# Frontier Productivity Growth

## A report prepared for the Energy Networks Association

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## Executive Summary

- This report by First Economics considers the rate of frontier productivity growth that gas distribution networks ought to be factoring into cost projections for the RIIO-2 price control period.

- Estimates of frontier shift are typically obtained by referring to historical rates of productivity growth in industries with similar characteristics. Table A summarises the relevant data.

**Table A: Average annual total factor productivity growth by sector**

| UK Sector | TFP (gross output) | | TFP (value added) | |
|---|---|---|---|---|
| | 1970 to 2007 | 1990 to 2007 | 1970 to 2007 | 1990 to 2007 |
| Construction | 0.3% | 0.2% | 0.7% | 0.6% |
| Manufacturing | 0.6% | 0.7% | 1.8% | 1.9% |
| Machinery | 0.5% | 0.9% | 1.2% | 2.3% |
| Chemicals and chemical products | 1.3% | 1.3% | 3.8% | 3.7% |
| Electrical and optical equipment | 1.5% | 1.8% | 4.1% | 4.8% |
| Transport and storage | 1.0% | 0.7% | 2.1% | 1.7% |
| Electricity, gas and water supply | 0.7% | 0.3% | 2.2% | 0.9% |
| Sale, maintenance and repair of motor vehicles; retail supply of fuel | 1.0% | 1.4% | 2.0% | 2.6% |
| Finance, insurance, real estate and business services | (0.5%) | 0.1% | (0.9%) | 0.2% |

- In its RIIO-GD1 review, Ofgem interpreted the evidence in table A to mean that a frontier gas distribution network would be able to reduce its opex by 1.0% per annum and its repex and capex by 0.7% per annum. Table B shows that this tallies very closely to views expressed by the Competition Commission (CC) and the Competition & Markets Authority (CMA) in recent regulatory decisions, as well as estimates made by other economic regulators.

**Table A: Assumptions made by regulators about rates of annual frontier productivity growth**

| | Opex | Capex |
|---|---|---|
| Ofgem, RIIO-GD1/T1, 2012 | 1.0% | 0.7% |
| CC, Northern Ireland Electricity, 2014 | 1.0% | 1.0% |
| Ofgem, RIIO-ED1, 2014 | 1.0% | 0.7% to 1.0% |
| Utility Regulator, NI Water, 2014 | 0.9% | 0.6% |
| CMA, Bristol Water, 2015 | 1.0% | - |
| Utility Regulator, GD17, 2016 | 1.0% | 1.0% |
| Ofwat, PR19, 2019 (current consultation range) | 0.6% to 1.2% | |

- One noteworthy feature of the figures in tables A and B is that they capture rates of productivity up to 2007. Since the global financial crisis, it is evident that there has been a marked slowdown in productivity growth across many industries. Where previously, it might have been natural and obvious that companies should roll forward the kind of figures shown in table B, a key question for Ofgem's RIIO-2 reviews will be how far this slowdown should be reflected in forward-looking productivity growth estimates.

- The reasons for stalled productivity, not just in the UK but also in many other western economies, are not well understood. Possible explanations include:

  - low business investment since the financial crisis, as firms have chosen to deleverage and horde cash rather than invest in new productive capital;

  - the adverse effect that ultra-loose monetary policy might have had on creative destruction within the economy (i.e. the processes by which unproductive firms go out of business and are replaced by more efficient rivals);

  - increasing concentration within many industries, leading to a weakening of competitive pressures on firms; and

  - a fundamental slowing of the rate of human technological progress.

- Several of these factors may be temporary, but others could have longer-lasting implications for productivity growth. The feeling that there may have been a "paradigm shift" has prompted the Bank of England and the OBR, among others, to significantly reduce their short-term forecasts of productivity growth. The Bank of England's February 2019 forecasts for total factor productivity growth are reproduced as table C.

**Table C: Bank of England estimates of annual total factor productivity growth**

| | 1998-07 | 2008-10 | 2011-14 | 2015-18Q3 | 2018Q4-22Q1 |
|---|---|---|---|---|---|
| TFP growth | 1.0% | -0.6% | -0.1% | 0.2% | 0.3% |

- Gas distribution networks are not immune from the productivity trends affecting the wider economy, not least because they rely heavily on supply chain alliances and contractors. Recent empirical evidence suggests that productivity might have been broadly flat across the network industries in the last ten years. Table D summarises the electricity distribution networks' experiences (as the sector in which data availability allows for the clearest pre- and post-crisis comparisons).

**Table D: Electricity DNOs' average annual total factor productivity growth**

| | DPC1/2 | DPCR3 | DPCR4 | DPCR5 | RIIO-ED1 |
|---|---|---|---|---|---|
| TFP growth | 3.3% | 4.0% | 3.2% | -1.2% | 0.4% |

- The 'productivity puzzle' makes it difficult to know how much new productivity improvement companies should be anticipating in their RIIO-2 plans. Prima facie, the evidence in this paper suggests that it would be a considerable leap of faith for a company to factor pre-2007 frontier productivity improvement (as reflected in tables A and B) into future cost projections. In the circumstances, we would therefore not consider it unreasonable if networks were to follow the Bank of England's and the

OBR's lead and choose to aim down from Ofgem's RIIO-GD1 assumptions during part or all of the RIIO-2 period.

## 1. Introduction

One of the key inputs that will need to feed into RIIO-2 business plan is an estimate of the rate at which companies will be able to improve cost efficiency. This report gives an independent perspective on the gas distribution networks' underlying productivity growth potential. It draws on evidence from both inside and outside the sector and seeks, in particular, to position the task of setting of future efficiency targets within the broader context of economy-wide productivity trends.

The paper is structured into five main parts, as follows:

- section 2 explains what we mean by productivity growth;
- section 3 sets out the ways in which regulators and regulated companies have arrived at frontier productivity growth assumptions in recent periodic reviews;
- section 4 tries to update this picture by looking at recent evidence on UK economy productivity growth;
- section 5 considers the specific circumstances of the gas distribution networks; and
- section 6 concludes.

## 2. Frontier Productivity Growth

When putting together a set of future cost projections, a company will typically begin with its actual current expenditure. From this starting point it will make allowance for:

- the steps that the business can take to eliminate current, company-specific inefficiencies;
- the rate at which even efficient businesses ought to be able to improve productivity over time;
- the expected input price inflation in the sector; and
- the cost of delivering new or better outcomes.

This report is concerned with the second of these factors. It looks at the change that one might expect there to be in a frontier company's totex absent any changes in input prices and outwith any adjustments to the outcomes that the company delivers to customers.

This concept of 'productivity' is fundamentally about the quantity of inputs that a company uses. In the course of its activities a network business will combine capital, labour, energy and material inputs into products and services that it sells to customers. We can say that there is productivity growth when a firm finds ways of delivering the same output using a lower quantity of inputs. Conversely, we can say that there is a decline in productivity if a firm increases the quantity of capital, labour, energy and/or materials that it uses without there being any commensurate change in output.

The particular definition of productivity growth that runs through this report is total factor productivity (TFP) – i.e. the ratio of all inputs to all output. Elsewhere in day-to-day life, it is commonplace to encounter references to other productivity measures, like output per worker or output per hour worked. These partial productivity measures can be relevant in other policy analysis (e.g. in exploring the links there might be between labour productivity, real wage growth and improvements in living standards), but for the specific purpose of projecting how a regulated firm's total expenditure might change over time it is important that we should take account of the full set of inputs that firms use when delivering services to customers.

In technical terms, therefore, we are concerned in this report with the evidence that there is about rates of change in TFP, where TFP is the rate of growth in output that is not explained by changes in the quantity of a firm's inputs, i.e.:

$$\Delta TFP = \Delta Y - \alpha_1 . \Delta K - \alpha_2 . \Delta L - \alpha_3 . \Delta E - \alpha_4 . \Delta M$$

where

$\Delta$ denotes growth
Y is output
K, L, E and M denote capital, labour, energy and intermediate materials inputs respectively
$\alpha_1$, $\alpha_2$, $\alpha_3$ and $\alpha_4$ are weights that reflect the share of the relevant inputs

## 3. Lessons From Previous Regulatory Reviews

This is not the first periodic review in which firms have had to think about the scope that there might be for efficient businesses to go on reducing costs. For at least the last ten years, analysis of the underlying rate of productivity growth has been a key part of price reviews in the water, electricity and gas industries, giving a sizeable body of literature which companies can draw from in their business plans.

Almost all of this work focuses on benchmarking. When faced with the task of pinpointing the rate at which a regulated firm or sector is capable of improving productivity, companies and regulators have felt that it is natural and obvious to look at the rate at which firms and sectors with similar characteristics have been improving their own productivity.[1] The thinking has been that if firms carrying out comparable activities can be observed to have been improving productivity at a rate of x% per annum, it ought to be reasonable to think that leading water companies or electricity networks or gas networks should also able to deliver productivity growth worth the same x% a year in their businesses.

Industries that are thought to give particularly relevant benchmarks, given the nature of the acitvies that network businesses carry out, are:

- industries in which things are being built or equipment is being installed;
- industries where firms are repairing/maintaining existing assets or operating some sort of established asset/network; and
- industries where the core activity is the provision of a business service.

The sectors of the UK economy which map most easily to these broad headings are:

- construction;
- manufacturing;
- machinery and equipment;
- manufacture of chemicals and chemical products;
- transport and storage;
- electricity, gas and water supply;
- sale, maintenance and repair of motor vehicles; retail sale of fuel; and
- professional, scientific, technical, administrative and support service activities.

Individually, none of these sectors is an exact match to an energy network. But a typical gas distribution business undertakes a mix of activities that in combination looks a lot like a mix of the above-mentioned industries. As such, it is not unreasonable to think that there might be some correspondence between the average or composite rate of productivity growth across the comparator industries and the natural, underlying rate of productivity growth for a gas distribution network.

By way of an illustration, table 1 overleaf provides an overview of a mapping that two GDNs suggested in their RIIO-1 business plans.

[1] The other obvious alternative of measuring and extrapolating from the historical rate of productivity improvement achieved either by individual GDNs or by the sector as a whole is problematic for two reasons. First, there was a significant jump in productivity growth immediately after privatisation which is unlikely to be replicable in the future. Second, there may be a circularity in using actual performance to judge underlying *potential* growth, especially in a regulated industry setting.

**Table 1: Gas distribution network activities and comparator industries**

| Activity | % of expenditure | Key comparator industries |
|---|---|---|
| Capex | - | Construction |
| Repex | - | Construction |
| Opex | | |
| Work management | 25% | Transport and storage; Electricity, gas, water supply; Sale, maintenance and repair of vehicles; Professional etc. services |
| Work execution | 50% | Transport and storage; Electricity, gas, water supply; Sale, maintenance and repair of vehicles; Construction |
| Indirect support costs | 25% | Professional etc. services |

*Source*: Northern Gas Networks and Scotia Gas Networks.

The most commonly cited source of raw productivity data is the EU KLEMS project – a collaborative piece of work involving academics from across the EU that has produced growth accounts at industry level for all EU member states from 1970 to the present.[2] There are a number of possible ways of reading the productivity figures in this database, especially as regards the exact statistical measure of productivity that one chooses and the time period that one focuses on, but tables 4 and 5 set out a broadly representative overview of the figures that have fed into recent periodic reviews.

**Table 2: Average annual total factor productivity growth by sector**

| | UK Sector | TFP (gross output) | | TFP (value added) | |
|---|---|---|---|---|---|
| | | 1970 to 2007 | 1990 to 2007 | 1970 to 2007 | 1990 to 2007 |
| A | Construction | 0.3% | 0.2% | 0.7% | 0.6% |
| B | Manufacturing | 0.6% | 0.7% | 1.8% | 1.9% |
| C | Machinery | 0.5% | 0.9% | 1.2% | 2.3% |
| D | Chemicals and chemical products | 1.3% | 1.3% | 3.8% | 3.7% |
| E | Electrical and optical equipment | 1.5% | 1.8% | 4.1% | 4.8% |
| F | Transport and storage | 1.0% | 0.7% | 2.1% | 1.7% |
| G | Electricity, gas and water supply | 0.7% | 0.3% | 2.2% | 0.9% |
| H | Sale, maintenance and repair of motor vehicles; retail supply of fuel | 1.0% | 1.4% | 2.0% | 2.6% |
| I | Finance, insurance, real estate and business services | (0.5%) | 0.1% | (0.9%) | 0.2% |

*Note*: the period 1970 to 2007 captures data from the start date in the database up to the onset of the global financial crisis and ensuing recession. The shorter 1990 to 2007 period has sometimes been a preferred alternative that captures more up-to-date rates of productivity growth across the most recent full business cycle only.
*Source*: EU KLEMS dataset.

[2] See http://www.euklems.net for more information.

There has to date been no obvious consensus among regulators and companies, or across sectors, on how precisely one should extract a benchmark rate of productivity growth for a network business from the above database. Some studies have extrapolated from the full 1970 to 2007 period, while others have preferred to focus on more recent experience. Some have used the gross output TFP figures, while others have said that it is better to take the value added TFP numbers and apply them to value added created in the network industries. In some reviews, regulators have tried to weight the different sectors, while in other reviews regulators have been happy to take a simple average.

Ofgem, for its part, said in the RIIO-GD1 review that its takeaway from the EU KLEMS data is that the underlying rate of productivity growth impacting different GDN expenditures is likely to be as follows:

- opex = 1.0% per annum
- repex = 0.7% per annum; and
- capex = 0.7% per annum.

This assessment was based on Ofgem's overall impression of the data set, rather than a specific methodology for calculating a benchmark. The slightly higher figure for opex, and the slightly lower figures for repex and capex, mainly reflect the historically slower rates of productivity growth in the construction industry – i.e. insofar as the construction sector is by far the most obvious comparator for repex and capex activities, and insofar as productivity growth has been noticeably slower in the construction industry than elsewhere, Ofgem judged that it was reasonable to provide for a slightly slower rate of productivity growth in 2013-21 repex and capex projections.

A cross-check on the reasonableness of Ofgem's 2012 position can be obtained by looking at the rates of frontier shift that regulators have included in periodic review decisions that were issued after Ofgem's RIIO-GD1 determination. Table 3 provides a chronological summary.

**Table 3: Assumptions made by regulators about the rates of annual frontier productivity growth for network industries**

| | **Opex** | **Capex** |
|---|---|---|
| Ofgem, RIIO-GD1/T1, 2012 | 1.0% | 0.7% |
| Competition Commission, Northern Ireland Electricity, 2014 | 1.0% | 1.0% |
| Ofgem, RIIO-ED1, 2014 [A] | 1.0% | 0.7% to 1.0% |
| Utility Regulator, NI Water, 2014 | 0.9% | 0.6% |
| CMA, Bristol Water, 2015 | 1.0% | - |
| Utility Regulator, GD17, 2016 | 1.0% | 1.0% |
| Ofwat, PR19, 2019 (current consultation range) | 0.6% to 1.2% | |

*Note*: [A] Ofgem's RIIO-ED1 determinations allowed for the frontier productivity growth that individual companies had factored into their business plans.
*Sources*: references for the reviews listed in the table are given in appendix 1.

The table shows that there has been a noticeable clustering of views around broadly the figures that Ofgem identified seven years ago. Estimates of annual productivity growth impacting companies' operational activities have invariably sat at or very close to 1%, while estimates of productivity growth potential in companies' capital programmes have sometimes been slightly below 1%.

Given that there is no single ‘right’ way of drawing a benchmark rate of productivity growth from the data, we do not consider it appropriate for us to disturb Ofgem’s previous RIIO-GD1 conclusions about long-term historical trends in this study. We therefore consider that the 1% per annum rule of thumb for opex productivity growth and a slightly lower 0.7% per annum trajectory for repex and capex are reasonable historical benchmarks for companies to initially reference in their forward-looking assessments of future frontier shift. We consider more recent evidence separately in the next section of the paper.

## 4. The Recent UK Productivity Puzzle

One stand-out feature of the benchmarking in section 3, and, by implication of the regulatory judgements about the scope for productivity growth that we have highlighted in table 1, is the way in which estimates of the productivity growth that regulated sectors ought to be capable of achieving in the future have been informed primarily by pre-2008 experience.[3]

Writing this report at the start 2019, this feels like an increasingly dated set of figures. The last decade has been a turbulent period for the UK economy, and it would be reasonable to think that there has been a degree of structural change since the onset of the global financial crisis. This is particularly the case when it comes to productivity in that one of the most talked about economic issues of the day has been the failure of the UK and other western economies to revert to pre-crisis levels of productivity growth since recovering from recession. This comes through quite clearly in the Bank of England's most recent set of TFP figures, which are reproduced in table 4.

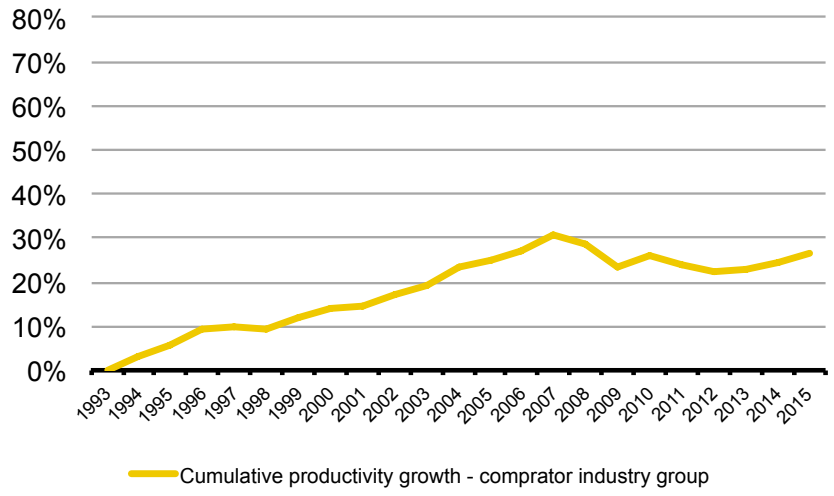
**Table 4: Average annual total factor productivity growth**

| | 1998-07 | 2008-10 | 2011-14 | 2015-18Q3 |
|---|---|---|---|---|
| TFP growth | 1.0% | -0.6% | -0.1% | 0.2% |

*Source*: Bank of England February 2019 inflation report.

Figure 1 illustrates the importance of this point more clearly by reproducing a recent piece of analysis that looked at productivity growth in the comparator sectors that have previously been used as benchmarks by UK regulators.[4] The chart shows a discernable levelling off of productivity growth after 2008 – i.e. since the start of the global financial crisis and after the cut-off date for the vast majority of the analysis that we reported in section 3.

**Figure 1: Total factor productivity growth in comparator sectors (cumulative)**




*Source*: Frontier Economics.

[3] This is partly a function of the timing of updates to the EU KLEMS database. Figures for 2010 onwards only first became available in 2016.

[4] The full set of comparator industries feeding into this calculation is: construction; manufacture of chemicals and chemical products; manufacture of electrical and optical equipment; manufacture of transport equipment; transport and storage; electricity, gas & water supply; sale, maintenance and repair of motor vehicles and the retail supply of fuel; renting of meachinery and equipment and other business activities; finance, insurance, real estate and business services; financial intermediation; post and telecommunications.

A variety of explanations have been put forward for the "productivity puzzle" that table 4 and figure 1 depict. We provide a brief survey in the box below.

**Box 1: Explanations for the fall in productivity growth**

The following is a synthesis of research and views that have come from the Bank of England, the Office of National Statistics and the Office for Budget Responsibility (OBR) during the last 12 months. References are given in appendix 2.

*Sector-specific effects*

When economists have dug below the whole-economy productivity data, they have found that certain sectors of the economy have contributed disproportionately to lower/flat productivity growth.

A chief culprit is the finance sector. Prior to the financial crisis, the finance sector was one of the engines of UK GDP and productivity growth. Since 2008, the ratio of output to inputs in this industry has fallen markedly. This can be seen to be a function of the underlying credit cycle: in the good times leading up to recession, increased leverage and higher risk taking boosted activity and sector revenues beyond sustainable levels; since the credit bubble burst, activity levels have fallen off and profits have been much harder to come by.

The contraction – which to some extent has been a deliberately policy choice – is estimated to account for as much as two fifths of the UK's recent loss of productivity growth.

*Lower capital investment*

Other sectors which have contributed disproportionately to the slowdown in productivity growth include manufacturing, professional services and ICT. In these sectors, there are not the kind of exceptional circumstances like there are in the finance sector. Instead, attention has been given to lower levels of R&D and capital investment and the effect that capital shallowing might have had on innovation and productivity growth.

Some of the possible reasons for low under-investment are intertwined with factors that we go on to pick out under subsequent headings below. However, one over-arching narrative is that managers might have become more risk averse after living through the financial crisis. This risk aversion appears to have caused firms to prefer to deleverage or accumulate cash reserves rather than invest, especially where new investment entails borrowing or taking on risk.

In the last three years, uncertainties about Brexit may also have had an effect on UK firms' appetites for new investment.

*Market concentration and competition between firms*

Empirical work suggests that there is a noticeable and growing disparity between efficient companies that operate at the frontier of their industries and a long-tail of less efficient, non-frontier companies that fail to keep pace with innovation. Normally one would expect to see a diffusion of technical progress across firms. In recent years, this doesn't appear to have been happening to the same extent as in the past.

This could be because there are increasingly large barriers to competition in modern-day markets, e.g. restrictions on patents and intellectual property. It could also be because certain market are more concentrated, with larger players dominating certain sectors and facing much less in the way of competitive threat from rival firms.

*Loose monetary policy*

Some commentators have argued that there is a link between accommodative interest rate policy and low productivity growth. The contention is that loose monetary policy has primarily benefited low-productivity companies who might otherwise have failed, and that policy actions may therefore have inhibited the processes of "create destruction" that would normally affect industries.

The continued existence of these "zombie firms" may be regarded as a problem in its own right. But there may also have been a multiplier effect if the survival of low-productivity firms has prevented the reallocation of labour and capital to more productive sectors of the economy.

*Slower technological progress*

Some economists believe that the persistence of low productivity growth, not just in the UK but across much of the developed world, is evidence that there has been a slowdown in innate technological progress. This could be because there are inherently diminishing returns from new research and development. Or it could be because the particular revolution that has been impacting on the global economy since the 1990s, centring on the harnessing of IT, is now quite mature, meaning that current and future waves of IT innovations are not having the same effect as past innovations.

While there is no clear consensus on the relative importance of these factors, one clear takeaway from the literature is that low productivity growth is likely be more than a temporary phenomenon. Some of the factors listed in the box above may dissipate over the next 5-7 years, e.g. if central banks are able to normalise monetary policy and when uncertainties around Brexit are resolved. But others may be more pervasive and entrenched, e.g. if competitive forces are weaker than in the past or if there really has been a fundamental slowdown in the rate of technical progress.

The Deputy Governor of the Bank of England expressed the following views in a speech last year:

> … after such a long period of weak productivity growth it is reasonable to argue that we are in a new paradigm of lower productivity growth, and that is reinforced by the global nature of the weakness.

The same view has been coming through clearly in the Bank of England's and OBR's recent economic forecasts, with both organisations downgrading medium-term growth projections and their estimates of the UK economy's natural "speed limit" in response to persistently disappointing productivity data. In November 2017, the OBR said:

> As the remarkable period of post-crisis weakness extends – and as various explanations pointing to a temporary slowdown become less compelling – it seems sensible to place more weight on recent trends as a guide to the next few years.

The Bank of England has taken the same position. Its latest forecasts for TFP growth are reproduced in table 5.

**Table 5: Average annual total factor productivity growth**

| | 1998-07 | 2008-10 | 2011-14 | 2015-18Q3 | 2018Q4-22Q1 |
|---|---|---|---|---|---|
| TFP growth | 1.0% | -0.6% | -0.1% | 0.2% | 0.3% |

*Source*: Bank of England February 2019 inflation report.

The emerging consensus, as exemplified in table 5, appears to be that it is reasonable for the foreseeable future to expect no more than half of the pre-crisis annual productivity to materialise. Elsewhere in the economy, this has been a key underpinning in most macroeconomic forecasts. It is also a position that has obvious relevance in the RIIO-2 reviews, given that pre-2008 data has until now been used as a guide for the future.

## 5. Recent Energy Network Industry Experience

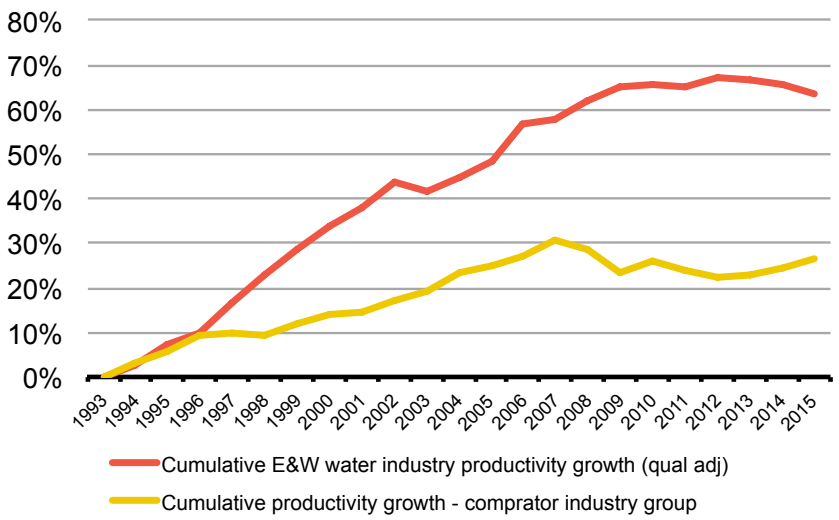
The evidence from the energy networks' recent expenditures is that the slowdown in economy-wide productivity growth has had a discernible impact on network companies' productivity. As one example,[5] table 6 reproduces Ajayi, Anaya and Pollitt's recently published analysis of electricity distribution TFP growth.

**Table 6: Electricity DNOs' average annual total factor productivity growth**

| | DPC1/2 | DPCR3 | DPCR4 | DPCR5 | RIIO-ED1 |
|---|---|---|---|---|---|
| TFP growth | 3.3% | 4.0% | 3.2% | -1.2% | 0.4% |

A similar picture is apparent in the water and sewerage industry. Figure 2 reproduces Professor David Saal's and Frontier Economics' recent analysis of industry productivity over the period 1993 to 2015. The chart shows a discernable levelling off of productivity growth starting shortly after productivity growth started to fall in comparator sectors of the economy.

**Figure 2: Total factor productivity growth (cumulative)**




*Source*: Frontier Economics.

A first reaction to the chart might be that it is surprising that productivity growth in regulated industries should have followed such a similar path to economy-wide productivity growth. Looking back at the factors that we catalogued in section 4, it is hard to see how or why several of the entries in box 1 should have made any difference to a regulated network company. The story about market concentration, for instance, is of no direct relevance to businesses that are mostly natural monopolies. Similarly, it is not the case that regulated networks firms have stopped investing and it would be difficult to explain why low interest rates should have created "zombie firms" or made any differences to behaviours in this particular sector.

There are, however, two possible explanations for the figures in table 6 and figure 2.

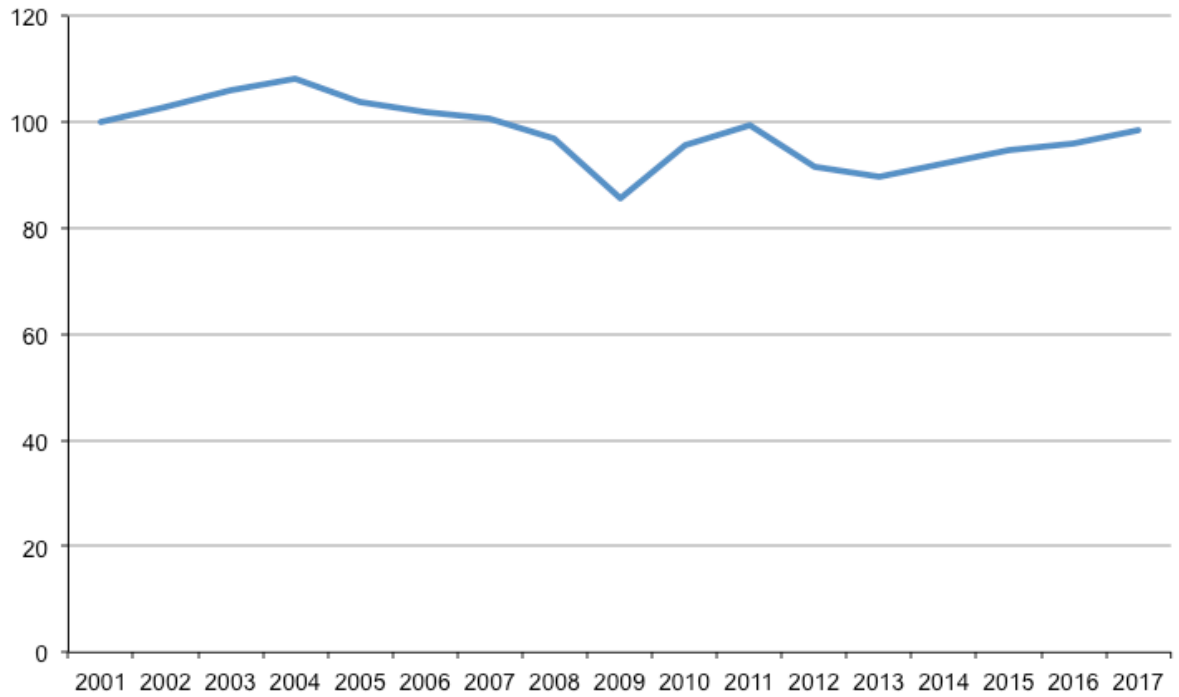
[5] Best practice in periodic reviews involves assessing the potential for productivity growth in a sector with reference to external benchmarks. The electricity DNOs are the only sector for which there is a full set of pre- and post-crisis data.

First, the researchers who put together the productivity numbers for the electricity, gas and water sectors explicitly acknowledge that they may not have fully captured recent improvements in outcomes. The measure of quality that they used is weighted towards traditional outcome metrics like customer minutes lost and drinking water quality and may not fully take account of the switch in focus that there has been in recent years towards improvements in customer satisfaction and resilience.

A second explanation, which is potentially more relevant to this report, is that regulated companies themselves may not have been particularly affected by the factors identified in section 4, yet the same factors have been very directly relevant to the companies operating in their supply chains. A modern-day network business will typically out-source the vast majority of its capital expenditure and maybe around one third of its operating expenditure (NB: Cadent tells us that its ratio of out-of-house to in-house totex is around [70:30]). If increasing market concentration, lower R&D and capital investment, a slowdown in the rate of creative destruction, etc. have weighed at all on the contractor market, the resulting slowdown in productivity growth will ultimately also have fed into a slowdown in overall electricity, gas and water industry productivity growth.

Figure 3 gives some credence to this view by picking out productivity growth in the construction sector only, as one of the places to which network industry out-sourcing is most prevalent. The chart shows flat productivity since before 2008 and a failure (to date) to recover to pre-recession productivity levels since the end of the financial crisis.

**Figure 3: Construction industry total factor productivity**




*Source*: ONS.

The scale of the gas distribution businesses' links to other firms and other sector means that it would be wrong to assume that the networks are at one step removed from or otherwise insulated from the slowdown in economy-wide productivity growth. While it would also be wrong to place too much emphasis on the precise numbers in table 6 and figure 1 (due to the measurement issues alluded to above), the overall trend in the empirical data is consistent with a hypothesis that some, albeit maybe not all, of the factors that have been weighing on UK productivity growth are also currently impacting on network industry costs.

## 6. Conclusion

The material laid out in this paper hands a dilemma to companies as they prepare their RIIO-2 business plans (and later to Ofgem when it assesses the reasonableness of those plans). Where previously it would have been natural and obvious for a company to factor ~1% per annum frontier opex productivity growth into future cost projections, and perhaps a slightly lower figure for repex and capex productivity growth, the headwinds that we have identified in sections 4 and 5 now give considerable pause for thought.

Usually we would recommend that a company should continue the practice of benchmarking to observed rates of productivity improvements in comparator sectors of the UK. However, this is problematic at this point in time for two reasons. First, there isn't a sufficiently long run of data in the EU KLEMS database or elsewhere with which to make a statistically robust extrapolation of current productivity growth rates (NB: each annual EU KLEMS estimate come with a considerable margin of error, while best practice involves taking a reading over a minimum of one full business cycle). Second, and more importantly, there can be genuine uncertainty about how much the factors that have pushed down productivity growth in other sectors might have shaved off of the energy networks' productivity growth potential and how long those factors will persist for.

In the face of this uncertainty, it is difficult to give definite conclusions about the productivity growth that companies should be factoring into future cost projections.

- One option would be to proceed anyway to factor the RIIO-GD1 1%, 0.7% and 0.7% per annum productivity growth rates for opex, repex and capex respectively into 2019/20 to 2025/26 cost projections as established and well-evidenced benchmarks for network industry frontier shift, but in doing so recognise that these are likely to be significantly more challenging cost reduction targets than might have appeared to be the case a few years ago.

- The alternative is to follow the Bank of England's and the OBR's lead and overlay a judgment that it is not going to be possible to replicate pre-crisis productivity achievements in the short-to-medium term. This would entail reducing the annual rate of frontier productivity growth feeding into plans. We do not have a precise way of calculating what replacement figures might be, but we do not think it would be unreasonable, given the evidence set out in this paper, to allow for as much as a halving of potential productivity growth during part or all of the RIIO-2 period.

Each of the gas distribution networks will need to make their own assessments of possible overall trajectories in the coming months – allocated appropriately between opex, repex and capex – informed by both the analysis in this paper and their own experience with alliances and other supply chain partners.

**Appendix 1: References from Other Price Reviews**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**Appendix 2: References for further reading on the UK productivity puzzle**


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Bank of England (2018), The fall in productivity growth: causes and implication – speech by Silvana Tenreyro, External MPC member

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## Appendix 3: Regulatory application of continuing efficiency assumptions

The terms of reference for this study asked us to look at some of the issues that the GDNs have previously raised about Ofgem's use of external productivity benchmarks. Our views are as follows.

*Do productivity benchmarks from other industries contain a mix of catch-up efficiencies and frontier shift?*

One of the arguments that companies made during Ofgem's RIIO-1 review was that there was a 'double count' arising from Ofgem's use of external productivity benchmarks and its setting of upper quartile GB expenditure allowances. The suggestion was that productivity growth in comparator industries has been driven in part by laggard companies in a sector catching up with leading companies and only in part by the leading companies continuing to improve efficiency. Insofar as Ofgem makes a separate, stand-alone allowance for the first of these things in its totex allowances, some companies considered that Ofgem ought to have added only a fraction of 'total' productivity growth on to its company-specific catch-up efficiencies.

We have previously said in published reports that we do not agree with this proposition. We agree that over a short time period, recorded productivity growth in an industry may include catch-up efficiencies. However, over the kinds of timescales shown in table 2 in the main body of the paper – i.e. up to 37 years – it is difficult to believe that recorded productivity growth in competitive industries is a function of some kind of never-ending catch-up effect.

We do not recall any other company making an argument of this type since 2012. Instead, electricity networks and water companies have been content to factor productivity benchmarks in full into cost projections.

*Implications of volume decline*

One of the GDNs separately argued during the RIIO-GD1 review that future volume decline in the gas industry would adversely impact productivity growth. Moreover, because some of the historical productivity growth in other industries would have arisen as a result of volume growth and economies of scale, the GDN considered that the kinds of numbers shown in table 2 would not be practically attainable by companies during the RIIO-1 period.

In our view, there would be merit in this argument if Ofgem were reading across from experience in other industries to make a forecast of gas network productivity growth, as defined in terms of a pure output-to-input calculation. However, Ofgem is not using productivity growth benchmarks in this way. Strictly speaking, Ofgem is forecasting the rate at which an efficient network would be able to reduce its opex, capex and repex from one year to the next. Volumes do not directly enter the equation.

If the GDNs' RIIO-2 business plans show that companies intend to respond to volume decline by cutting back on activity and expenditures, we would be sympathetic to an argument that there will be a loss of economies of scale. If this is not the case, we do not think it is unreasonable for Ofgem to challenge companies to match the kind of external productivity benchmarks identified in this report.

*Capital substitution*

A final point of contention during the RIIO-GD1 review concerned Ofgem's treatment of capital substitution, specifically its treatment of the opex reductions arising from companies' mains replacement programmes. One GDN argued was that the opex savings were a form of productivity improvement and should count towards Ofgem's overall productivity target.

Ofgem nevertheless chose to apply a full 1% productivity overlay to post-mains-replacement opex forecasts.

The merits in this argument depend on the precise measure of productivity growth that one is drawing from comparator sectors. In this report, we have focused on total factor productivity. It follows that if there is scope for capital substitution, the rate of opex reduction could exceed the benchmark numbers we have identified and the rate of repex and/or capex reduction could fall short of our benchmarks. We would have no objection if companies were to 'reallocate' productivity growth across individual expenditure categories. But this should be subject to a constraint that the overall totex reduction should not be very substantially smaller.