Frontier Shift: An Update

April 2010

FIRST
ECONOMICS

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First Economics Limited
Registered office: 72a Belgrave Court, Westferry Circus, London, E14 8RL
Registered in England and Wales, no: 5075274

Foreword

One of the regulatory debates that First Economics has participated in most actively during recent years concerns the rate at which frontier companies' opex can be expected to move over time. Following the conclusion of Ofwat's PR09 and Ofgem's DPCR5, this paper reviews the frontier shift analysis that has been used in recent periodic reviews, gives an overall assessment of the current state in regulatory thinking, and highlights a number of challenges that regulators still need to address.

We do this in three parts:

- section 1 takes an overall look at the way in which regulators' assumptions have changed over the course of the reviews carried out during the last five years;
- section 2 gives a checklist of regulatory 'good practice' which we think can be used by regulators and companies looking to perform analysis of frontier shift in future reviews; and
- section 3 concludes with the issues that we think arise from the periodic review determinations published in the last 18 months.

In addition, two annexes:

- give a more detailed outline of the principles on which estimation of frontier shift is based; and
- provide a factual summary of the key numbers appearing in recent decisions.

Note: We are grateful to Anglian Water, Wessex Water and Yorkshire Water for part funding the research as a continuation of our work for Water UK during PR09. For the avoidance of doubt, the views and analysis set out below are entirely our own.

1. Review of Recent Regulatory Decisions

1.1 Overall summary

When First Economics entered the debate about frontier shift in late 2005 our first contribution was to query what at the time seemed to be a widespread belief that even the most efficient regulated companies remain capable of delivering real terms reductions in opex. We had spotted that a body of literature had built up which indicated that network companies ought to be capable of improving productivity more quickly than the average firm in the UK economy. However, we questioned whether this evidence provided sufficient justification for regulators to be setting leading companies annual cost reduction targets of RPI – 0.5% to RPI – 1.5% for reasons of ongoing 'frontier shift', as had become common practice at that time.

As we write this report a little over four years later, we think it is fair to say that regulatory thinking has moved on considerably. In table 1.1 we show the assumptions that regulators have made in reviews carried out during 2008 and 2009 against assumptions made in earlier determinations. The table shows a growing acceptance that efficient regulated companies probably see their opex escalate in line with or slightly above RPI-measured inflation. As a consequence, it has been a common occurrence in recent years to see bills being allowed to increase faster than forecast RPI-measured inflation to accommodate an expected real terms increase in frontier companies' opex over time.

Table 1.1: Summary of recent opex[1] frontier shift estimates (annual)

	Proposals/ decisions issued prior to 2007	**Decisions issued in 2008 or 2009**
Ofgem – electricity transmission	RPI – 1.5%	–
Ofgem – electricity distribution	RPI – 1.5%	RPI + 0.4%
Ofwat – water	RPI – 0.6%	RPI – 0.25%
Ofwat – sewerage	RPI – 1.0%	
ORR – Network Rail, opex	RPI – 1% to RPI – 2%	RPI + 0.75%
ORR – Network Rail, maintenance		RPI + 0%
PPP Arbiter – underground infracos, central costs*	–	RPI + 0.8%
PPP Arbiter – underground infracos, opex*		RPI + 0.3%

Note: * First Economics' estimates pending publication of the Arbiter's detailed calculations.

The one outlier from this consensus is Ofwat's PR09 determination. One of the themes that we will return to during the course of this paper is the question of why it is that Ofwat retained a below-RPI frontier shift assumption in its PR09 determination and whether it could be that the water regulator is yet to tap fully into the arguments and evidence used by its fellow regulators in recent months. We leave a detailed critique to later sections, but for now we note that Ofwat is the exception to current practice of allowing for at- or above-RPI frontier shift in forward projections of network business opex.

1.2 Why has this happened?

The explanation for the shift in thinking that table 1 depicts has at least two parts to it.

[1] The costs covered by the figures in table 1.1 vary slightly from industry to industry. Of particular note, Ofgem, Ofwat and ORR all make separate allowance – i.e. over and above the stated figures – for changes in business rates. In addition, Ofwat in PR09 made separate allowance for increases in some (but not necessarily frontier) companies' power costs. All four regulators also deal with changes in pension contributions separately. If these uplifts are factored into the calculations they would slightly increase the figures quoted in table 1.1.

First, some of the numbers in the middle column of table 1 contain within them an implicit 'privatisation effect' – i.e. an assumption that even the most efficient companies in the stated industries were still to eliminate the legacy of their time in the public sector. In reviews conducted prior to 2007, this hypothesis helped regulators to get comfortable with the idea that they should set even leading companies real terms cost reduction targets. However, in the most recent round of periodic reviews regulators have generally come to accept that this short-term boost to out-turn efficiency savings has run its course and that it is no longer appropriate to factor such an effect into forward-looking opex allowances.

There is, however, more to the story than this. The second part of the explanation is that most regulators have changed fundamentally the way in which they estimate frontier shift. As we alluded to in our starting summary, there was up until three years ago a view that the key determinant of whether or not regulated firms are capable of delivering ongoing real terms cost reduction was the rate at which they improve productivity relative to the average firm in the UK economy. The logic was that RPI-measured inflation already captures the rate of productivity growth achieved by the average firm in the UK economy and that the link between RPI prices by itself forces regulated companies to match those savings. It followed that firms that improve productivity slower than the average firm were seen as being the sorts of firms that might see their costs increase in real terms. Conversely, firms that have the ability to out-perform the average rate of productivity growth in the UK – like utilities – should be considered capable of producing real terms cost reductions.

How regulators used to measure frontier shift:

Frontier shift in real terms ≈ productivity out-performance

Regulators no longer see frontier shift in such simplistic terms. In annex 1 to this paper we explain what drove earlier thinking and how regulators now seek to measure frontier shift. The key points to note are that:

- regulators have come to recognise that RPI-measured inflation is a benchmark that is increasingly influenced by the prices of goods manufactured overseas. The productivity growth that RPI already captures is therefore the productivity growth achieved not by the average UK company but by a very broad group of international firms who supply the household goods and services that go into the RPI basket;
- in the absence of any way of measuring the true 'average' within RPI, the old approach of measuring productivity out-performance is no longer valid. The only way for regulators to obtain a feel for the way in which network companies' costs are likely to move over time it is to undertake analysis of cost drivers and to estimate year-on-year escalation in costs from the bottom up;
- this means analysing in some detail the absolute rate of input price inflation in an industry (which will push costs up from year to year) and the absolute rate of productivity improvement in an industry (which will push costs down);
- it also means subtracting forecasts of RPI-measured inflation directly to obtain numbers in real terms and in doing so giving due regard to the short- to medium term profile of inflation resulting from things like changes in mortgage interest rates and other factors linked to the recovery of the UK economy from recession.

How regulators now measure frontier shift:

Frontier shift in real terms = input price inflation *minus*
productivity improvement *minus*
forecast RPI-measured inflation

Importantly, this change in thinking has shown to regulators that there is no reason a priori why the costs of leading regulated firms should increase more slowly than RPI. In particular, it is perfectly possible for a company to be delivering significant productivity improvements – indeed to be improving productivity more quickly than the average UK firm – yet still see costs increase in real terms. (It could be, for example, that firms are having to grapple with significant, sector-specific input price pressures. Or it could be that in particular years RPI-measured inflation is held very low by mortgage interest rate reductions.)

As we show in the next section, most regulators now find it helpful to isolate and highlight explicitly to customers the assumptions that they are making about ongoing *productivity* improvement and to use the term 'efficiency improvement' interchangeably with this measure. In the past, this was not the case: regulators would publicise only the final real terms cost trend. Perhaps tellingly, given the figures that we highlighted in table 1, the only regulator that hasn't yet changed approach in reviews carried out during the last two years is Ofwat (which still equates efficiency improvement to real terms cost reduction (and vice versa)).

Irrespective of the labelling, the key point to take from these opening remarks is that the figures in table 1.1 are not indications of the rate at which leading firms will be improving productivity/efficiency in future years. What these figures are is a measure of the rate at which network businesses' costs change in relation to the price of a representative basket of goods purchased by UK households. When one understands and acknowledges the nature of this latter benchmark it should be straight-forward to see that efficiency improvement could be consistent with below-, at- or above-RPI cost escalation; to be able to interpret the headline figures properly requires considerably deeper analysis.

2. Review of Lessons Learned

As a relatively recent addition to the periodic review process, a great deal has been learned in a relatively short space of time about the ways of estimating the key inputs into the second of the equations of p.4 – i.e. future input price inflation and future productivity growth. To help regulators and companies who wish to utilise this sort of analysis in future periodic reviews we set out in this section the current state of regulatory 'good practice' as we see it. In addition, we also highlight key areas where it has not been possible to establish any sort of agreement among the regulators, companies and consultants that have participated in recent reviews.

More detailed summaries of recent regulatory decisions can be found in annex 2.

2.1 Regulatory good practice

2.1.1 Data collected as part of the EU KLEMS project gives the best insights into likely rates of future productivity growth

All four of the reviews that we highlighted in table 1 made use of data on historical rates of productivity growth in sectors that can be considered to have similar characteristics to network industries. The thinking has been that history acts as the best guide to the future and that the achievements of close comparators provides the best available benchmarks for the natural, long-term rate of productivity improvement in regulated sectors.

The source information for this benchmarking work has been a database[2] compiled by researchers from 18 academic institutes across Europe known as the EU KLEMS dataset. The database comprises growth and productivity accounts for 36 sectors, sub-sectors and sub-sub-sectors of the UK economy for the period 1970 to 2007.[3] Comparator sectors that regulators have found to be particularly helpful comparators include:

- electricity, gas and water supply;
- transport and storage;
- sale, maintenance and repair of motor vehicles and motorcycles; and
- finance, insurance, real estate and business services (or its sub-component sectors).

(A full list of the sectors in the EU KLEMS dataset is included as annex 3 to this report.)

Although it is possible to think of reasons why each individual sector in the above list is not exactly the same as a network business, regulators have become comfortable with the idea that an overall look at productivity trends in these labour-intensive industries gives a good guide to the way in which labour-dominated network business opex can be compressed over time. Companies, for their part, seem to agree with this view, meaning that the reference to EU KLEMS data has been an accepted and uncontroversial part of the periodic review process.

2.1.2 A reasonable benchmark for ongoing productivity growth in network industries is 1% per annum

As in any benchmarking exercise, there have been a range of views about the best way of translating the experiences of others into a precise figure or benchmark for insertion into the frontier shift calculation. Among other things, it is apparent that there are differing viewpoints on:

[2] Available at www.euklems.net.
[3] It also contains information for 29 other EU and OECD countries.

- the best economic measure of productivity growth;
- the period of time over which comparators' productivity growth should be measured;
- how to make allowance for capital-labour substitution; and
- how to take account of changes in product quality and volume growth.

Despite these differences in approach, there has, however, been a remarkable degree of similarity in the conclusions that regulators have drawn. In table 2.1 we summarise the figures that the different regulators have used into their computations. It shows a very clear convergence around a point estimate of around 1.0% per annum.

Table 2.1: Regulator's calculation of the productivity growth component of frontier shift

	% reduction in opex per annum
Ofgem – electricity distribution	1.0%
Ofwat – water Ofwat – sewerage	not stated
ORR – Network Rail, opex ORR – Network Rail, maintenance	0.7% 1.4%
PPP Arbiter – underground infracos, central costs PPP Arbiter – underground infracos, opex	0.7% 0.9%

To put this into context, EU KLEMS data puts UK-wide productivity growth at no more than 0.7% (on a like-for-like measure). Therefore regulators are saying that they need to allow for productivity growth a little above that in the UK as a whole in their price control calculations – an outcome that to us at least feels intuitively right[4] given the nature of the activities that network businesses undertake.

2.1.3 Input price inflation needs to be disaggregated as far as is reasonably practicable

In contrast to the very top-down approach to productivity analysis that we have just described, regulators have found that it is necessary to carry out far more detailed, bottom-up analysis of input price inflation in order to capture properly the different influences affecting the different inputs that regulated firms buy.

The general rule of thumb has been that opex inputs are best divided up into at least half a dozen individual line items, comprising as a minimum:

- general labour;
- specialist labour with sector-specific infrastructure skills;
- general materials;
- specialist materials;
- rent and/or rates;

plus any further purchases that have particular importance in the sector being considered (e.g. power in the water industry). If visibility of costs is such that it is possible to dig further

[4] We say this because the UK average is held down by negligible or negative productivity growth in the public sector and in the 'pure' service sectors like finance and business services. Although network operating companies don't benefit as much as, say, manufacturing companies from technological change, to our mind such firms ought nevertheless to be dynamic enough to out-perform an economy-wide average which includes the above-mentioned sectors.

than this, the above categories can be divided up into further sub-categories for so long as there is reason to think that disaggregation gives meaningful new insights into cost drivers.

A regulator can then compile year-by-year forecasts of input price increases or input price reductions for each individual item and weight together the figures to get an overall sense of the aggregate input price pressures that network businesses are having to contend with in running their businesses.

2.1.4 There is a rich seam of data from which to draw insights into trends in input price inflation

This is necessarily a forward-looking exercise. However, as in the analysis of productivity growth, regulators have found that recent experience and data can provide useful insights into the underlying cost pressures in the industries they regulate.

There has been no shortage of data sources to tap into. On-the-shelf sources of information include:

- ONS data;
- sector-specific price and cost time series collected by other government departments like the Department for Business, Innovation and Skills (BIS);
- statistical time series collated sold by industry associations like the Royal Institution of Chartered Surveyors (RICS) and the British Electrical and Allied Manufacturers' Association (BEAMA); and
- private data sold by management consultancies.

If anything, regulators have been overwhelmed by the data that has been thrown at them. In trying to understand what has happened in recent times to specialist wages, to give just one example, a regulator can refer to profession-specific time series data found in the ONS's Annual Survey of Hours and Earnings, BIS's Construction Statistics Annual, RICS's Building Cost Information Service and BEAMA's Contract Price Adjustment Service. Not unexpectedly, each data source tells a slightly different story leaving the regulator having to exercise a certain amount of judgment in order to establish how much input price inflation has been impacting on costs in previous years.

Once these judgments have been made, regulators have been comfortable assuming that recent trends give as good a guide as any to the input price increases that companies will might expect to face in the future. They have, though, recognised that the next 2-3 years are going to be unusual as the UK first of all continues to suffer from the after-effects of recession and then moves back towards a 'normal' rate of economic growth. This has meant that reviews carried out by the likes of Ofgem and the PPP Arbiter have had to allow for a glidepath – informed as far as possible by independent macroeconomic forecasts – in which input price inflation trends back from current levels to historical trends.

2.1.5 A reasonable estimate of economy-wide wage inflation when the economy is growing 'normally' is 4.0% to 4.25% per annum

Among the different judgments that regulators have been required to make, the area in which there has been greatest consensus is in relation to the expected growth in economy-wide average earnings during periods in which GDP is growing in line with long-term trends (i.e. 2.5% to 3% per annum). To show this, table 2.2 gives the regulators' forecasts of average earnings growth in the last year of their respective forecasting periods.

Table 2.2: 'Steady-state' forecasts of average earnings growth

	% increase per annum
Ofgem	4.1
Ofwat	not stated
ORR	not stated
PPP Arbiter	4.2
Historical average, 1994 to 2007	4.25

The figures in the table are broadly consistent with our own calculation that private-sector earnings grew on average by 4.25% per annum over the period 1994 to 2007. We would suggest anywhere between 4.0% and 4.25% is a relatively uncontroversial figure to be included in input price forecasts from, say, 2012 and beyond.

2.1.6 Wage inflation in network industries lies above average earnings growth

This 4.25% benchmark does not tell the whole story about wage inflation in the infrastructure sector, however. All three of the regulators that have given detailed figures have in their reviews allowed for a premium to be paid to labour with specialist infrastructure skills. Table 2.3 sets out the amounts involved.

Table 2.3: 'Steady-state' forecasts of the differential between specialist wage inflation and average earnings growth

	% increase per annum
Ofgem	0.7
Ofwat	not stated
ORR	1.0 to 2.0
PPP Arbiter	0.4

The justification for this premium is the sense that there is simultaneously an unprecedented demand for infrastructure specialists in UK, caused by an unprecedented ramp up in volumes of infrastructure work over recent years, and a genuine shortage of skilled workers. If average earnings growth as depicted in table 2.2 is exactly that – i.e. an average – and by definition some workers in the economy see their pay increase by more than the 4.25% per annum while others see their wages go up by less, there is every reason to think that infrastructure workers will be among those individuals who can bargain for higher salary increases.

This certainly seems to have been the case in the past, judging by all of the data sources mentioned in section 2.1.4, and while it is reasonable for views to differ on the extent to which premia will persist in the future, there does not appear to be any sense in the regulators' offices that some differential will not exist for the foreseeable future.

2.2 Areas in which good practice is less easy to identify

2.2.1 Materials inflation

Having until now made it seem that there is a good deal of agreement among regulators (and companies) as regards the inputs into the frontier shift calculation, it is necessary to

conclude the discussion by highlighting that there are two important areas in which no consensus exists.

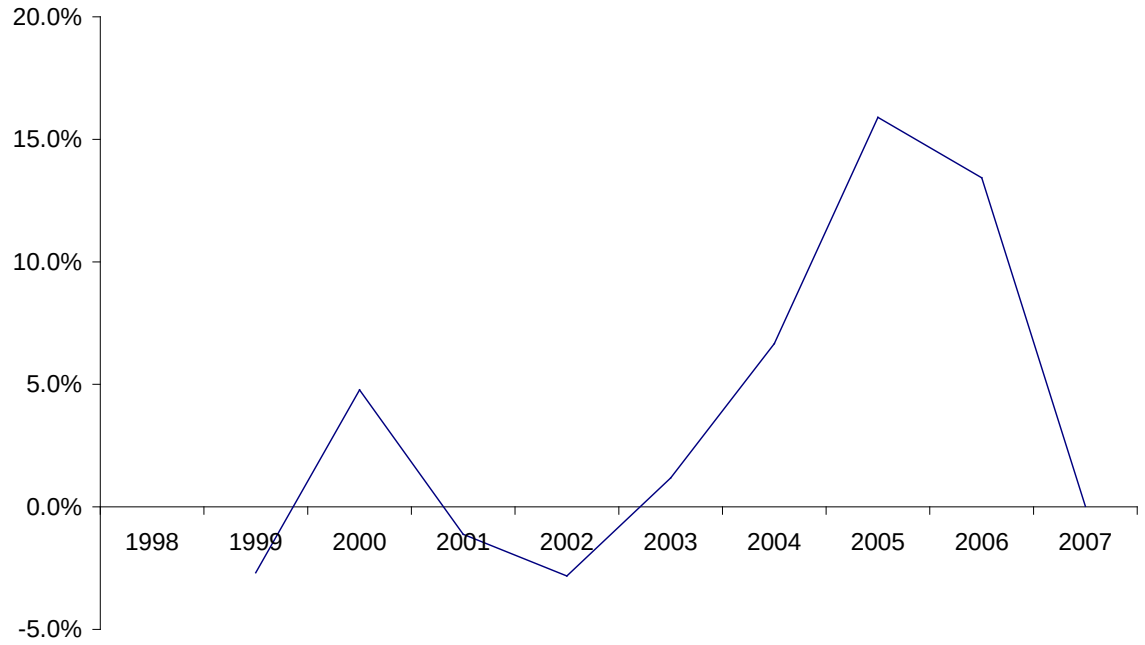
The first of these areas is materials inflation. In reviews carried out over the last 18 months we have seen regulators form quite different views on the rate at which materials costs will increase over the course of the regulatory period. (If one widens the scope of the analysis to include the submissions made by companies, the range of views on offer grows even further.) Table 2.4 exemplifies this with a summary of regulators' forecasts of the annual increase in the price of general construction materials in 2013/14 (the last year for which all regulators have been forecasting).

Table 2.4: Forecasts of increases in the price of general construction materials, 2013/14

	% increase per annum
Ofgem	RPI + 0.6
Ofwat	not stated
ORR	RPI – 0.5
PPP Arbiter	RPI + 1.5

The cause of these discrepancies is uncertainty about the future direction of commodity markets. When analysing wage inflation regulators have been able to look back at historical data which shows consistent year-on-year change for a period stretching back maybe 15 years prior to the start of the recent recession. When they look back at materials inflation they see big spikes in prices between 2005 and 2007 preceded by much lower, but still volatile, rates of price increase. Figure 2.5 is one fairly typically picture.

Figure 2.5: Annual increases in basic electrical materials costs



Source: BEAMA.

The question that many people, not just those in the regulated industries, have is: just what will the next five years bring? Will the rampant commodity inflation of 2005 to 2008 prove to be a blip? Or is it unrealistic to expect price increases to ever go back to rates seen in the late 1990s and early part of this decade? Perhaps unsurprisingly, since such questions are impossible to answer, regulators and companies have taken different views on these matters and in doing so come to the sorts of differences in forecast that table 2.4 depicts.

2.2.2 RPI-measured inflation

One perhaps more surprising area of contention has been the forecasting of RPI. Over very short horizons – e.g. two years – regulators have been able to use government and/or independent forecasts to describe what is likely happen to inflation as the UK recovers from recession. Thereafter they have been happy to assume that the Bank of England will be able to hit the government's inflation target.

The issue that arises is that the government's inflation target is expressed in terms of a 2% annual increase in the Consumer Prices Index (CPI) whereas regulators require a forecast of RPI for their frontier shift calculations. There are a number of differences between the two indices, which may be categorised under two headings:

- differences in the composition of the basket of items underpinning the two indices and statistical differences in the way of measuring annual changes in prices;[5] and
- the inclusion of housing costs in RPI and not in CPI

There is a broad agreement that the factors identified in the first of these bullets typically causes RPI-measured inflation to be 0.5 percentage points higher than CPI-measured inflation. All other things being equal, this means that 2% CPI-measured inflation translates into 2.5% RPI-measured inflation. However, there is no agreement on the value of the housing effect identified in the second bullet.

One view – indeed, First Economics' view – is that the effect in the medium to long term will be zero. In support of this position, one can look at statements that the government made when it moved to a CPI target back in 2003 which imply that the inclusion of housing costs in RPI and not in CPI is a non-issue and that CPI of 2% was seen as being equivalent to RPI of 2.5%. The other view starts from the observation that house prices over the ten years or so prior to the start of the recession grew much more quickly than expected and consistently drove RPI up faster than CPI. On the basis that the past provides the best guide to the future, which after all is a principle that is applied elsewhere in the frontier shift calculation, some argue that it is perfectly reasonable for a regulator to expect rising house prices to continue to drive a wedge between RPI and CPI.

Although the difference in views is 'only' worth up to 0.3 percentage points – i.e. those in the first camp see RPI trending upward at a natural rate of 2.5% per annum while those in the second camp use figures of up to 2.8% – this is actually quite a large amount given the context within which the numbers are being used.

[5] For example, CPI uses geometric averages while RPI uses arithmetic averages.

3. Analysis

Having described the current state of regulatory practice, we ask the question: what happens next? We structure this into two parts, focusing first on Ofwat and then on regulatory reviews more generally.

3.1 Frontier shift analysis in the water industry

At various points in the preceding discussion we have highlighted that Ofwat's decision on frontier shift in PR09 reads very differently from the decisions made by the other regulators in their respective reviews. This is apparent in two main respects: the absence of any explicit input price inflation or productivity calculations in Ofwat's decision documents; and Ofwat's conclusion that leading companies are capable of reducing opex in real terms.

We know that Ofwat had the opportunity to consider detailed evidence of the type commissioned by other regulators because we produced two reports setting out such analysis for the industry association Water UK. Quite how much weight Ofwat attached to this sort of evidence is much less clear. We note that mention is made in the final determination – but not the draft determination – of Ofwat making its own input price inflation and productivity calculations. Despite this, the only formal comment Ofwat made on our work was the following statement 'because the water sector is not the same as the economy as a whole, RPI will under-compensate some cost increases and over-compensate others; it is our view based on past experience that these usually balance each other out'.

We think it would be helpful to the transparency of the regulatory process if Ofwat in future reviews were to make public and consult upon its input price inflation and productivity calculations in the same way that Ofgem, ORR and the PPP Arbiter have with theirs. On the experience of the last 18 months, as summarised in this report, there are more than sufficient grounds for describing analysis of input price inflation and productivity growth as a core and unavoidable part of the periodic review process. It follows that it should be open to stakeholder scrutiny and debate.

We also think it would be helpful if Ofwat were to alter the terminologies it uses to be consistent with the labelling used by other regulators. We noted in section 1 that Ofwat is the only one of the four regulators to define efficiency improvement in terms of real terms reduction in cost. Throughout Ofwat's recent review we kept on finding that this can produce a sort of false logic – i.e. if it must be the case that leading companies are still capable of improving efficiency, then this must mean that they can reduce costs in real terms; likewise, if a regulator or a company is saying that opex will change at a rate of RPI – 0% (or RPI + something) this must mean that efficiency improvements have come to an end.

Although we have no way of knowing for sure, we wonder if this looseness in terminology was part of the reason why Ofwat ended up with an RPI – 0.25% frontier shift assumption. Remember that in Ofwat's language this becomes a 0.25% 'continuing efficiency' assumption, which sounds pretty innocuous but understates quite significantly the productivity or 'true' efficiency improvements that firms have to make in order to hold opex increases below inflation. To see this, imagine that a regulator were to suggest during its consultation process that it might allow a zero 'continuing efficiency' assumption – we suspect that many people's intuitive reaction to this proposition would be quite negative. However, if a regulator were to rephrase the question to the less loaded 'should we assume that productivity improvement outweighs input price inflation or vice versa?', we suspect that people would have fewer pre-conceived ideas and would be quite prepared to accept input price inflation that matches or exceeds productivity growth.

Our own experience tells us that one cannot repeat often enough that a company can still be making significant productivity improvements yet still see its opex increase more quickly than

RPI. It is to everyone's benefit if this logic is reflected more clearly in the regulatory framework.

3.2 Frontier shift analysis in other regulatory reviews

We have two final observations to make about the future progress of frontier shift analysis more generally.

3.2.1 Use of consultants

One feature of recent reviews has been the reliance that regulators have placed on consultants to calculate the input price inflation component of frontier shift. Specifically, it is noticeable that in each of Ofgem's, ORR's, and the PPP Arbiter's reviews, the regulator's input price estimates are copied without modification or alteration from reports by CEPA, L.E.K. and CEPA respectively.

This is not usual regulatory practice. In debates about the cost of capital, to give just one example, regulators see reports by their consultants as just one viewpoint and invariably feel confident departing from the consultants' calculations when they come to set an allowed rate of return. This has not been the case in debates about input prices, perhaps because of the newness or complexity of the subject matter, with the result that on certain occasions it has felt to us like the consultant is the decision-maker.

To avoid such situations in future, regulators might wish to think about how they can develop the skills they have in-house so as to allow for a more rounded debate about the forecasting of input prices

3.2.2 Cross-checks

A second area of potential concern is the absence in recent reviews of any sort of secondary evidence to cross-check the results of the frontier shift computation. We raise this as an issue because we have found ourselves that focusing on productivity growth, wage inflation, materials inflation and so on, in isolation can sometimes make the calculations look like a bit of a black box. After one has fed all the numbers into a spreadsheet and turned the handle, it is useful to have some way of gauging whether the overall results look sensible even if one has confidence in the component parts.

We have previously applied three sorts of sense-check in our reports:

- first, we have looked at the composition of RPI-measured inflation to see whether there is any sort of pattern in the sorts of firms that see costs/prices rise faster than inflation and the sorts of firms that see costs/prices rise more slowly. Prior to the recession we were finding that the prices of goods manufactured overseas were barely increasing from one year to the next while the price of services supplied by a UK-based workforce almost always increased ahead of inflation (meaning that imported goods were holding down the UK's inflation rate and masking what otherwise would be regarded as fairly rapid domestic inflation). We took this to mean that it was understandable for UK-based, labour-dominated network businesses' opex to be increasing faster than RPI;

- second, we have looked at how output price indices in industries that share some similarities with the regulated sectors move over time. In particular, we have highlighted that it is regarded as uncontroversial that construction output price inflation – a commonly used benchmark for capital unit costs – should run ahead of RPI in normal economic conditions. Again, this seems to us to suggest there is no reason why an index of network business operating costs cannot outpace RPI-measured inflation; and

- third, we have looked at cost data from leading companies in the airport, electricity and water sectors (i.e. now mature industries privatised prior to 1990) in an effort to ascertain whether recent experience has been one of above-, at- or below-RPI opex increases. Generally we have found evidence of costs rising ahead of inflation at the industry frontier.

It may be that these sorts of cross-checks have made some sort of impression on regulators, but there is no evidence in their published documents that this is the case. We think that customers would have greater confidence in regulators' calculations if it were possible to develop either the above ideas or something entirely different into a robust cross-check at the next round of reviews.

Annex 1: The Evolving Nature of Frontier Shift Analysis

A1.1 Principles

When companies or regulators are required to forecast future opex, it is usually necessary to take into account three distinct influences in expenditure:

- variations in outputs: will the service offered to customers change, necessitating changes in the level or mix of activities that a company undertakes;
- input price inflation: how much more will companies have to pay in future for the labour, materials and equipment that they require in order to run their businesses; and
- productivity improvement: what opportunities are there to make savings in manpower or other inputs so as to improve the overall efficiency with which activities are carried out?

These three factors can be combined as follows:

Annual change in costs ≈ cost associated with variations in outputs *plus* input price inflation *minus* productivity improvement (1)

Each of the terms in this formula will vary from company to company. There should, however, be a common component to companies' estimates of the second and the third terms on the grounds that all of the companies in a given industry are exposed to similar input price pressures and all of the companies in an industry should benefit from the same underlying, sector-wide rate of technical progress. It is this natural drift in costs that regulators label 'frontier shift' in their periodic review consultation papers, i.e.:

Frontier shift ≈ industry input price inflation *minus* natural long-term rate of productivity improvement (2)

Regulators almost always ask companies to present projections of cost in constant prices. At one level, this simply means that it is necessary to deduct forecast RPI-measured inflation from equation 2, i.e.:

Frontier shift in real terms ≈ input price inflation *minus* productivity improvement *minus* forecast RPI-measured inflation (3)

Provided that forecasts of RPI are easy to obtain, the convention of presenting cost forecasts in real terms raises no real practical issues and is unlikely to be controversial. The fact that RPI – X regulation creates a link between prices and out-turn inflation does, however, suggest an alternative way of looking at frontier shift estimates. This is because the rate of growth in RPI is inextricably linked to the rate at which businesses in general are improving productivity and holding down input prices.

The relationship, often quoted by regulators, is as follows:

RPI-measured inflation ≈ average input inflation *minus* average productivity improvement (4)

Box 1

The logic underpinning equation 4 is surprisingly straightforward. If input prices in a particular industry rise, the increase in costs will be reflected in the prices that firms within that industry charge for their products. Similarly, if those firms are able to improve productivity (i.e. they are able to produce more output for a given level of inputs, or they are able to produce the same output using a lower quantity of inputs), unit costs will fall and feed into lower prices for customers as a result of competition between firms. Since RPI is simply an aggregate index that measures changes in prices among a representative basket of goods and services, it follows that the annual change in RPI will represent the average pace of input price inflation less the average rate of improvement in productivity among those firms whose goods and services are in the RPI basket.

This relationship is important because it means that the annual rate of growth in RPI can be thought of as a benchmark. If, for example, firms outside the utility sector start to improve productivity more quickly than in the past, the rate of growth in RPI will fall and a regulated company will automatically be forced to match these improvements in productivity in order to hold their own costs in line with RPI-measured inflation. Conversely, if productivity growth starts to decline in other sectors, the rate of growth in RPI will increase and a regulated business can get away with making less demanding productivity improvements of its own while still holding costs constant in real terms. Similar relationships hold true for changes in input prices.

In this context, a real terms efficiency target represents the extent to which a regulator or company expects to see out-performance relative to the rate at which other firms supplying UK households with goods and services are able to improve productivity growth and constrain increases in input prices. Importantly, it is not a measure of absolute improvement in productivity – it is entirely conceivable, for example, that a firm could deliver improvements in productivity and still see its costs rise in real terms (because other industries are seeing more benign input prices or faster improvements in productivity).

This insight provides an alternative way of defining frontier shift:

Frontier shift in real terms	≈	relative input price inflation minus productivity out-performance	(5)

Importantly, equation 5 in no way contradicts the first definition of frontier shift that we gave in equation 3;[6] rather, it provides a different way to estimate the figure that companies should be incorporating into business plans.

A1.2 Frontier shift analysis prior to 2007

Past work on frontier shift in network industries can be categorised into reports that build from equation 3 and studies that make use of equation 5. Prior to 2007 regulators as a rule used equation 5; specifically, they would ask consultants to estimate the rate at which the industry they regulate could out-perform UK-wide productivity growth and would translate the findings of those studies directly into a real terms frontier shift target.

As an example of this approach, the RPI – 1.5% per annum frontier shift assumption that we have for Ofgem's reviews in the first line of table 1 on p.3 comes from work carried out for

[a] This can be seen by substituting equation 3 into equation 4 and rearranging terms.

Ofgem by CEPA in 2004.[7] The consultant's report begins with the observation that productivity growth in the UK economy as a whole is typically 1.3% per annum. CEPA then goes on to identify a range of reasons why regulated electricity networks could be expected to improve productivity growth by more than this amount over the period 2005 to 2010, eventually concluding that out-performance will be in the range 0.7% to 3.7% per annum. The 1.5% is a point estimate that Ofgem selected from within this range.

A1.3 First Economics' critique

Between 2005 and 2008 we repeatedly expressed concerns about this sort of analysis. Our critique had two parts to it. On the analysis of productivity growth, our main issue was that the average that was being used to calculate out-performance is not the average that is embedded in RPI-measured inflation. Because RPI is built from the goods and services that are purchased by a representative UK household, the average against which regulated companies should be compared should actually be thought of as the average productivity growth achieved by the firms that supply the products in the RPI basket. Unfortunately, this was not the average that regulators were asking their consultants to calculate – they instead took as their benchmark to be the average productivity growth achieved by firms based in the UK.

There are a number of reasons why this is a non-trivial error, most critically:

- the UK economy has a service-sector bias. As a nation, we are a net importer of goods and a net exporter of services. This means that a UK-economy benchmark and the RPI basket have a fundamentally different composition; and
- specifically, it is widely acknowledged that the rate of productivity growth in the service sector lags behind the rate of productivity growth in the goods sector. It follows from the previous bullet that the annual change in productivity across the basket of goods and services that UK households purchase exceeds the annual rate of productivity improvement achieved by the UK as a nation.

A simple example helps to illustrate this point. Among the goods and services that UK households buy, purchases of electrical appliances and audio-visual equipment constitute approximately 2% of annual household expenditure. The UK is a net importer of these goods – most electronics firms have set up factories overseas for the bulk of their production – and it so happens that the rate of productivity growth in these industries is probably faster than in any other major industry. As a consequence, prices have been falling by on average 8% a year since 1998 – a phenomenon that makes a very important contribution to holding down the UK's inflation rate. Despite this, the productivity achievements of electronics firms are omitted almost completely from UK 'average' (i.e. the benchmark rate of productivity growth that appeared in regulators' out-performance analysis).

There is a whole range of firms represented in the RPI basket who manufacture their goods overseas like the manufacturers of electrical appliances and audio-visual equipment. Many of these firms also benefit from rapid technical progress, helping to deliver strong year-on-year productivity growth and stable or falling prices. By omitting the full contribution that these sectors make to RPI-measured inflation, regulators were under-stating the 'average' that network businesses ought to be compared to and over-stating the likely extent of the these firms' out-performance.

Our concerns about the analysis of input price inflation were slightly different in that we typically found little reference in regulators' studies to the possibility that input price pressures affecting regulated companies might be different from the average level of input price inflation built into RPI-measured inflation. Some like Ofgem, having made use of equation 5 in its productivity analysis, were completely silent on input price inflation and

[7] CEPA (2003), Productivity Improvements in Distribution Network Operators – Final Report.

effectively assumed by default that regulated companies' input price inflation matches the average level of input price inflation seen by the firms who supply the goods and services in the RPI basket. Others like Ofwat gave input price inflation no more than a cursory glance and would make relatively small adjustments to allow for the fact that network business opex is relatively labour intensive and that wages tend to increase more quickly than other input costs.

Whether this was a conscious decision or not, these assumptions are extremely difficult to justify. To the extent that most of the goods purchased by UK households are manufactured overseas, the average level of input price inflation embedded in the RPI basket is affected quite considerably by the very benign wage conditions enjoyed by firms that locate in less developed countries. To expect regulated companies with a UK-based workforce to see the same input price inflation as the average firm supplying goods and services to UK households hardly seems credible.

Taking the two points together, we did not think that regulators' decision documents provided any real evidence to back the assertion that the regulated industries' opex frontiers would shift (significantly) more slowly than RPI-measured inflation. Indeed, we thought we could say with some confidence that regulators had been overstating the downward drift in costs as a consequence of the over-statement of productivity growth and the apparent non-inclusion of any allowance for above-average input price inflation.

A1.4 The regulators' response

Regulators' response to this critique was broadly one of agreement. As a consequence, there hasn't been a frontier shift study since 2007 that makes use of equation 5. Regulators have instead commissioned consultants to look at frontier shift through the component parts identified in equation 3.

Annex 2: Summaries of Recent Decisions

A2.1 Ofgem

Ofgem's electricity distribution price control decision[8] was published in December 2009. It provides for opex frontier shift of RPI + 0.4% per annum averaged over the six years from 2009/10 to 2014/15, calculated as:

- average annual input price inflation of RPI + 1.4%;
- less ongoing productivity improvement of 1% per annum.

The real input price inflation assumptions in Ofgem's calculations are set out in table A1. Ofgem disaggregated costs into three principal categories plus an 'other' category which was assumed to track forecast RPI-measured inflation. It produced annual inflation forecasts for each input type based on historical trends and forecasts for future GDP growth, finding that:

- average earnings growth would revert to its long-term trend of RPI + 1.4% or 4.1% per annum within three years;
- allowance should be made for a premium of 0.7% per annum for specialist wage inflation; and
- materials inflation would run ahead of RPI throughout the period.

Table A1: Ofgem's assumptions about annual input price inflation relative to RPI-measured inflation (%)

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
General labour	1.9	1.6	1.5	1.4	1.4	1.4
Specialist labour	2.6	2.3	2.2	2.1	2.1	2.1
Materials	0.9	0.6	0.6	0.6	0.6	0.6
Other	0.0	0.0	0.0	0.0	0.0	0.0
Overall	1.8	1.5	1.4	1.3	1.3	1.3

Ofgem's analysis of productivity growth was less detailed. Its final decision document reports that an assumption of 1% per annum ongoing productivity growth is consistent with:

- calculations produced by First Economics in reports prepared for the electricity network companies; and
- Ofgem's earlier reading of historical rates of productivity growth among comparator industries in the EU KLEMS data set.

The data that Ofgem had extracted from the EU KLEMS database is reproduced in table A2. Ofgem at no point found it necessary to focus in on specific entries within the table, but was instead content to take 1% as an overall benchmark from the seven sectors examined.

[8] Ofgem (2009), Electricity Distribution Price Control Review – Final Proposals.

Table A2: Annualised productivity growth adjusted for constant capital (1970-2005)

	Labour and intermediate inputs productivity growth, gross output measure
Construction	0.3%
Financial intermediation	(0.5%)
Manufacture of chemicals, chemical products and man-made fibres	1.4%
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	0.7%
Transport and storage	1.2%
Manufacture of electrical and optical equipment	1.6%
Manufacture of transport equipment	1.0%

A2.2 ORR

ORR's approach to the estimation of frontier shift in its 2008 review of Network Rail[9] shares a good number of similarities with Ofgem's work last year. ORR's assumptions are summarised in table A3.

Table A3: Summary of ORR's annual opex and maintenance frontier shift analysis (%)

	2009/10	2010/11	2011/12	2012/13	2013/14
Opex					
Input price inflation	RPI + 2.3	RPI + 2.3	RPI + 1.1	RPI + 1.1	RPI + 1.1
Productivity growth	(0.7)	(0.7)	(0.7)	(0.7)	(0.7)
Frontier shift	RPI + 1.6	RPI + 1.6	RPI + 0.4	RPI + 0.4	RPI + 0.4
Maintenance					
Input price inflation	RPI + 2.0	RPI + 2.1	RPI + 1.3	RPI + 0.5	RPI + 0.5
Productivity growth	(1.4)	(1.4)	(1.4)	(1.4)	(1.4)
Frontier shift	RPI + 0.6	RPI + 0.7	RPI – 0.1	RPI – 0.9	RPI – 0.9

The input price inflation estimates were based on detailed forecasts produced for Network Rail by the consultants L.E.K.. The report is the most detailed that we have seen to date in that it breaks opex and maintenance costs into 15 different categories and puts forward annual inflation forecasts for each input type for the period 2009/10 to 2013/14. A summary of the L.E.K. numbers is given in table A4.

[9] ORR (2008), Periodic Review 2008 – Determination of Network Rail's Outputs and Funding for 2009-14.

Table A4: ORR's assumptions about input price inflation relative to RPI-measured inflation (%)

	Annual average, 2009/10 to 2013/14
Labour – civil engineers	2.0
Labour – planners and project managers	2.9
Labour – skilled trades	1.9
Labour – rail operatives	2.2
Labour – operatives	2.0
Labour – signallers	1.5
Labour – drivers	1.8
Materials – steel	(0.0)
Materials – concrete	1.4
Materials – ballast	(1.5)
Materials – fuel	0.0
Materials – general construction	(0.5)
Plant and equipment	(1.1)
Utilities	0.1
Telecoms	0.9

ORR's productivity analysis came from a report from Oxera, which benchmarked the railway's potential to improve efficiency against historical (1981-2004) rates of productivity improvement across five sectors from within the EU KLEMS data set:

- rental of machinery and equipment and other business activities;
- electricity, gas and water supply;
- financial intermediation;
- transport and storage; and
- post and telecommunications.

Oxera's benchmarking implied that there could be total factor productivity gains of 0.5% per annum in opex and 2.1% per annum in maintenance. Oxera and ORR between them then made three further adjustments not seen in Ofgem's work:

- an uplift to the opex figure to take account of capital-labour substitution and the potential for a partial productivity measure like opex to grow more quickly than total factor productivity;
- a 25% discount to the headline figures to allow for the possibility that some of the historical productivity growth in the comparator sectors was firms catching up to the frontier rather than frontier shift per se; and
- a further reduction to the maintenance figure based on ORR's view that productivity growth assumptions should be applied only to the labour and equipment components of unit costs.

The combination of these adjustments saw Oxera's original 0.5% and 2.1% move to 0.7% and 1.4% respectively.

A2.3 PPP Arbiter

The March 2010 determination[10] by the PPP Arbiter in Tube Lines' periodic review has also made use of separate estimates of input price inflation and productivity growth. The Arbiter's detailed calculations are not yet in the public domain, but our analysis suggest that the calculations were broadly as follows:

Table A5: The PPP Arbiter's calculations of frontier shift (%)

	Annual average, July 2010 to December 2017
Central costs	
Input price inflation	RPI + 1.5
Productivity growth	(0.7)
Frontier shift	RPI + 0.8
Opex/maintenance	
Input price inflation	RPI + 1.2
Productivity growth	(0.9)
Frontier shift	RPI + 0.3

The Arbiter's input price inflation forecasts were taken from an expert report prepared for him by CEPA. The consultants have a total of six input types in their analysis, each of which they forecast annually through to 2017. A summary of CEPA's projections is set out in table A6.

Table A6: Input price inflation relative to RPIX-measured inflation (%)

	Annual average, July 2010 to December 2017
Labour – general	1.3
Labour – specialist	1.9
Materials – iron and steel	(0.3)
Materials – general	0.9
Rent and rates	3.0
Other	0.0

The productivity growth assumptions also come from an expert report written by CEPA. CEPA's benchmarks are the historical rates of total factor productivity growth achieved by three sectors over the period 1997 to 2005, namely:

- rental of machinery and equipment and other business activities;
- electricity, gas and water supply; and
- transport and storage.

CEPA's reading of the EU KLEMS data is that there could be total factor productivity gains of 0.7% per annum in central costs and 0.85% per annum in opex/maintenance. Following ORR's lead, CEPA advises that these figures should be applied to the labour and equipment

[10] The PPP Arbiter (2010), Reference for Guidance and Directions from London Underground Ltd in respect of the Periodic Review of Tube Lines' PPP Agreement: Directions on Costs and Related Matters.

components of costs only. CEPA also performs a cross-check to the productivity assumptions applied by other regulators in recent reviews. The consultants ultimately conclude that the Arbiter should allow for productivity-related reductions in costs of 0.7% and 0.9% per annum respectively in his projections of central costs and opex.

A2.4 Ofwat

Ofwat's approach in the 2009 review of water and sewerage charges[11] differs markedly from the approach outlined in the three preceding case studies.

Rather than analyse input price inflation and frontier productivity growth explicitly, Ofwat collapsed its conclusions about frontier shift into a single, headline RPI – 0.25% per annum 'continuing efficiency' assumption. As we note in section 3, the analysis that led Ofwat to this figure has not been shared with companies.

Ofwat does make reference to the results of a study it commissioned from the consultants Reckon which sought to measure cost trends in other sectors of the UK economy. Reckon's report shares some similarities with the analysis described in the preceding sections in that it uses EU KLEMS data to measure past productivity growth but it is unique in using only historical information on input price inflation rather than forward-looking forecasts. The result is that Reckon's work is best described as a strictly historical account of cost trends in comparator industries.

[11] Ofwat (2009), Future Water and Sewerage Charges 2010-15: Final Determinations.

Annex 3: Full List of Sectors in the EU KLEMS Dataset

- Agriculture, hunting, forestry and fishing
- Mining and quarrying
- Manufacturing
  - Food, beverages and tobacco
  - Textiles, textile, leather and footwear
  - Wood and of wood and cork
  - Pulp, paper, printing and publishing
  - Chemical, rubber, plastics and fuel
    - Coke, refined petroleum and nuclear fuel
    - Chemicals and chemical
  - Other non-metallic mineral
  - Basic metals and fabricated metal
  - Machinery not elsewhere classified
  - Electrical and optical equipment
  - Transport equipment
  - Manufacturing not elsewhere classified, recycling
- Electricity, gas and water supply
- Construction
- Wholesale and retail trade
  - Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel
  - Wholesale trade and commission trade, except of motor vehicles and motorcycles
  - Retail trade, except of motor vehicles and motorcycles; repair of household goods
- Hotels and restaurants
- Transport and storage and communications
  - Transport and storage
  - Post and telecommunications
- Finance, insurance, real estate and business services
  - Financial intermediation
  - Real estate, renting and business activities
    - Real estate activities
    - Renting of machinery and equipment and other business activities
- Community, social and personal services
  - Public administration and defence; compulsory social security
  - Education
  - Health and social work
  - Other community, social and personal services

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