transportation, 1987-2004", *Transportation Research Board, 87th Annual Meeting 2008*, Washington, DC

(c) Capital inputs, including equipment, buildings and structures but excluding land.

(d) Natural gas consumption by gas pipelines.

(e) Other intermediate inputs, including chemicals, fabricated metals and services. The measures of these inputs used data adjusted to exclude natural gas consumption.

5.10 The data sources used for these inputs included the US Bureau of Labour Statistics, the Bureau of Economic Analysis and the Energy Information Administration.

5.11 The index for the volume of industry output is calculated using data on gross output. Lawrence and Skolnik (2008) highlights that "[i]ssues in measuring output include accounting for change in quality of output, adjusting for the composition of between various industries of the subsector (crude, petroleum products, natural gas), considering whether any non-market impacts will be included, and resolving how to measure the physical output of pipelines" (page 4). But no further information is provided in this paper on the method used to produce the output volume index.

5.12 Lawrence and Skolnik (2008) uses two different methods to combine data on changes over time in the volumes of different categories of inputs, and in the volume of output, to calculate multifactor productivity growth. These seem to be calculated as follows:

(a) In the "basic growth accounting" method, multi-factor productivity growth from one year to the next is calculated as the percentage change in the output volume index from one year to the next minus the weighted average of the percentage changes of each of the input volume measures. The weights for each input category are given by the share of the value of each input in gross output in the second year.

(b) In the Tornqvist method, the multi-factor productivity growth from one year to the next is calculated as the difference in the natural logarithm of the output volume index from one year to the next, minus the difference in the natural logarithm of a combined input volume index from one year to the next. The difference in the combined input volume index is calculated as the sum of the weighted growth rates of the volume measure for each of the five input categories, with weights given by the average shares of the value of each input in gross output between the two years.

5.13 Lawrence and Skolnik (2008) reports an index for multi-factor productivity for each of these two methods.

5.14 Over the period 1987 to 2004, the multi-factor productivity index reported for the basic growth accounting method increases from 100 to 114.9 and the multi-factor productivity index reported for the Tornqvist method increases from 100 to 122.1. There is more rapid growth in these multifactor productivity indices in the second half of the period than in the first.

5.15 The calculation used to produce the multi-factor productivity index for the basic growth accounting method is described on page 7 of the paper. We found this particular calculation rather odd and suspect that it slightly distorts the results. Although the description at page 7 suggests that the same calculation was used for the Tornqvist method we checked with the data provided in the paper and this is not the case; the index for the Tornqvist method is calculated in the way that we would have expected.

5.16 The Tornqvist method seems more reliable and is consistent with the approach we use in our analysis of the EU KLEMS data. The Tornqvist method implies a compound annual growth rate of 1.2 per cent over the period 1987 to 2004.

Study on productivity and efficiency of US gas transmission companies

5.17 Jamasb, Pollitt and Triebs (2008) provides an analysis of efficiency and productivity change for a sample of regulated US interstate gas transmission pipelines.[9]

5.18 Jamasb, Pollitt and Triebs (2008) recognises that "[g]iven the vast literature applying productivity and efficiency measurement we know that our results are likely to be

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[9] Jamasb T, Pollitt M and Triebs T (2008) "Productivity and efficiency of US gas transmission companies: a European regulatory perspective", *Cambridge Working Paper in Economics 0812,* Faculty of Economics, University of Cambridge.

sensitive to both the model we choose and the variables we select" (page 8)". Indeed, the approach taken is quite different to that used in the other studies that we cover in this section and that which we have used in analysis of the EU KLEMS data.

5.19 The approach taken in the paper has following features:

(a) The concept of efficiency/productivity concerns the relationship between a measure of the total costs of a gas pipeline company and various measures of the output or scale of the company's outputs (e.g. the volume of gas delivered and the total length of its pipelines).

(b) A technique called data envelopment analysis (DEA) is used to produce an efficiency score for each gas pipeline company in each year. The DEA technique is used to calculate an "efficiency frontier" for the companies in the industry, independently in each year. This efficiency frontier is an estimate of the maximum outputs of a gas pipeline company (e.g. different combinations of gas delivered and gas pipeline length) that could be achieved for a given input of total costs. The efficiency score for each company is a measure of the distance between that company's position and the efficiency frontier, with the furthest away being the least efficient.

(c) A technique called the Malmquist index is used to calculate a measure of the change over time in efficiency/productivity based on changes in gas pipeline companies' positions relative to the efficiency frontiers calculated for successive years.

5.20 The data used are from the Federal Energy Regulatory Commission (FERC), which requires all inter-state transmission companies over a certain size to file an annual regulatory report. Jamasb et al state that, as far as possible, data are confined to the transmission function of the company. The data cover 39 companies over the period from 1996 to 2004.

5.21 To measure the changes over time in the output of the gas pipeline companies, Jamasb et al use two different models for the analysis. One model has three outputs. These are: a measure of delivery, the annual total of gas transmitted for others, excluding losses; the total length of pipelines (miles); and the total horsepower rating at compressor stations (which is taken as proxy for the amount of capacity for a given pipeline length). The other model only uses pipelines and total horsepower rating. The weight given to each of these outputs is determined by the DEA technique.

5.22 Productivity and efficiency concern the relationship between outputs and inputs. Estimates of total factor productivity growth based on data from sources such as EU KLEMS are typically made by combining estimates of the volume of inputs from different inputs categories (e.g. a labour category and a capital category). In contrast, Jamasb et al (2008) use a single monetary input measure that is intended to cover all types of inputs. The single input measure is a measure of total costs, in 2004 prices. This is explained as follows (page 14):

> The main advantage of a single monetary input measure from a regulator's point of view is that correct physical measures are difficult to obtain due to outsourcing, quality differences or simple non-reporting. Also, as mentioned in Jamasb and Pollitt (2003), our output measure accounts implicitly for all possible trade-offs between the various inputs. Last, consumers (and hopefully regulators too) are interested not in technical efficiency as such but the cost of the service. In this light we also use an alternative measure: total revenue.

5.23 Jamasb, Pollitt and Triebs (2008) also analyses two models in which the single input measure is total revenue rather than the "totex" measure. We focus here on the analysis of the total cost measure, as our interest is about the underlying costs rather than the other regulatory and political factors that can influence revenue.

5.24 The measure of total costs used in the paper includes reported operating and maintenance expenditure, depreciation and a profit element. The cost of fuel is excluded because "most pipelines withhold fixed percentages of the gas actually delivered as compensation for compressor fuel usage" (page 17). Presumably, if some companies incur fuel costs for compressors, whilst others withhold a proportion of gas delivered, then excluding fuel costs is intended to allow for a more like-for-like comparison across companies.

5.25 Table 8 provides a summary of the results for the two total cost models, which differ in the output measures used to estimate output growth.

Table 8 Summary of models and results

	Model 1	Model 3
Coverage	39 US gas pipeline companies over the period 1996 to 2004	39 US gas pipeline companies over the period 1996 to 2004
Measure of inputs	Operating and maintenance expenditure (excluding fuel costs) plus depreciation plus measure of cost of capital (2004$)	Operating and maintenance expenditure (excluding fuel costs) plus depreciation plus measure of cost of capital (2004$)
Output measures	Total length of pipe (miles) Total horsepower rating at compressor stations Delivery: annual total of gas transmitted for others, excluding losses (decatherm)	Total length of pipe (miles) Total horsepower rating at compressor stations
Main results	Average annual growth rate in Malmquist index of 2.9% This is decomposed into a "technical efficiency change" of 3.5% and a "technical change" of –0.5%	Average annual growth rate in Malmquist index of 5.9% This is decomposed into a "technical efficiency change" of 5% and a "technical change" of 0.8%

5.26 Jamasb, Pollitt and Triebs (2008) reports the average annual growth in the Malmquist index (e.g. the figure of 2.9 per cent reported for model 1) as "TFP growth" and state that model 1 "would produce an average yearly productivity increase of 2.9 percent" (page 23).

5.27 We suspect that it is misleading to report the estimates from these models as estimates of "TFP growth" or "productivity increase". The nature of the input measure used in the analysis has an important bearing on the interpretation of the results. The amount of input that each company uses is a measure of total costs (including a profit element) in 2004 dollars. Our experience of looking at data and results from other sources suggests that it is unlikely that the prices of the inputs used by US gas transmission companies (e.g. labour and materials) will, on average, track the changes in the US consumer price index (CPI).

5.28 Changes over time in the Malmquist index calculated by Jamasb et al will reflect not only productivity growth (as it is usually defined) but also changes in input prices, relative to the CPI. For example, wages tend to rise faster than the CPI, at least over the long term. If wages rise faster than the CPI, this would suppress the growth in this Malmquist index.

5.29 The growth in the Malmquist index calculated in this paper is better seen as a measure of the average annual rate of decrease in the total costs of US gas transmission pipelines (relative to the CPI) per unit of output — where output is a weighted average of delivery volumes and measures of the capacity of gas pipelines. For instance, model 1 can be interpreted as implying an average annual reduction in total costs per unit of output of 2.9 per cent. The results are sensitive to the output measure, as shown by the difference between the growth rate of the Malmquist index for the two models in table 8 — 2.9 per cent or 5.9 per cent depending on whether delivery volumes are included in the output measure.

5.30 Because the growth in these Malmquist indices reflects input price growth, these are probably more comparable to the output price indices, and the LEMS cost measure, that we have calculated for industries in the Netherlands using the EU KLEMS data, than to measures of total factor productivity. But the nature of the measure of output growth used in Jamasb, Pollitt and Triebs (2008) is quite different to those available from the EU KLEMS data.

5.31 The growth rates under either of the output measures would imply greater unit cost reductions in US gas pipelines than those we estimate using EU KLEMS data for the various sectors of the Dutch economy over the period 1970 to 2007. It is possible that this difference reflects, in part, the transitory impact of changes in the regulatory and competitive environment for gas pipelines in the US, rather than being indicative of long-term productivity and costs for gas transmission companies. Jamasb, Pollitt and Triebs (2008) states, on page 3, that:

given that our sample (1996–2004) starts several years after the latest regulatory push for more competition in 1992 (FERC Order 636), we would expect to observe increasing efficiency and possibly convergence in contrast to earlier periods

Studies on productivity for gas distribution companies in Australia

5.32 The next sub-section describes the study by Pacific Economics Group (2008) which concerns three gas distribution companies in Australia. We then highlight two similar studies relating to gas distribution companies in Australia.

Pacific Economics Group (2008) TFP research for Victoria's gas distribution industry

5.33 This report was commissioned by the Essential Services Commission in Australia.[10] The introduction provides some context (page 1):

> The Essential Services Commission (ESC) has been investigating the application of productivity-based regulation (PBR) to Victoria's gas distribution businesses (GDBs). In contrast to the basic "building blocks" model used to set Victoria's current price controls, PBR would use information on industry total factor productivity (TFP) trends to set allowed prices. The first step in investigating a PBR approach is to assemble the necessary data and estimate TFP trends for Victoria's gas distribution industry.

5.34 The study covers three gas distribution companies in the state of Victoria: Envestra, Multinet and SP Ausnet. Their networks are primarily gas distribution networks, but also include transmission pipelines. The data cover the period 1998 to 2007. This corresponds to the entire privatisation experience of Victoria's gas distribution industry.

5.35 Pacific Economics Group claim that the data are "more than adequate for rigorous productivity research" and that "the breadth and quality of the Victorian data are superior to analogous US data in several respects" (page 5).

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[10] Pacific Economics Group (2008) "TFP Research for Victoria's Gas Distribution Industry", available from http://www.esc.vic.gov.au/NR/rdonlyres/8573C211-57AD-493D-B492-BD8A4C4C942E/0/GASTFPReport2008.pdf, accessed on 11 March 2011

5.36 The method involves the calculation of total factor productivity growth as the growth rate of an index of output volumes minus the growth rate of an index of input volumes. The Tornqvist index method is used. Under this method, the growth rate of an index that comprises several elements (e.g. an index for input prices that covers several different categories of inputs) is calculated by taking a weighted average of the growth in each element, with the weights given by each element's share of value (e.g. the value of labour inputs in turnover). This is a standard method used for the calculation of total factor productivity growth. We have used the Tornqvist index method in our productivity analysis using the EU KLEMS dataset.

5.37 Under this approach, the bulk of the analysis lies in the construction of relevant indices for output volumes and for input volumes.

5.38 The output volume index is calculated as the weighted average growth in three sub-indices: the number of customers; total gas delivery volumes; and, for customers on certain types of tariffs, a measure of peak demand. These outputs relate to the different products that customers pay for in their tariffs. The weight attached to each of these outputs in the output volume index is based on the share of revenue that is attributable to that output (e.g. revenue earned from per customer charges), using data from companies' annual tariff filings.

5.39 The growth in the input volume index is a weighted average of the growth in volume indices related to two categories of inputs: operation and maintenance (O&M) expenses and capital inputs. Pacific Economics Group recognises that it would be desirable to divide O&M further into labour and non-labour (intermediate inputs), but reliable time series on companies' labour expenses were not available.

5.40 The data on O&M expenditure are taken from companies' Regulatory Accounting Statements. An output volume index for O&M is calculated by deflating O&M expenditure by an input price index. Because no data were available on the breakdown of gas distribution companies' O&M costs, Pacific Economics Group used an input price index that it had developed as part of previous work to analyse power distribution companies in Victoria. This input price index is based on the following method:

(a) Decompose power distribution O&M expenditure into different cost categories for which data are available (e.g. meter data services, network operating costs, customer service).

(b) For each category, identify the most relevant price index from the Australian Bureau of Statistics (e.g. network operating costs was mapped to a labour cost index and meter data services was mapped to the producer price index for computer services; and customer service was mapped to the producer price index for secretarial services).

(c) Calculate a composite input price index as a weighted average of the various price indices identified, with weights based on the share of each cost category in O&M in 2003 (The report suggests at page 10 that this is the shares for gas distribution companies' O&M, but this conflicts with there being no breakdown of O&M for these companies, so we suspect that the weights are based on data for power distribution O&M expenditure).

5.41 Over the period of the data, the input price index used for O&M grew at a rate of 3.58 per cent per year in nominal terms.

5.42 The method for the calculation of the capital quantity index is more complicated. It is approximately as follows. The capital quantity index in each year is calculated as the value of the quantity index in the previous year multiplied by a depreciation rate, plus the value of gross additions to utility plant divided by a price index for that additional capital. The depreciation rate was calculated as the amount of capital depreciation the company "booked" divided by the value of its capital stock in the previous year. The cost per unit of capital is calculated as price control revenues, minus depreciation and O&M expenses and divided by the value of capital stock in previous year. Under this approach, the total costs attributed to capital are price control revenues less O&M expenses.

5.43 The O&M volume index and the capital quantity index are combined to produce a composite input quantity index, with the weight attached to changes in each index based on shares of each input in the company's "applicable total cost".

5.44 Based on the methods summarised above, the study provides an estimate of the total factor productivity growth rate for the industry of 2.85 per cent per year over the period 1998 to 2007. This reflects a growth in the output quantity index of 1.08 per cent per year and a reduction in the input volume index of 1.77 per cent per year.

5.45 The report also provides estimates of total factor productivity growth for each of the three companies within the Victorian gas distribution industry. These are 3 per cent per year for Envestra, 3.27 per cent per year for Multinet and 2.19 per cent per year for SP Ausnet.

5.46 These TFP estimates excludes the costs of "full retail contestability", which Pacific Economics Group considers most appropriate for measuring the companies historical productivity growth.

Meyrick and Associates (2007) The total factor productivity performance of Victoria's gas distribution industry

5.47 This study concerns the same three gas distribution companies as in Pacific Economics Group (2008).[11] It was commissioned by those companies.

5.48 The output measures used in this study relate to throughput, the number of customers and system capacity. To produce a single index of output volumes, these elements are weighted using weights derived from an econometric analysis of costs: "A weighted average of the cost shares is formed using the share of each observation's estimated costs in the total estimated costs for all [gas distribution businesses] and all time periods" (page 21).

5.49 The quantity measure for operating expenditure was based on an approach of taking the value of gas distribution operating expenditure and deflating it using a price deflator that had been originally developed for electricity distribution companies' operating expenditure.

[11] Meyrick and Associates (2007) "The Total Factor Productivity Performance of Victoria's Gas Distribution Industry", available from http://www.multinetgas.com.au/regulatoryIssues/downloads/RegulatoryEnviroment/GasAccessArrangements/Meyrick_Report_on_Gas_DB_TFP_23Mar2007.pdf, accessed on 11 March 2011.

5.50 Meyrick and Associates (2007) use measures for seven different categories of capital inputs:

(a) length of transmission pipelines;

(b) length of high pressure pipelines;

(c) length of medium pressure pipeline;

(d) length of low pressure pipelines;

(e) length of services pipelines;

(f) total number of meters; and

(g) other assets, for which the volume measure is based on data for the value of depreciated optimised replacement cost (DORC) deflated by the implicit price deflator for the electricity, gas and water sector net capital stock.

5.51 To calculate total factor productivity, weights are attached to these inputs. The weight attributed to the operating expenditure input is the share of operating expenditure in total revenue. For the other inputs, the weight is calculated by first taking the difference between total revenue and operating expenditure and then dividing this between the seven capital inputs according to the share of depreciated optimised replacement cost attributed to each capital input.

5.52 Meyrick and Associates (2007) estimates that total factor productivity in the Victorian gas distribution industry has grown at an average annual rate of 2.7 per cent. The main TFP estimates are similar to those from Pacific Economics Group (2008) which were discussed earlier. Meyrick and Associates (2007) finds that most of the total factor productivity has been achieved through reductions in operating and maintenance expenditure.

5.53 Meyrick and Associates (2007) state that considerable caution is needed in drawing implications about future achievable productivity growth rates of the gas distribution businesses from the historical rates in the study. The report also draws parallels with a similar study for electricity distribution in which a period of high productivity growth was associated with the impact of privatisation.

5.54 Meyrick and Associates provide estimates of TFP growth based on the gas distribution companies' forecasts of changes in outputs and inputs over the period 2006 to 2012. These implied an annual TFP growth rate of 0.1 per cent over the forecast period.

Economic Insights (2009) The productivity performance of Jemena Gas Networks' NSW gas distribution system

5.55 This study was commissioned by Jemena Gas Networks (NSW) Ltd and concerns the productivity performance of the company's gas distribution system in New South Wales.[12]

5.56 It uses a similar method to that in Meyrick and Associates (2007) and the contact person for the two studies is the same person. The same set of three output measures is used and the same categorisation of eights types of inputs is used.

5.57 Economic Insights (2009) estimates annual average TFP growth rates of 1.9 per cent for the period 1999 to 2009.

5.58 Economic Insights argue that: "caution needs to be exercised in using past productivity growth rates as a guide to likely future attainable efficiency improvements". Economic Insights highlight the effects of "convergence" of levels of efficiency between companies as a reason for relatively high productivity growth in the past, expected changes in safety and compliance requirements for GDBs as a reason why productivity growth may be slower in the future.

[12] Economic Insights (2009) "The Productivity Performance of Jemena Gas Networks' NSW Gas Distribution System", and Economic Insights (2009) "Jemena Gas Networks (NSW) - Access Arrangement Information - Appendix 6.7", available from http://www.economicinsights.com.au/reports/ Appendix_6.7_Economic_Insights_ JGN_Final_TFP_Report.pdf, accessed on 11 March 2011

6 Information from expenditure data for gas transportation companies

6.1 This section provides estimates of the changes over time in measures of operating expenditure, and operating expenditure per unit of output, that we have calculated using data relating to GTS and to other gas transportation companies.

Summary of estimates

6.2 We have produced a number of estimates of the changes over time in measures of operating expenditure for various gas transportation companies. These are summarised in table 9.

Table 9 Estimates for measure of gas transportation operating expenditure

Measure	Compound annual growth rate
GTS — total operating expenditure plus incidental, adjusted for changes in measures of outputs, relative to Dutch CPI (2005–2009)	–7.1%
GTS — total operating expenditure plus incidental less energy, nitrogen and flexibility costs, adjusted for changes in measures of outputs, relative to Dutch CPI (2005–2009)	1.5%
Labour and intermediate input (including natural gas) expenditure per unit of output relative to US CPI-U for US oil and gas transmission pipelines (1987–2004)	–1.3%
Operating expenditure for gas transmission company in Great Britain relative to the UK CPI (2005–2009) — range calculated using different output measures	–0.4% to 4%
Measure of "controllable operating expenditure" for gas transmission company in Great Britain relative to the UK CPI (2006– 2009) — range calculated using different output measures	–5.8% to 3%
Operating and maintenance expenditure per unit of output for three Australian gas distribution companies relative to Australian CPI (1998–2007)	–4.2%

6.3 The following sections provide more information on each of these estimates.

GTS operating expenditure

6.4 We have conducted an analysis of data on GTS provided by Energiekamer.

6.5 For the purpose of this analysis, we have added "OPEX incidental" to any operating cost measures that includes "Pension contributions and other personnel costs", on the basis that the "OPEX incidental" data items appear to be dominated by accounting adjustments related to pension liabilities.

6.6 Having made this adjustment, the data did not seem unreasonable. There remain significant year-on-year fluctuations, but this is to be expected for single-company data.

6.7 Table 10 sets out the estimates of the trends in GTS cost data over the period 2005–2009.

Table 10 Trends in GTS cost data (2005–2009 annual growth, in logarithms)

	Transport	Balancing	Quality conversion	Total GTS
Total opex plus incidental opex	CPI – 3.5%	CPI – 17.2%	CPI – 2.9%	CPI – 4.2%
Total opex plus incidental opex less energy, nitrogen and flexibility	CPI + 3.9%	CPI – 15.9%	CPI + 5.8%	CPI + 4.0%

6.8 In addition, Energiekamer has supplied us with data on the changes in GTS's output for each expenditure category per year. The data on annual changes in GTS output are calculated as a weighted average of capacities sold, where the weights used are the specific tariffs in a certain year. The weights are the same for all years so that all changes in the output index are due to changes in capacity sold. The table below reports the trends in GTS cost data after adjusted for growth in output.

Table 11 Growth in GTS cost data adjusted for output growth (2005–2009 annual growth, in logarithms)

	Transport	Balancing	Quality conversion	Total GTS
Total opex plus incidental opex per unit of output	CPI – 5.5%	CPI – 19.1%	CPI – 10.9%	CPI – 7.1%
Total opex plus incidental opex less energy, nitrogen and flexibility per unit of output	CPI + 2.0%	CPI – 17.9%	CPI – 4.3%	CPI + 1.5%

Operating expenditure for gas transmission in Great Britain

6.9 The gas transmission network in Great Britain (England, Scotland and Wales) is owned and operated by National Grid Gas, which is a subsidiary of National Grid Plc.

6.10 We have calculated the compound annual change in operating expenditure for the transmission network. In order to take account in some way for the level of activity on the transmission network, we have calculated changes in unit expenditure where a unit of expenditure is equal to expenditure divided by a measure of output.

6.11 We have used several sources of data for this analysis and present a range of results below. We use two different definitions for operating expenditure and two different output measures.

6.12 Controllable operating expenditure data are taken from the yearly "Annual Transmission Report" published by Ofgem.[13] Data are available from 2006/2007 to 2008/2009. Controllable operating expenditure excludes uncontrollable costs and exceptional provisions (e.g. restructuring costs), and the net movement in provisions.[14] It includes the "non operational" capital expenditure which has been excluded from the assessment of RAV, such as personal computers and vehicles. Separate data are published for the transmission owner business and the system

[13] Available from http://www.ofgem.gov.uk/Networks/Trans/RegReporting/Pages/RegulatoryReporting.aspx, accessed on 11 March 2011.

[14] Uncontrollable costs are not deemed to be within the direct control of the licensee and allowed to be passed on to the customer. These include network rates, license fees, security costs, Scottish Independent Undertakings price differential and xoserve transmission owner costs.

operations business. Controllable operating expenditure is around 15 per cent of the level of turnover for the transmission owner business.

6.13 The second measure of operating expenditure used is taken from the regulatory accounts published by National Grid Gas for the transmission business.[15] The data extend from 2005/2006 to 2008/2009 and cover the entire transmission business rather than just the transmission owner sides, i.e. they include system operation costs as well. We report operating expenditure as the sum of payroll costs, rates, purchases of gas and other expenditure and exclude depreciation, amortisation and exceptional items[16]. These costs cover approximately 45 per cent of total revenue for the transmission business.

6.14 The two output measures used are network length and total gas input into the system. Data on network length are taken from the Annual Transmission Report; they are reported in kilometres, except for the year 2005/2006 where a figure, in miles, is taken from the Regulatory Accounts. Data on total gas input into the system are taken from Table 4.2 of the UK's Department of Energy and Climate Change monthly publication on natural gas production and supply.[17]

6.15 In addition to expressing changes in the two measures of operating expenditure over these two output measures, we also present the changes in operating expenditure without adjustment for output changes.

6.16 All results are relative to the UK CPI data on which are taken from the Office of National Statistics.

6.17 We present the results for the two different measures of operating expenditure below. Table 12 presents changes in the operating costs from the Regulatory Accounts, adjusted for outputs. Table 13 presents changes in the various measures of

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[15] Available from http://www.nationalgrid.com/corporate/Investor+Relations/Reports/, accessed on 11 March 2011.

[16] Exceptional items include large payments to address pension deficits.

[17] Available from http://www.decc.gov.uk/assets/decc/statistics/source/gas/et4_2.xls, accessed on 11 March 2011.

controllable operating expenditure taken from the Annual Transmission Report. All changes are taken as changes in natural logarithms.

Table 12 Average annual changes in unit controllable operating expenditure relative to the CPI, April 2006 to March 2009

Output measure	Annualised unit controllable operating expenditure change relative to CPI
Network length (km)	–5.8%
Gas input into the transmission system (GWh)	–3.0%
None	–1.3%

Table 13 Average annual changes in unit operating expenditure relative to the CPI, April 2005 to March 2009

Output measure	Annualised unit operating expenditure change relative to CPI
Network length (km)	– 0.4%
Gas input into the transmission system (GWh)	4.0%
None	2.8%

Operating and maintenance expenditure for US oil and gas pipelines

6.18 We have calculated some similar growth rates for oil and natural gas pipelines in the US. We have used data reported in Lawrence and Skolnik (2008) which provides estimates of multi-factor productivity for the industry.[18] This paper is summarised in Section 5.

6.19 The cost measure that we focus on here includes labour costs and intermediate input costs, including natural gas. Lawrence and Skolnik (2008) uses an output quantity

[18] Lawrence M and J Skolnik (2008) Estimating Multifactor Productivity (MFP) in Pipeline Transportation, 1987-2004, Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC

index to calculate multi-factor productivity. We use this to provide estimates of labour costs and intermediate input costs per unit of output. We do this by dividing total labour costs and intermediate input costs by the value of the output quantity index in each year.

6.20 We calculate the compound average change in this unit labour and intermediate inputs cost measure relative to the US CPI-U index for the period 1987 – 2004.[19] Over the period, the compound annual growth rate for labour and intermediate input costs per unit of output was –1.3 per cent.

6.21 In addition, we have taken the data on industry turnover and the output quantity to construct an implied output price index. We have calculated the compound annual growth rate for the output price index (or deflator) relative to US CPI-U for the period 1987 to 2004 to be –1.4 per cent.

Operating and maintenance expenditure for gas distribution in Victoria

6.22 We present a similar analysis to that conducted above for gas distribution companies in the state of Victoria in Australia. The data are taken from a paper by Pacific Economics Group in 2008 looking into the total factor productivity of Victoria's gas distribution industry.[20] This paper is described in Section 5.

6.23 The paper provides data on the level of operating and maintenance expenditure across the industry as well as an output index for the years 1998 to 2007. The output index is calculated using changes in the volumes of outputs that determine charges, the number of customers, total gas delivery volumes, and peak demands weighted by associated revenues.

6.24 We calculate unit operating and maintenance expenditure by dividing the operating and maintenance expenditure in each year by the respective value of the output index. We then calculate the growth in this unit operating and maintenance expenditure relative to the Australian CPI.

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[19] The US CPI-U index measures changes in the prices of goods purchased in urban areas for the US.

[20] Pacific Economics Group (2008) TFP Research for Victoria's Gas Distribution Industry.

6.25 We found that, over the period 1998 to 2007, the compound annual growth rate for operating and maintenance expenditure for the gas distribution companies relative to the Australian CPI, per unit of output, was –4.19 per cent.

7 Information from regulatory precedents

7.1 This section discusses a number of recent regulatory decisions relating to price controls for gas transportation companies in a number of European countries, as well as recent price control decisions for a broader set of sectors from the UK. The focus is on aspects of these decisions that relate to the expected changes over time in regulated companies' costs, including assumptions about productivity growth and input price inflation, but excluding changes in costs driven by changes in the scale of the business or its outputs.

Overview

7.2 Table 14 provides a summary of the regulatory decisions covered in this review. The table covers each utility and country on a case by case basis and provides a high level summary of the decisions used for setting annual efficiency assumptions. We then provide further details on each case set out in the table.

Table 14 Summary overview of regulatory precedents

Price control	Decision (% per year)	Comment
England and Wales: water and sewerage (2010-2015)	Base opex: –0.25 Enhancement opex: –0.375 Capex: –0.4 Catch-up range: 0 – 2.9 (water), 0 – 2.2 (sewerage)	Allowed trend relative to RPI. Capex trend taken for allowed expenditure to the RAV.
Northern Ireland (water) (2010–2013)	Base opex: –0.25 PPP: –0.125 Capex: –0.4	Allowed trend relative to RPI. Capex trend taken for allowed expenditure to the RAV.
Northern Ireland: electricity transmission and distribution (2007–2012)	N/A	Rolling mechanism used for operating costs. One off adjustments made for efficiency.
Northern Ireland: gas distribution (2007–2011)	Opex: –1 Capex: –1	Allowable trend relative to RPI for Firmus Energy

Price control	Decision (% per year)	Comment
Northern Ireland: gas transmission (pipelines) (2009–2011)	–1	Allowed operating expenditure trend relative to RPI.
Scotland: water (2010–2015)	N/A	Operating expenditure trend assumed to equal RPI.
UK electricity and gas transmission (2007–2012, rolled over to 2013)	–1.5	Allowed operating expenditure trend relative to RPI.
UK: air traffic control (2011–2014)	–1.25	Allowed operating expenditure trend relative to RPI.
UK: electricity distribution (2010–2015)	Opex: 0.4 Network investment: 0.1	Combined continuing efficiencies and input price expenditure trend relative to RPI.
UK: post (2006–2010, extended to 2011)	–3	Efficiency factor setting operating expenditure trend relative to RPI.
GB: rail network (2009–2014)	Opex: 1.5 Renewals: 0 Maintenance: 0.6	Combined frontier-shift and input price expenditure trend relative to RPI.
Portugal: electricity transmission (2009 – 2011)	Opex: –0.5	Allowed operating expenditure trend relative to GNP deflator.
Portugal: electricity distribution (2009 – 2011)	Controllable opex: –3.5	Implied controllable opex trend relative to GNP deflator. Used to set X.
Italy: gas networks (2010 – 2013)	N/A	Company specific productivity factor relative to CPI.

Price control	Decision (% per year)	Comment
Spain: gas transmission	N/A	Maximum revenue updated annually using an index of inflation and an efficiency factor.
Spain: gas distribution	N/A	85 per cent of IPH inflation (an average of industry and consumer prices) is carried through into price limits.
France: GRTgaz gas transmission network (2009 – 2012)	Opex: 1.1	Allowed operating expenditure trend relative to CPI.
France: electricity transmission and distribution (2009 – 2012)	Controllable opex: –1 (distribution) Controllable opex: –0.5 (transmission)	Allowed controllable operating expenditure trend relative to CPI.

England and Wales: water and sewerage

7.3 The water and sewerage industry in England and Wales is regulated by the Office of water regulation (Ofwat). At its recent periodic review 2009 (PR09), Ofwat set the prices for the regional water and sewerage companies in England and Wales for the period 1 April 2010 to 31 March 2015.

7.4 Ofwat uses a building blocks approach to setting prices for the companies, setting prices by determining the revenue required by each company to deliver a set of required outputs. This includes an assessment of the efficiency gains which can be achieved over the period. The required revenue is then converted into a revenue base corresponding to bill payers and then into price limits. The maximum increase in these limits each year is then set out, relative to the retail prices index (RPI), a UK inflation index.

7.5 The efficiency targets are composed of a catch-up element for each company to reflect their relative efficiency, and an element to capture continuing efficiencies that leading or frontier companies would be expected to achieve.

7.6 The continuing efficiencies target considers trends in both future productivity and input prices. The industry's input costs for both operating and capital expenditure are strongly influenced by trends in labour costs, although with different proportions for each category. The scope for continuing efficiencies in operating and capital expenditure reflects these different mix of input costs and different expectations of future productivity.

7.7 For base operating expenditure, Ofwat sets continued efficiency improvement for all companies at 0.25 per cent per year. Enhancement operating expenditure is given a higher reduction target of 0.375 per cent.

7.8 This continued efficiency is combined with a catch-up estimate for each company which is given by the relative efficiency band of that company, relative to a frontier company. These bands are calculated using econometric analysis. For base operating expenditure it is assumed that by the end of the regulatory period, inefficient companies will close 60 per cent of the efficiency gap with the leading (or frontier) company or companies. Catch-up factors for enhancement operating expenditure are assumed to be one and a half times those of base operating expenditure. The catch-up factors are calculated based on Ofwat's 2008 – 2009 assessment of each company's relative efficiency.

7.9 For PR09, the catch-up factors range between 0 per cent and 2.9 per cent a year for water, and 0 per cent and 2.2 per cent a year for sewerage.

7.10 The efficiency targets for capital expenditure are calculated in a similar way to those for operating expenditure, although the company specific relative efficiency element is calculated with reference to the middle ranking company rather than the frontier company.

7.11 For capital expenditure, Ofwat has set continuing efficiency improvement for all companies at 0.4 per cent per year for investments undertaken in the 2010 – 2015 period. For investments undertaken between 2015 and 2020 the continuing efficiency target is set at 0.25 per cent. For 2020 and beyond it is set to zero.

7.12 The reported reason for the reduction in the continuing efficiency target in later years is to reflect the greater level of uncertainty in predicting costs and productivity a greater distance into the future.

7.13 Relative capital efficiency assumptions are set in relation to the estimated unit costs for capital projects. Each company is then compared to the median. The relative efficiency element of capital expenditure falls within Ofwat's capital incentive scheme which aims to improve the quality of capital forecasts from companies by making the proportions of over and under recovery of expenditure a function of the accuracy of each company's capital expenditure forecast.

Northern Ireland: water and sewerage

7.14 Northern Ireland Water (NIW) is the main supplier of water and sewerage services in Northern Ireland. These services are regulated by the Northern Ireland Authority for Utility Regulation (the 'Utility Regulator'). The first price control for NIW set prices from the 1 April 2010 to 31 March 2013 (PC10) as set out in the Utility Regulator's 'Water and Sewerage Service Price Control 2010-13 Final Determination Main Report' in February 2010.

7.15 The regulatory regime is broadly similar to that applied by Ofwat for England and Wales, and by the Water Industry Commission for Scotland.

7.16 NIW's efficiency target combines two factors; a catch-up element and a continuing efficiency element.

7.17 For operating expenditure, the continuing efficiency element for base operating expenditure is set at 0.25 per cent per year, in line with Ofwat's approach. Further efficiency targets are then placed on NIW with regard to their relative efficiency.

7.18 In addition, a continuing efficiency challenge of 0.125 per cent per annum is applied to the opex element of the Public Private Partnership unitary charges accounted for within operating expenditure.

7.19 For capital expenditure, the frontier shift is assumed to be 0.4 per cent per year. This is then combined with a catch-up element for NIW which has been derived using the upper quartile of England and Wales operator’s unit costs and an assumption that 75 of the gap can be closed over one year.

7.20 Along with the efficiency targets there are also specific allowances given for certain areas of input prices. For example, additional allowances are given for Voluntary Early Retirement and Voluntary Severance costs.

Scotland: water and sewerage

7.21 Scottish Water is the operator of the water and sewerage network in Scotland. Scottish Water’s prices to domestic customers are regulated through price controls set by the Water Industry Commission for Scotland (WICS).

7.22 The most recent price control set charge caps for Scottish Water from 2010 to 2015. The charge caps are set by establishing a level of revenue that allows Scottish Water to cover its operating, capital and financial costs.

7.23 The allowance for operating costs is based largely on the historical performance of companies in the water industry, and particular attention is paid to the performance of companies in England and Wales. WICS states that the evidence from England and Wales suggests that water and sewerage companies are able to deliver broadly constant real operating expenditure and it expects Scottish Water to be able to do the same. The final determination document features a graph (page 13) displaying operating expenditure in England and Wales across a 16 year period in 2007 – 2008 prices, with expenditure moving within a relatively constrained band.[21] In essence this refers to a continuous improvement in operating expenditure equal to inflation.

7.24 On the basis of an analysis of relative efficiency carried out for Scottish Water compared to the England and Wales companies, Scottish Water is set the challenge of achieving upper quartile operating efficiency and levels of service by 2013/2014 with regard to the 2007/2008 levels of the England and Wales companies. An initial increase in operating expenditure is allowed to fund the future fall to that level, with

[21] WICS (2009) “The strategic review of charges: the final determination”, available from http://www.watercommission.co.uk/UserFiles/Documents/Final%20Determination%20document.pdf, accessed on 11 March 2011.

the allowance decreasing in the future. After the initial increase, the final operating expenditure for Scottish Water is based on WICS's expectation that (page 13 of WICS' final determination document):

> Scottish Water should be able to maintain operating costs in future regulatory control periods at between around £275 million and £280 million in 2007 – 2008 prices.

7.25 Despite the assumption of constant real operating expenditure, WICS performed an econometric analysis using combined data from England and Wales and Scottish Water. This suggested that the upper quartile performance of England and Wales companies could improve beyond current levels by 2013/2014. This is set out in the draft determination (page 13):[22]

> Our benchmarking analysis suggests that, given determined management, Scottish Water could outperform our allowance of constant real operating expenditure by up to 5% by 2013-14. This would be consistent with recent upper quartile company performance. If Scottish Water were to improve its efficiency at a steady pace towards this level, it could generate outperformance savings of around £20 million to £30 million over the regulatory control period for the benefit of customers.

7.26 The efficiency targets for capital maintenance and enhancement expenditure are based on a similar cost base approach at the programme level to that used by Ofwat for the England and Wales water companies. This sets out a series of standard costs for companies that can then be compared. Benchmarking techniques were used to compare the performance of Scottish Water with England and Wales companies and a target of upper quartile efficiency used.

7.27 The overall efficiency challenge in the final determination was a reduction in 14.5 per cent in allowed investment for the price control, which reflects expected efficiency

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[22] WICS (2009) "The strategic review of charges: 2010-14: the draft determinations", available from http://www.watercommission.co.uk/UserFiles/Documents/WICS%20DraftDetermination_1.pdf, accessed on 11 March 2011.

improvements as well as general reductions in the projected cost levels. This was applied to the total level of enhancement expenditure which was built up from a consideration of the cost of a number of projects that together form the investment programme for Scottish Water.

Northern Ireland: electricity distribution and transmission

7.28 Electricity distribution and transmission are supplied by Northern Ireland Electricity's Transmission and Distribution (NIE T&D) business. The services are regulated by the Northern Ireland Authority for Energy Regulation ("Utility Regulator").

7.29 The fourth regulatory period for electricity transmission and distribution services, RP4, began on 1 April 2007 and will run until 31 March 2012. The final proposals are set out in the Utility Regulator's final proposals document published in September 2006.

7.30 For the fourth regulatory period, the Utility Regulator introduced a rolling mechanism to set the level of allowable controllable operating expenditure (opex). The rolling mechanism sets the allowable controlled opex for each year of the price control equal to the level of realised controllable opex in the corresponding year of the previous price control period (RP3), indexed to RPI. For example, the controllable opex allowance in year one of RP4 (2007/08) was set equal to the amount of controllable opex incurred in year one of the RP3 price control (2002/03), indexed to RPI. This would then continue for the rest of the price control.

7.31 The rolling mechanism presents an automatic pass-through of the savings in controllable opex achieved by NIE T&D to customers, albeit five years on. This system negates the requirement to estimate the base level of operating expenditure required by NIE T&D and therefore there are no explicit annual adjustments for opex efficiency improvements. However, two adjustments are made to the starting level of allowed operating expenditure for RP4 as discussed in the final proposals document:

> The Authority proposes two adjustments to this rolling mechanism — one in relation to disallowing £225k per annum of Opex in relation to pensions early retirement deficiency costs and a one off absolute reduction in Opex for the first two years of the new price control of £2.6m in year 1 and £1.6m in year 2.

7.32 The two “one off” absolute reductions in the allowable level of controlled operating expenditure correspond to a starting allowance of £46.6m in 2007/2008 and £45.8m in 2008/2009 (both in 2004/2005 prices).

7.33 The capital expenditure projection for NIE T&D over the fourth regulatory period was calculated after cross examining the projected costs of its investment plans and deciding on a final budget for investments over RP4. The projected costs included an expectation by NIE T&D that they could reduce their investment costs by 10 per cent over the period, relating to a 4 per cent reduction in volume and 6 per cent efficiency gains.

7.34 A separate capex efficiency incentive is applied in RP4. The efficiency incentive compares actual expenditure on investments to those allowed in the budget and allows NIE T&G to share a proportion of the difference with customers. Over RP4, NIE T&G will retain 38.9 per cent of every £1m saved through notified efficiency gains, with customers benefiting from the other 61.1 per cent. The rationale for the 38.9 per cent corresponds to the amount of return on capital and depreciation charges that would have been earned over five years if NIE T&D had incurred the capital expenditure.

7.35 Efficiency savings in capital expenditure are expected to correspond to the procurement of materials and services and labour productivity.

Northern Ireland: gas distribution

7.36 Phoenix Natural Gas Limited (PNG) operates the gas distribution network in the Greater Belfast and Larne areas of Northern Ireland. The Northern Ireland Authority for Utility Regulation (the ‘Utility Regulator’) sets five year price controls which determine the allowed revenues for the distribution business over that period.

7.37 The third regulatory review, PC03, formed the basis for distribution charges between 1 January 2007 and 31 December 2011. The allowed revenue of PNG is calculated by determining the level of operating and capital expenditure required over the period as well as forecasting volumes.

7.38 The Utility Regulator sets the allowed operating expenditure over the period which includes an allowance for efficiency, described as follows (page 5):[23]

> It was decided to apply an efficiency factor of 2.5 per cent to the majority of distribution operating expenditure with the exceptions of rates, advertising, marketing and PR, licence fee, incentives, rent and information technology. It was felt that PNG should be able to avail significant efficiencies over the PC03 period due to e.g. expectations over potential benefits of adopting a Reliability Centred Maintenance approach to maintenance activities as well as ongoing general productivity improvements.

7.39 As well as this efficiency factor, the Utility Regulator also sets out an adjustment for manpower (page 5):

> Having considered the PNG assertions regarding the high turnover of staff and recruitment difficulties, our decision is to apply a 1 per cent real increase to the 2006 unit rates [for manpower].

7.40 A similar approach is used for capital expenditure. No explicit efficiency factor is presented in the final determination document but allowances are made for an uplift in input prices due to a new engineering contract that recently came into force.

7.41 Firmus Energy (firmus) operates the distribution network for a set of towns in Northern Ireland known as 'the ten towns'. Its price control is set separately to that of PNG. The second price control period for firmus covers the period from 1 January 2009 to 31 December 2013.

7.42 Information on that price control is set out in the Utility Regulator's document "Firmus Energy Distribution PC02 (2009 – 2013) Price Control Decision". Operating and capital expenditure is determined in a similar way to that of PNG.

7.43 On the efficiency factor, the Utility Regulator states that (page 7):

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[23] Utility Regulator (2010) "Information relating to thePhoenix Distribution Price Control Review 2007 – 2011 Final Determination".

> It has been decided to apply a 2.5 per cent efficiency factor to both firmus's capex and opex. This is in line with efficiency factors applied to gas distribution companies in GB and will be offset by a 1.5 per cent allowance for real price effects producing a net 1 per cent efficiency factor.

7.44 In addition, the document reports an allowance for manpower costs (page 6):

> When forecasting PC02 manpower expenditure, firmus's forecast manpower numbers have been accepted and a 1.5 per cent real salary increase applied going forward.

7.45 It is unclear from the published documents whether the 1.5 per cent manpower number relates to the real price effects identified in the efficiency factor.

Northern Ireland: gas transmission pipelines

7.46 There are three separate gas transmission companies in Northern Ireland, each owning a number of different networks or pipelines. Premier Transmission limited owns and operates the Scotland to Northern Ireland Pipeline, and Belfast Gas Transmission Limited owns the Belfast Gas Transmission pipeline. Both of these companies are subsidiaries of a company limited by guarantee and are financed through a long term bond.

7.47 Regulatory control over operating expenditure has been removed from these companies, although a shadow price control was set for the three gas years 2008/2009, 2009/2010 and 2010/2011. According to the Utility Regulator, the aim of the shadow price control was to set a benchmark for operating expenditure for the two companies and to increase the transparency of costs to the wider public.

7.48 The shadow price control does not constrain the revenues or prices of the two companies. However, it does attempt to set a reasonable benchmark.

7.49 As part of the estimation of controllable operating expenditure for the three gas years, an efficiency factor of 1 per cent is included for the years 2009/2010 and 2010/2011. The Utility Regulator states that this is consistent with the Ofgem Distribution Price

Control. It is calculated on the basis of an efficiency factor of 2.5 per cent offset by an allowance of 1.5 for real price effects.

7.50 Two further gas transmission pipelines are owned and operated by Bord Gáis Éireann Northern Ireland. A price control was set for the period of 2007 to 2012 but the price control decision was not published.

Great Britain: electricity and gas transmission

7.51 In Great Britain there is one gas transmission company and three electricity transmission companies. They are regulated by the Office of the gas and electricity markets (Ofgem).

7.52 In 2006, Ofgem published its decision with respect to the review of electricity and gas transmission price controls which set prices for these transmission companies from 2007 – 2012. Ofgem's approach to setting operating expenditure allowances was as follows (page 10):[24]

> Our view on the appropriate allowances for operating expenditure has been informed by a detailed assessment of the efficiency of the controllable operating expenditure for each licensee. We have:
>
> (a) 'normalised' 2004/05 (our base year) operating costs by removing, amongst other things, non-recurring and atypical cost items. We have also made adjustments for different accounting treatments of certain types of expenditure.
>
> (b) considered the scope for efficiency improvements during the next price control period against the normalised level of base year controllable costs; and
>
> (c) considered upward cost pressures for some elements of operating cost and the need for additional allowances in respect of new categories of cost.

7.53 Ofgem's controllable operating expenditure allowances included an assumption of ongoing efficiency savings (relative to RPI) of 1.5 per cent, plus specific identifiable

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[24] Ofgem (2006) "Transmission Price Control Review: Final Proposals"

savings; the 1.5 per cent figure was said to be "consistent with the assumption used itself by one of the companies".

7.54 Operating expenditure projections have a relatively small effect on revenues for these companies compared to the effect of capital expenditure and rate of return projections.

7.55 Forecast capital expenditure for the period between 2005/2006 to 2011/2012 included an allowance for input price increases and a reduction in costs due to procurement efficiencies, based upon studies conducted by Ofgem's consultants.

7.56 This price control is going to be rolled over for an additional year until 2013. As set out in the 2010 Ofgem document "Transmission Price Control 4 – Rollover (2012/2013) Scope decision and consultation", the operating expenditure efficiency target will be set for each transmission operator separately.

7.57 A full assessment of historical capital expenditure will be held at the next full price control review.

Great Britain: electricity distribution

7.58 There are 14 electricity distribution network operators (DNOs) in Great Britain. They are regulated by Ofgem who sets a revenue allowance every five years through a price control.

7.59 The most recent price control period set the allowed revenues for the network operators for the period 2010 – 2015. It was the fifth price control since privatisation and is known as Distribution Price Control Review 5 (DPCR5).

7.60 The method of setting the price control is similar to that used by other regulators in Great Britain, such as Ofwat, and uses a building blocks approach to determine the level of expenditure required by each network to carry out their duties over the control period.

7.61 The approach to efficiency is built upon the combination of a relative efficiency term for each company, a continuing productivity element for all companies and real price effects that allow for increases in inputs above RPI.

7.62 Ofgem sets the ongoing efficiency target for all operators at 1 per cent per annum. This reflects productivity growth in comparator sectors and relates to the expectation that operators will be able to constrain the increase in expenditure required in the face of increased network investment.

7.63 The ongoing efficiency target is then combined with an estimate for real price effects, which estimates the extent to which input prices will grow relative to the RPI. An allowance of 1.1 per cent a year is made for network investment and 1.4 per cent per year for operational activities.

7.64 Combined with the ongoing efficiency element of 1 per cent per annum, this leaves an allowance for expenditure to increase above RPI at a rate of 0.4 per cent for operational activities and 0.1 per cent for network investment.

7.65 In addition to the ongoing efficiencies facing DNOs, a benchmarking approach is used to assess the relative efficiency of network operating expenditure and indirect costs. The benchmarking exercise uses a number of regression techniques and derives an efficiency score for each DNO. The benchmark level for each company is set at the upper third level for operating costs and at the upper quartile level for indirect costs. This benchmark was set for the first year of the price control and no allowance was made for inefficient companies to catch-up over a period of time.

7.66 In order to allow revenue for companies to continue to fund their indirect costs in the face of increased investment, Ofgem assumed that efficient indirect costs associated with investment would increase at one third of the rate of the increase in network investment.

Great Britain: national railway network

7.67 The rail network in Great Britain is owned and operated by Network Rail. Access to the rail network is sought by train and freight operating companies who must pay an access charge to Network Rail in order to cover the costs of running the network, including renewals and enhancements.

7.68 The Office of Rail Regulation (ORR) sets the level of access charges that Network Rail can charge through five yearly periodic reviews. The most recent periodic review took place in 2008 (PR08) and set access charges for control period 4 (CP4), which runs from 2009 to 2014.

7.69 ORR considers the scope for efficiency savings in Network Rail's operating, maintenance, renewals and enhancement expenditure. Their approach is broadly similar to that used by other British regulators and incorporates elements relating to:

(a) catch-up efficiency;

(b) frontier-shift efficiency; and

(c) input prices.

7.70 ORR sets the efficiency improvements achievable for controllable operating expenditure, maintenance expenditure and renewals expenditure separately from that of enhancement expenditure. It sets separate targets for each of the four expenditure categories but uses a similar method to set targets for operating, maintenance and renewals (OM&R).

7.71 The efficiency targets for OM&R take the three elements above — catch-up, frontier-shift and input prices — to determine the scope for total efficiency over the entire control period. The catch-up element assesses the relative efficiency of Network Rail with respect to comparators, such as other rail network operators in different countries. A number of different benchmarking techniques are used, including top-down statistical analysis and bottom-up process evaluation. The catch-up element is calculated using an estimate of the efficiency gap between Network Rail and these comparators, and an assumption that two-thirds of the gap can be caught up over the next five years (CP4) and the remainder will be caught up over the following five year period (Control Period 5). A separate element is given for operating expenditure, maintenance expenditure and renewals expenditure respectfully.

7.72 The catch-up element is then combined with a frontier-shift adjustment over the period. This is calculated using historical trends in total factor productivity in comparator industries for operating expenditure and maintenance and renewals expenditure separately, relative to economy wide total factor productivity. The adjustment for frontier-shift over CP4 is 3 per cent for maintenance and renewals and

1 per cent for operating expenditure relative to RPI. This equates to an annual reduction of around 0.6 per cent per annum for maintenance and renewals, and 0.2 per cent per annum for operating expenditure.

7.73 An adjustment is then made for projected input price growth above RPI. An allowance of 6 per cent is given for maintenance expenditure, 3 per cent for renewals expenditure and input price growth of 8 per cent for operating expenditure. All of these numbers correspond to the entire five year period. The annual equivalents are 1.2 per cent for maintenance, 0.6 per cent for renewals and 1.7 per cent for operating expenditure.

7.74 ORR's approach to enhancement expenditure includes an allowance for efficiency. The efficiency factor is based on the analysis on renewable expenditure, a frontier-shift adjustment and an allowance for input price inflation.

7.75 Since some parts of enhancement expenditure are similar to renewable expenditure, ORR placed some weight on the future efficiency factor determined for renewable expenditure. However, this only applied for certain elements of enhancement and did not use the full 14 per cent reductions given for renewals after factoring in catch-up. For example, an average cost reduction of 12.5 per cent (2.7 per cent per annum) was applied for platform extension and an average cost reduction of 7.5 per cent (1.6 per cent per annum) applicable for power supply works. An assumption of 5 per cent (1 per cent per annum) efficiency saving was used for other work, achievable through catch-up efficiency and scope efficiency.

7.76 As well as this, a frontier-shift efficiency adjustment relative to RPI was applied to forecast expenditure in each for the control period. The gain was assumed to be 0.7 per cent per annum and was calculated in a similar way to the total factor productivity number for OM&R expenditure.

7.77 In addition, an allowance was made for input price inflation above RPI.

United Kingdom: air traffic control services

7.78 En route air traffic control services for the UK's European and Oceanic flight information regions are provided by NATS (En Route) plc (NERL). These services form the Eurocontrol and Oceanic businesses of NERL and are regulated by the Civil Aviation Authority (CAA), who control the prices for each service.

7.79 The most recent price controls covered a four year period beginning on the 1 January 2011 for the Eurocontrol business and the 1 April 2011 for the Oceanic business (CP3). The CAA uses a building blocks approach to regulation.

7.80 Operating costs account for around 60 per cent of NERL's determined costs and are therefore very important in setting the unit rates payable by airlines. In determining the allowance for operating expenditure, the CAA conducted a number of benchmarking analyses as well as a study into labour productivity.[25] The operating expenditure allowance is calculated by taking account of:

(a) an efficiency factor is applied to 2009/2010 actual costs;

(b) an allowance for traffic growth is made;

(c) adjustments for redundancy, relocation and cost of services are made;

(d) an allowance for bad debt is made; and of

(e) an adjustment for the level of contingency is made.

7.81 In its initial proposals the CAA set the efficiency factor at 2 per cent per annum. However, after responses from NERL this was reduced by 0.75 per cent to 1.25 per cent per annum, based upon the studies conducted by the CAA and the points raised by NERL in relation to the ability to reduce operating costs.

7.82 Pension costs are provided on a pass through basis for CP3, on the provision that they are reasonably incurred. An assessment of this will occur in CP4.

7.83 For CP3, the CAA adopted NERL's projections of capital expenditure that were set out in their formal proposals.

[25] CAA (2010) "NATS (En Route) plc price control: CAA formal proposals for control period 3 (2011-2014): under Section 11 of Transport Act 2000"

United Kingdom: postal services

7.84 The universal service provider for postal services in the UK is the Royal Mail. The Postal Services Commission (Postcomm) currently regulates the prices that Royal Mail charges to some of its customers; this forms the regulated business. Royal Mail's regulated products are split into two baskets and an average maximum increase in price is set for each basket, relative to RPI. Price sub-caps also exist to restrict changes to the prices of individual products within the baskets. In addition, there is a volume adjuster that allows prices to adjust as a result of falling or rising volumes.

7.85 The last full price control ran from 1 April 2006 to 31 March 2010. Since then, two separate one year rollovers of this price control have taken place to run until 31 March 2012.

7.86 In the first price control, Postcomm set the maximum price rise of Royal Mail products for the four year period from April 2006. In terms of operating expenditure efficiency, Postcomm stated (paragraph S49):[26]

> Postcomm has concluded that overall LECG's position remains soundly based and that the efficiency factor of 3% a year, in real and constant volume terms, should therefore be confirmed. The LECG work uses extensive benchmarking analysis from a wide range of sources, including from within Royal Mail's own operations, between international operators, companies performing similar value chain activities and other regulated companies.

7.87 The 3 per cent per year in real and constant volume terms for operating expenditure was based on the work of Postcomm's consultants LECG, who used the following techniques to assess the level of efficiency gains achievable by the Royal Mail over the price control period:

(a) an assessment of Royal Mail's allowable regulatory costs in the base year, 2003/2004;

(b) a forecast of costs using volume forecasts and assuming no efficiency gains;

[26] Postcomm (2005) "Royal Mail Price and Service Quality Review: Final Proposals for Consultation".

(c) a statistical internal benchmarking analysis; and

(d) a top down benchmarking analysis using Royal Mail's past efficiency trends, as well as those of other postal networks and other regulated industries.

7.88 The 3 per cent number was accompanied with a significant allowance for capital expenditure and a number of adjustments for different areas of expenditure, such as funding the pension deficit.

7.89 The first one year extension to the price control rolled the control over until March 2011. The efficiency target for this extension remained the same, albeit with an adjustment to the determination of inflation which was set to zero in the face of the negative change in RPI. In its November 2009 "Decision and Notice of proposed licence modifications" document, Postcomm set out its decision with regards to efficiency in Royal Mail's operating expenses (paragraphs S9–S12):[27]

> Most of the responses that disagreed with our proposals did so on the basis that Royal Mail should be required to become more efficient. However, we are aware Royal Mail has had to reduce its cost base to maintain its profitability in response to falling volumes - which it expects to be close to 10% in 2009-10. In addition, as part of its price control, Royal Mail will have to meet a target of improving efficiency by 3% per annum. This would be made harder if RPI was also negative and as a result its revenue would be lower. As this is a one-year extension to the current price control, Royal Mail will not be able to offset any revenue losses with gains in other years of the control.
>
> Regardless of the additional revenue allowed by these proposals and given that it is currently spending £500 million a year more than it earns, without an improvement in efficiency, Royal Mail will continue to spend more cash than it receives from customers. We estimated that Royal Mail could only recover up to £100 million annually from our proposals. Royal Mail itself considers that the

[27] Postcomm (2009) "Royal Mail's Price Control from April 2010 (Tariff 2010 - Decision and Notice of proposed licence modifications".

> actual impact will only be a maximum of £50 million. We consider that this will continue to provide a strong incentive on Royal Mail to become more efficient.
>
> […]
>
> We have therefore decided to implement the proposal to set inflation to zero in the price control formula.

7.90 The second one year rollover of Royal Mail's price control will apply from 1 April 2011 to 31 March 2012. A final decision will be reached in February 2011.

7.91 The initial intention was to rollover the previous price control with only a few adjustments to certain elements, such as the introduction of a third basket for access products. However, Royal Mail has requested additional revenues in the region of £100m over the course of the rollover in order to fund modernisation and accelerate cost reductions in the medium term. In their November 2010 document, Postcomm stated that they were minded to allow the extra revenues through an increase in the rate at which prices could increase in relation to RPI.

Portugal: electricity transmission and distribution

7.92 ERSE, the Portuguese regulator in the energy sector, published in December 2009 the document "Regulamento Tarifário do Sector Eléctrico" that sets out the regulation for setting tariffs and prices in the electricity sector in Portugal for a three-year period, from 2009 to 2011.[28]

7.93 The Tariff Regulation 2009 defines the set of regulated activities and, for each, defines the revenue and tariff structure that is allowed to be recovered. The revenue allowed for the activities relating to transmission and for distribution takes into account consideration of efficiency gains. The rest of this review focuses on these two activities.

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[28] Available from http://www.erse.pt/pt/electricidade/regulamentos/tarifario/Documents/RT%20Dez%202009_vers%C3%A3o%20INTERNET.pdf (247 pages, PDF in Portuguese), accessed on 11 March 2011.

Transmission

7.94 Article 77 of the Tariff Regulation 2009 sets out the allowed revenue for electricity transmission. The revenue limit is given by the sum of the following components:

(a) operational expenditure;

(b) capital costs;

(c) an element to provide an incentive to maintain assets at the end of their life;

(d) estimate of the compensation (balance) between transmission operators;

(e) expenditure relating to the promotion of certain environmental efforts;

(f) expenditure incurred in year *t-1* that had not been foreseen in the regulatory period, expenditure with audits triggered by regulator

(g) an adjustment to revenues associated to transmission two years before

7.95 Consideration of efficiency gains are taken into account when determining the operational expenditure (the first component listed above).

7.96 The allowed operational expenditure and the incremental costs associated with the extension of the network and to the substation panel are updated to take account of inflation, using the GNP deflator, and of efficiency gains.

7.97 The determination of these efficiency gains are set out in ERSE's paper "Parâmetros de regulaçãio e custos de capital para o período 2009 a 2011", published in December 2008.

7.98 The efficiency factor to be applied to operational expenditure is set at 0.5 per cent, per year.

7.99 The value for the efficiency factor is arrived at by taking into account the aim of having tariff stability, the past trend in expenditure and level of the efficiency factors put forward in studies carried out by external constants. In this last regard, the document refers to the findings from an international benchmarking — stemming from the ECOM+ Results 2005 — according to which REN (the Portuguese transmission operator) had an efficiency score between 68 and 72 per cent, which translated into a variation from average efficiency of between 11 and 13 per cent. The document notes that ERSE's efficiency target takes into account average efficiency and not the most efficient.

7.100 In its discussion, ERSE draws the distinction between catch-up and frontier shift, and that it would be desirable for the efficiency target to be set in recognition of both. However, ERSE comes to the view that (page 10, our translation):

> The efficiency target set by ERSE is based on static models, that is, analysing efficiency in a given year, 2006. No consideration was given to technological progress as there are no robust estimates for the evolution of the frontier.

7.101 The December 2008 document states that a study relating the efficiency gains for the incremental expenditure will be determined in the subsequent year, as part of a study to be carried out. We understand that this study was carried out by Deloitte and we have not found a published version of it. A document setting out the allowed revenue for 2011 makes reference to the efficiency target relating to the expansion of the network and to the change in the number of substation panels. This efficiency target is deemed to be 0.5 per cent for 2011 (and deemed to have been zero in 2009 and 2010.

7.102 In closing, we note that in the previous regulatory period no adjustment relating to expected efficiency gains had been made.

Electricity distribution

7.103 Article 82 of ERSE's Tariff Regulation 2009 defines the allowed revenue for the distribution service in each of the three years of the regulatory period 2009–2011. Separate limits are defined for high and medium voltage (effective voltage between phases above 1 KV) and for low voltage (up to 1kV). The revenue limit for each voltage category is given by the sum of the following components:

(a) a fixed component of distribution revenue;

(b) a variable component defined as the product of an allowed revenue per kWh and predicted electricity delivered by the distribution system of the voltage type;

(c) expenditure relating to the restructuring plans associated with distribution and allowed by ERSE, for the voltage type;

(d) expenditure relating to rents payable to local municipalities, for the voltage type;

(e) expenditure relating to certain environmental activities;

(f) unforeseen expenditure incurred in previous year, namely expenditure associated with auditing actions prompted by ERSE's initiative;

(g) an adjustment to revenue relating to distribution in that voltage type two years before, so that operator repays any revenue collected in excess of what had been allowed.

7.104 The fixed and variable components of the allowed revenue are set for the first year of the regulatory period. Article 82 sets out that each of these two components will evolve in the subsequent two years of the regulatory period to reflect inflation and efficiency gains. The regulation allows for different efficiency gains to be imposed on each of the two components.

7.105 As with electricity transmission, the measure of inflation used is the GNP deflator, denoted by IPIB.

7.106 The level of the target efficiency gains are set out in the December 2008 document, referred to above. Table 15 reproduces the values for the second and third year of the regulatory period, 2010 and 2011.

Table 15 Parameters fixing the evolution of allowed distribution revenues

		2010	2011
X (fixed component)	High/medium voltage	0.45 per cent	0.79 per cent
	Low voltage	2.27 per cent	2.24 per cent
X (variable component)	High/medium voltage	2.95 per cent	3.35 per cent
	Low voltage	5.06 per cent	5.06 per cent

Source: ERSE (2008) "Parâmetros de regulacao e custom de capital para o período 2009 a 2011", p 33.

7.107 The values of the parameters reported in table 15 do not apply to operating costs alone. Rather, they apply to constituent elements of the allowed revenue. This, in turn, reflects controllable operating expenditure, non-controllable operating expenditure such as amortisation and concession licence, and the return on capital.

7.108 It follows that the value of these parameters reflect the efficiency gains that ERSE set on controllable operating expenditure, as well as the predicted trend of non-controllable operating expenditure, of the return on capital and on the growth in energy consumed. We turn now to outline the assumption regarding the efficiency gains in controllable operating expenditure, one of the ingredients in ERSE's calculation of the X factors reported in the table above.

7.109 ERSE forms a view on expected efficiency gains on the basis of:

(a) A review of DEA and SFA models submitted to it by EDP Distribuição. These modelled "controllable costs" for 14 distribution areas, using yearly data for 2003, 2004, 2005 and 2006. ERSE ruled out some of the models on the basis of statistical shortcomings (e.g. concerns about multicollinearity) and proceeds to examine the consistency amongst the remaining, in terms of the ranking they attributed to different distribution areas. On the basis of that analysis of consistency, ERSE finds that the models estimate that the average efficiency across the 14 areas is between 87 and 93 per cent.

(b) ERSE discusses whether an efficiency target (of something between 7 and 13 per cent) should be applied to the costs that were modelled in the various models put forward by EDP Distribuição or to the totality of controllable costs. Modelled costs were 82 per cent of total controllable costs.

(c) ERSE discusses the setting of the frontier shift, which is to be in addition to the catch-up rate to be expected within the firm. With regard to the frontier shift, ERSE recalls its decision in the previous regulatory period to assume a frontier shift of 1 per cent, which had taken into consideration the value used by Ofgem in Great Britain and DTe in The Netherlands. With regard to the current regulatory period, ERSE notes Ofgem's proposed 1.5 per cent figure for the 2005–2010, and DTe proposed 1.5 per cent figure for the year 2005. ERSE chooses to assume a frontier shift of 1 per cent for the 2009–2011 regulatory period, without providing further indication of the reasoning leading it to take this view.

(d) ERSE chooses to set an efficiency target of 3.5 per cent per year. This covers both catch-up and frontier shift, and covers all of the controllable costs (not just the 82 per cent of costs that had been modelled by EDP Distribuição). Over the three year period, this equates to a 10.14 per cent efficiency gains.

(e) The level of controllable operating expenditure for the first year of the regulatory period, 2009, was set on the basis of a forecast of that expenditure. This, in turn, was done by applying to actual expenditure in 2006, a reduction of 6.8 per cent — the efficiency gain that had been set in the previous regulatory period — to derive a value for 2008, and then applying to that 2008 number a further reduction of 3.5 per cent (the efficiency gain ERSE had determined for the current regulatory period).

(f) The split between voltage types was done on the basis of the information of cost structures submitted by EDP Distribuição.

Italy: gas network price control

7.110 We review here the price control of the Italian gas network for 2010–2013, the third regulatory period.

7.111 The key document setting the tariffs is Delibera ARG/gas 184/09 dated 21 December 2009 (Delibera 184/09) by the Autorità per l'energia elettrica e il gas (Autorità). This has since been modified by two further delibera (ARG/gas 198/09 and 218/10).

7.112 The Autorità sets allowed revenue for each of the years in the regulatory period. We outline below how this is done, focusing on those components that take account of efficiency gains. We do so by discussing first how allowed revenue for 2010, the first year of the regulatory period, are set, and then discussing the setting of allowed revenue for subsequent years.

Setting allowed revenue for first year

7.113 Article 3 of the Delibera 184/09 defines allowed revenue for 2010 as the sum of:

(a) return on capital;

(b) amortisation; and

(c) allowed operating expenditure.

7.114 Articles 3.8 to 3.11 specify what constitute allowed operating costs. The allowed operating costs include all operating expenditure and expenditure of a general nature that can be attributed to the transportation activity actually incurred in 2008 and that have been properly audited. It is net of expenditure that has been capitalised. Allowed operating costs exclude expenditure relating to the rent of infrastructure owned by a third-party, provisions/accruals incurred due to accounting rules alone, financing costs, costs of litigation where the company is in fault, costs of fines, penalties and compensation and extraordinary costs.

7.115 If actual operating expenditure for 2008 is below the allowed operating expenditure for the gas year 2007–2008, the allowed operating expenditure for 2010 will be calculated as:

$$COR_{2010} = [COE_{2008} + 50\% * (COR_{2008} - COE_{2008})] * (1 + I_{2009} - X) * (1 + I_{2010} - \overline{X})$$

where

COR_{2010}	Allowed operating costs for 2010
COE_{2008}	Operating costs actually incurred in accounting year 2008
COR_{2008}	Allowed operating costs for the gas year 2007-2008, the first year of the second regulatory period
I_{2009} and I_{2010}	Annual inflation rates for 2009 and 2010 relevant to the update of the tariff price cap. These are set at 1.7 and 2.1 per cent respectively.
X	Productivity gains set for the second regulatory period, set to 3.5 per cent
$\overline{X}$	Productivity gains set for the third regulatory period

7.116 The discussion of how the productivity gains for the third regulatory period (2010–2013), $\overline{X}$, is set is provided further below.

7.117 The above formula sets the allowed operating costs on the basis of the actual expenditure in 2008, plus a sharing — split 50:50 — of the difference between allowed and actual operating expenditure in 2008. The value is updated to 2010 by applying relevant inflation rate and efficiency gains for 2009 and 2010.

7.118 If actual operating costs for 2008 are above allowed operating expenditure for the gas year 2007–2008 then the allowed operating expenditure for 2010 will be defined as the actual expenditure in 2008, updated to reflect inflation and productivity gains. Algebraically, and using same terms as defined above:

$$COR_{2010} = COE_{2008} * (1 + I_{2009} - X) * (1 + I_{2010} - \overline{X})$$

Updating revenue

7.119 After the first year of the regulatory period, unit operational costs are updated to take account of inflation and of productivity gains. The inflation index used is the annual average rate of change in relation to previous 12 months of the consumer price index, as published by Istat, the Italian statistics office. Further to considerations of inflation and of productivity gains, the regulation also foresees the inclusion of another parameter to pick up unforeseen events or changes in law. This factor has been set at zero.

7.120 The parameter reflecting productivity gains is company specific. These are updated as set out below:

(a) For companies where the actual operating expenditure in 2008 are below the allowed operating expenditure for 2008, then the productivity factor X is set such that

$$(1-\overline{X})^{9} = \frac{COE_{2008} * (1 + I_{2009} - X)}{[COE_{2008} + 50\% * (COR_{2008} - COE_{2008})] * (1 + I_{2009} - X)}$$

(b) For companies where the actual operating expenditure in 2008 is above the allowed operating expenditure for 2008, and which have unit operating costs above the industry average unit cost then the productivity factor is set such that the unit costs are brought to equal the industry average costs over a four year period. Algebraically,

$$(1-\overline{X})^{5} = \frac{COM_{2008} * km^{i}_{2008}}{COE^{i}_{2008} * (1 + I_{2009} - X)}$$

where km^{i}_{2008} is the length of the network of company I, expressed in kilometres in 2008, and COM_{2008} is the average unit operational expenditure (euro per kilometre) in 2008, estimated to be EUR 6,600/km.

(c) For companies where the actual operating expenditure in 2008 is above the allowed operating expenditure for 2008 and which have unit operating costs below the industry average, the productivity factor is set to 0 per cent. A zero per cent figure is also used for new companies.

7.121 We find no reasoning for the decision to settle on four years as the period over which unit costs were to be brought to industry average levels.

Spain: gas distribution

7.122 Natural gas distribution operators in Spain are set a maximum allowed revenue.

7.123 Allowed revenue is updated annually from a reference level defined in 2006 by applying a series of factors that reflect:

(a) inflation; and the

(b) growth in activity.[29]

7.124 Account is taken of inflation by applying the product of an efficiency factor to an index denoted by IPH. IPH is defined as the arithmetic average of the change in the consumer price index (IPC) and of the change in the index of industrial prices (IPRI). The efficiency factor applied to IPH has been at 0.85. This implies that 85 per cent of IPH inflation is carried through into price limits.

7.125 The growth in activity also feeds through to the updating of the allowed revenue by taking account of (a) the change in the number of consumers connected on network with a pressure below or equal to 4 bars, (b) the change in total gas consumed on networks with a pressure below or equal to 4 bars and (c) the change in the total gas consumed on networks with a pressure between 4 and 60 bars. To each of these elements of growth is applied a "weighting and efficiency factor". The value of the factors for these three components are set at .426, 0.142 and 0.142 respectively.

Spain: gas transmission

7.126 As with distribution, natural gas transmission operators in Spain have a maximum allowed revenue which is set to reflect costs.

7.127 Different treatment is given with respect to investments that started operating before 1 January 2008, and those that started to operate after that date.

7.128 Orden ITC/3993/2006 dated 30 December 2006, and revised subsequently by Orden ITC/3802/3008, sets the allowed revenue for investments that went into use before 1 January 2008. The allowed revenue associated with these investments are updated annually by applying a factor set to the product of IPH — as defined earlier when discussing gas distribution. The factor has been set at 0.85.

7.129 The allowed revenue associated with investments that started operations after 1 January 2008, are based on "reference values" for those types of investments. The

[29] See Orden ITC/3993/2006 dated 29 December 2006, revised by Orden ITC/3802/2008 dated 31 December 2008.

reference values, for both capital and operating expenditure, are defined on an annual basis and are updated annually to reflect inflation.

7.130 For 2011, reference unit capital expenditure is updated by the index of industrial prices (IPRI) associated with capital goods ($IPRI_{bienes\ de\ equipo}$) minus a factor *X* that was set at 0.005. *X* took the same value for 2010 and for 2009.

7.131 The reference unit operating and maintenance expenditure is also updated annually to reflect a measure of inflation. More specifically, the unit values are updated by multiplying the reference values of the previous year by $1+ 0.2* (IPRI_{bienes\ de\ equipo} - X) + 0.8* (IPC- Y)$, where, $IPRI_{bienes\ de\ equipo}$. is the index of industrial prices for capital goods, IPC is the consumer price index and X and Y are two coefficients. For 2011, X was set at 0.005 and Y was set at 0.01.

France: gas transmission

7.132 The Commission de regulation de l'énergie is the regulatory agency for electricity and gas networks in France. It sets multi-year price controls for electricity and gas transmission and distribution networks on the basis of estimates of operating and capital expenditures.

7.133 Price limits are set by reference to an estimate of allowed revenue, which is obtained as the combination of an estimate of operating expenditure, an allowance for depreciation, a profit allowance, and adjustments for regulatory factors such as previous over- or under-recovery, and quality of service.

7.134 There are two major gas transmission networks in France: GRTgaz and TIGF.

7.135 The 2008 determination of price controls for these networks refers to the following estimates or assumptions about efficiency gains or cost trends:[30]

(a) For GRTgaz, operating expenditure allowances in each year of the 2009–2012 price control period are said to be obtained (except in the event of major energy price changes) by rolling forward a 2009 figure with an index of CPI+1.1, where

[30] Proposition tarifaire de la Commission de régulation de l'énergie du 10 juillet 2008 pour l'utilisation des réseaux de transport de gaz naturel.

CPI is a French consumer price index excluding tobacco products. The operating expenditure concept used in this context is net of some revenues, including connection charges. Reference is also made to a CPI+0.26 index being applied to a narrower measure of controllable operating expenditure in order to provide a basis for productivity measurement.

(b) For TIGF, the price control only applies for two years (2009 and 2010), and the decision quotes explicit figures for each year. The net operating expenditure allowed is 18.5 per cent lower in 2010 than in 2009, but this is mainly due to a forecast increase in revenues from an inter-transmission agreement with GRTgaz, which are netted off the notion of operating expenditure used in this part of the price control calculations. The estimated gross operating expenditure is 7.9 per cent higher in 2010 than in 2009.

7.136 We could not find in the published documents that we looked at an explanation of how these figures were derived or checked.

France: electricity transmission and distribution

7.137 A 2009 Commission de regulation de l'énergie document explaining the basis of electricity transmission and distribution price controls for the four-year period 2009–2012 sets out a CPI–X price control system in which the inflation index in the EU-harmonised consumer price index.[31] Increases in distribution price limits are set to CPI–1.3% and increases for transmission price limits are set to CPI–0.4%.

7.138 The document gives year-by-year estimates for the controllable expenditure implied in these price limits. Controllable expenditure is defined as operating expenditure excluding energy costs, taxes and some other items. The figures for the transmission network correspond to an annual rate of change of CPI–0.5%. The figures for the distribution network correspond to an annual rate of change of CPI–1%.

[31] Proposition de la Commission de régulation de l'énergie du 26 février 2009 relative aux tarifs d'utilisation des réseaux publics de transport et de distribution d'électricité.