Affinity Water

AFW111 Economic Insight - Frontier shift report

20 August 2024

THE IMPORTANCE OF A BALANCED APPROACH TO FRONTIER SHIFT

Further Evidence for Final Determinations

Economic Insight Ltd

CONTENTS

01

INTRODUCTION AND EXECUTIVE SUMMARY

INTRODUCTION

In their business plans, water companies proposed a frontier shift (ongoing efficiency) challenge on costs of 0.6% pa on average. In doing so, companies primarily relied on two reports by Economic Insight: (i) '*Productivity and frontier shift at PR24*'; and (ii) '*Further evidence on frontier shift at PR24*'.

In its DDs, Ofwat has proposed a materially higher frontier shift challenge of 1.0% pa, which the regulator states is in the middle of the range identified by its consultants, CEPA, (0.8%-1.2% pa). In addition to the CEPA estimates, Ofwat's DD position on frontier shift was informed by a report by Europe Economics (EE): *'Europe Economics' critique of Economic Insight reports on productivity and frontier shift at PR24'*.

In the above context, the challenge for Ofwat at the PR24 Final Determinations is how best to evaluate the range of available evidence and distinguish between materially differing viewpoints, including (in some instances) considering new and quite detailed technical arguments.

OUR FINDINGS

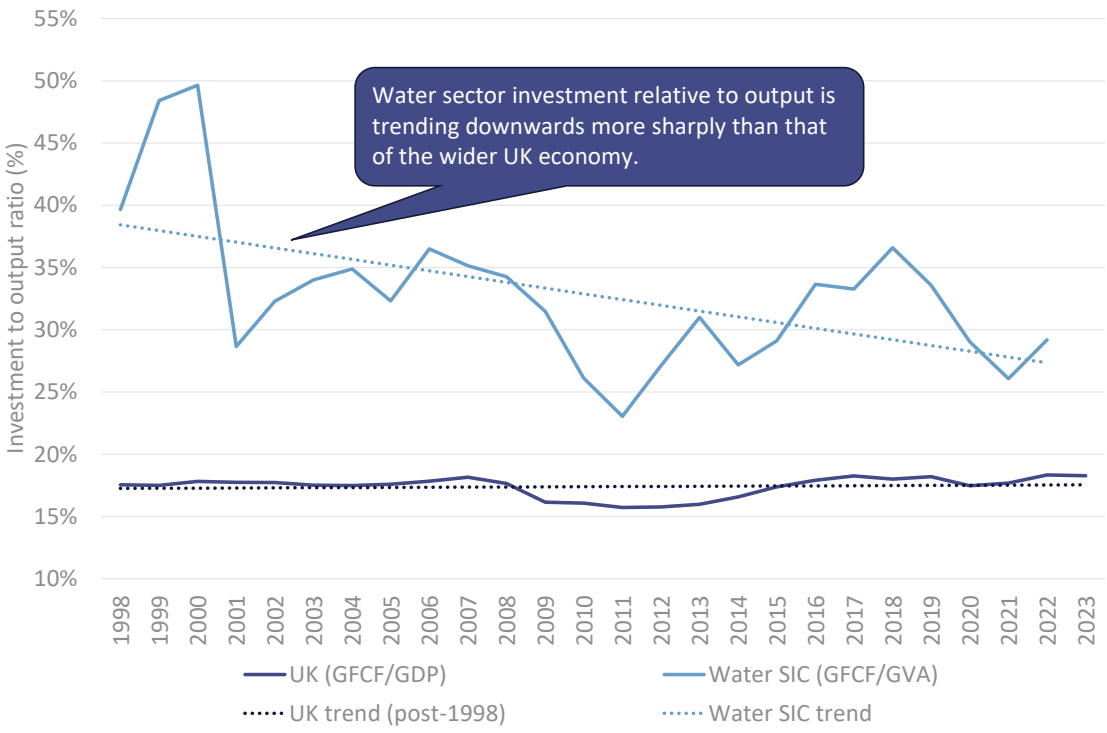
When one focuses on the core intuition, and appraises the evidence in a balanced way, it remains the case that frontier shift for the water industry at PR24 should be set at a substantially lower level than currently proposed by Ofwat (i.e. should be in line with our previous reports). This is becuase: (i) we would expect frontier shift to be higher at times of high productivity, and lower at times of low productivity; (ii) data shows that over PR14 and PR19, the water industry delivered low productivity, in-line with the low and flat productivity performance of the UK; and (iii) the water industry is intrinsically not 'high-tech' and so cannot enjoy the productivity benefits of industries that are.

1 Under a benchmarking approach to determining frontier shift, one would generally expect the challenge to be 'higher' at times of high productivity and 'lower' at times of low productivity.

Under a benchmarking approach to determining frontier shift, if a stable method is applied across consecutive price controls, one would generally expect the challenge to be 'higher' at times of high productivity and 'lower' at times of low productivity. Whilst this pattern might be *mitigated* (or *accentuated*) by the extent to which the water sector was less (or more) exposed to the drivers of wider productivity performance, this pattern should, nonetheless, be observable. It is therefore problematic that the current proposals for PR24 do not reflect this.

Moreover: (i) the main factors causing the UK's productivity slowdown, as identified by leading academic experts in productivity in the UK, are primarily economy-wide; (ii) the causal factor (underinvestment) that Ofwat's regulatory framework *might* (in principle) mitigate to some degree is only one factor of many factors contributing to the UK's slowdown in productivity; and (iii) trends in different investment metrics do not suggest the water industry has, in fact, been particularly protected from underinvestment, relative to the UK overall. In fact, **Figure 1** shows that investment relative to output has been declining more rapidly in the water sector than in the UK overall.

Figure 1: Investment relative to output for the UK overall compared to the water sector (see Chapter 4).



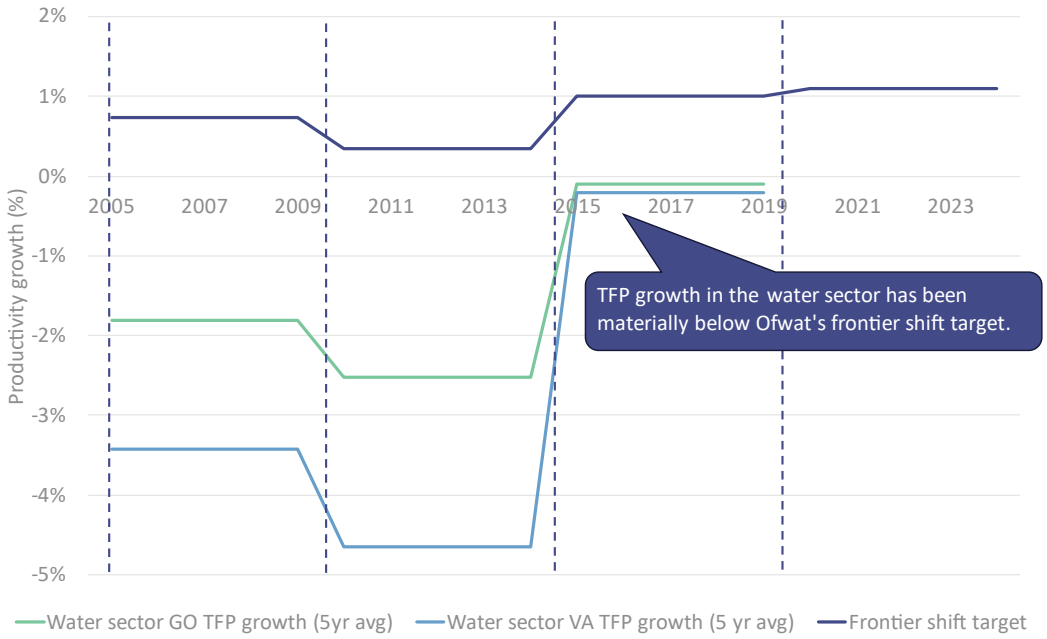
Source: Economic Insight analysis of ONS data and OECD data.

2 Historical data shows that, factually, over PR14 and PR19, the water industry delivered low productivity, in-line with the low and flat productivity performance of the UK.

Historical data shows that, factually, over PR14 and PR19, the water industry delivered low productivity, in-line with the low and flat productivity performance of the UK (and well below the frontier shift challenge Ofwat set at PR14 and PR19). This has three important implications, which we set out below.

Firstly, it would appear consistent with the water industry being affected by the wider UK slowdown (consistent with intuition and the views of independent academic experts). Secondly, it implies the industry has been materially underfunded over the previous two AMPs.[1] Thirdly, it calls into question the validity of speculation that the future productivity of the water industry, or the UK, will be *materially* better than the recent past in the short term (i.e. over AMP8).[2] Whilst we would not advocate setting the frontier shift challenge on a forward-looking basis, based *only* on actual water industry productivity performance, at some point this persistent wedge between regulatory frontier shift targets and observable outturn productivity performance for the sector should motivate a recalibration. Not least to avoid storing up an even larger under-funding problem that will need resolving in the future, with implications for customers.

Figure 2: Water sector productivity growth (%) compared to frontier shift target (see Chapter 3).



Source: Economic Insight analysis of EU KLEMS data and Ofwat's fronter shift targets.

[1] *Where FDs were set with falling real prices, despite: population growth; climate change; and a fixed supply of water on Earth.*

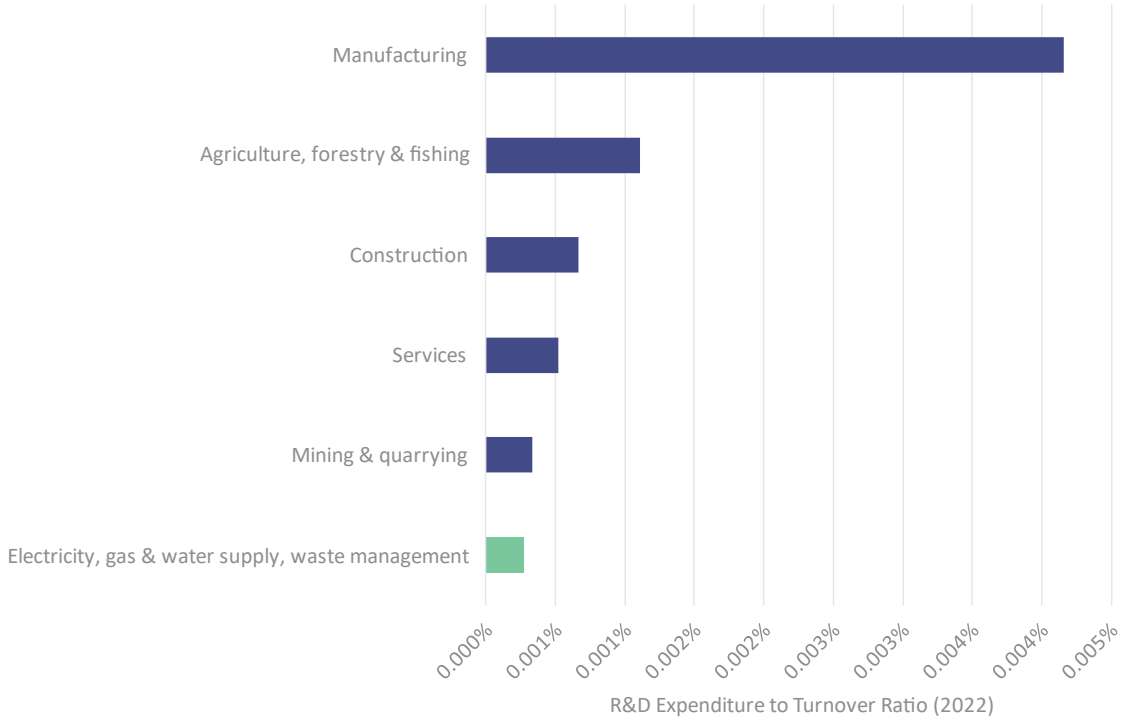
[2] *This improvement may eventually come, but a material divergence between Ofwat's targets and reality has already emerged.*

3 The water industry is intrinsically not a 'high-tech' industry.

Productivity data shows that (as one would expect) productivity performance tends to be greater in more 'high-tech' industries, and lower in more 'low-tech' industries. The water industry, by virtue of having: (i) to provide a homogenous product, the fundamental characteristics of which cannot change, for perpetuity (unlike pharmaceuticals, whereby a continuous cycle of innovation is needed to develop new products); (ii) having a relatively low utilisation of technology (say, compared to semiconductor manufacturing); and (iii) long-lived assets (which means the speed of the introduction of new technology is inherently slower than industries where the opposite is true – all else equal), is inherently *not* a high-tech industry.

Whilst we consider the above point to be fairly self-evident, in this report we highlight a range of independent third-party data and evidence demonstrating that the water industry is not, in relative terms, 'high-tech'. For example, and as illustrated below, data shows that the 'Electricity, gas and water supply; Waste management' industry contributes little to the UK's total R&D spending (controlling for relative industry size, by expressing this as a ratio of turnover).

Figure 3: The 'Electricity, gas and water supply; waste management' industry has the lowest R&D spending in the UK economy (see Chapter 5).



Source: Economic Insight analysis of ONS data.

Further considerations for Ofwat.

To be of further assistance to Ofwat, there are two specific issues that we should also like to highlight in this executive summary.

Firstly, in EE's critique of our reports, they advise Ofwat that the survey of academics is of *"limited relevance to setting a frontier shift challenge at PR24."*[3] EE continues: *"More generally, Economic Insight present no evidence that the academic experts that they selected have expertise in the water sector, so there is no reason to place much weight on their views regarding water sector productivity growth… For example, there is no evidence that these academic experts are aware of the innovative and high-tech solutions that companies are developing through Ofwat's Innovation Fund."*[4]

We consider the survey evidence to be valuable for three reasons:

(a) Firstly, the views are those of some of the UK's leading experts in productivity, meaning they are, in fact, especially well-placed to give views on historical and future productivity (and whether its drivers are industry specific or common);

(b) Secondly, the survey formed part of a wider academic research piece, and was not commissioned by Economic Insight, nor the firm's clients. Thus, the views provided by the academics were entirely independent and were not given in the context of setting regulatory frontier shift targets (i.e. the participating academics had no incentive or reason to either over, nor under-state future productivity potential); and

(c) That survey was part of an academic article that, subsequent to the submission of company business plans and our previous reports, has now been through a formal peer-review process and has been published in a credible academic journal.[5]

Thus, the methodology used; results; and inferences drawn from them, were deemed of sufficient quality for academic publication. We would suggest peer-reviewed research should generally meet the 'compelling' evidence standard set by Ofwat (but recognise it is for Ofwat to consider the relevance of evidence, notwithstanding its quality).

Secondly, we would encourage Ofwat to consider with care whether the recommendations made to its by its advisors represent a balanced appraisal of evidence. From our review of the relevant reports, there seem to be many examples whereby the advisors raise specific technical issues that, from one perspective, might be used to rationalise a 'higher' frontier shift target, but without consideration (nor therefore evaluation) of the countervailing possibility. To give just three examples in the critique report submitted by EE, there is no consideration of:

[3] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 4, Europe Economics (July 2024).*

[4] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 137, Europe Economics (July 2024).*

[5] *See: "The UK Productivity Puzzle: A Survey of the Literature and Expert Views", Williams, S; Glass, A; Matos, M; Elder, T; Arnett, D., International Journal of the Economics of Business (January 2024).*

- whether elements of the wider UK productivity slowdown might actually affect the water sector *more* than other sectors[6];
- whether *increases* in catch up efficiency over time might mean that TFP has overstated frontier shift potential (particularly over previous AMPs); and
- why Ofwat's precedent of setting much lower frontier shift challenges prior to PR14 is *irrelevant*, but the precedent of setting challenges of C. 1% post PR14 is *relevant*.

We hope that this targeted report, which keeps intuition and the substantive evidential points as its focus, will be of help to Ofwat as it considers its Final Determinations. The issue of frontier shift remains a critical one, not only to the water industry but, by virtue of the intrinsic link between infrastructure investment and wider economic performance, to the UK. In the context of an increasingly accepted underinvestment concern in the UK, a balanced approach is imperative.

[6] To clarify, we are not suggesting that this is the case. Rather, our point is merely that, if one is to consider whether the water industry may be affected differently by the causal factors of the slowdown, it is unclear why that consideration is limited to the industry being unaffected or less affected, rather than the possibility that any given factor might affect it 'more', or 'less', than the UK 'on average'.

Report structure

In this report, we highlight what we consider to be the most pertinent considerations to setting an appropriate level of frontier shift at PR24, in order to ensure efficient companies are appropriately funded at the Final Determinations, to deliver for customers and society in the long-run. In doing so, our focus is therefore on the key intuitive issues and supporting evidence relevant to that assessment. We consider this to be more constructive than further discussion of narrow technical issues which (whilst not irrelevant) are, in some cases, either irresolvable or, (if deemed material), would seem to call into question the purpose of TFP benchmarking as a means of setting frontier shift in the first place.

The remainder of this report is structured as follows:

- **Chapter 2** briefly summarises the existing submissions to Ofwat on frontier shift at PR24.
- **Chapter 3** investigates whether the actual productivity growth achieved by the water sector and its comparators has been in-line with Ofwat's frontier shift targets and expectations.
- **Chapter 4** examines whether the water sector has been protected from underinvestment, relative to the wider UK economy.
- **Chapter 5** demonstrates that the UK water industry is not high-tech.
- **Chapter 6** addresses EE's arguments in relation to catch up efficiency and the risk that it causes a downwards bias in estimates of frontier shift based on TFP growth.
- **Chapter 7** contains bulleted conclusions following from the preceding evidence.
- **Annexes** contain additional evidence relating to our underinvestment analysis in Chapter 4 and a short 'agree/disagree' table, the purpose of which is to provide a succinct overview on issues where our views differ from those of Ofwat's advisors and the reasons for those differences.

02

ADDITIONAL CONTEXT

In this chapter, we briefly summarise the existing submissions to Ofwat on the estimation of frontier shift at PR24.

02.01 Chapter structure

As we discussed in the Introduction and Executive Summary, Ofwat has received a number of submissions on the estimation of the frontier shift that is achievable by companies at PR24.

In this chapter, we briefly summarise the key submissions by:

- Economic Insight; and
- Ofwat's economic advisors, CEPA and EE.

02.02 Submissions by Economic Insight

In their business plans, water companies proposed a frontier shift (ongoing efficiency) challenge on costs of 0.6% pa on average.[7] In doing so, companies primarily relied on two reports by Economic Insight:

- **'Productivity and frontier shift at PR24'**[8]. This (April 2023) report contained a framework for determining frontier shift; a discussion of the conceptual issues relevant to that; alongside a benchmarking analysis (using EU KLEMS data). The report identified a 'focused range' for frontier shift at PR24 of 0.3%-0.7% pa.
- **'Further evidence on frontier shift at PR24'**[9]. This subsequent (March 2024) report evaluated whether more recent evidence suggested any change to the range for frontier shift identified in the first above report. It also included new evidence, based on a survey of UK academic experts in productivity and considered the extent to which the factors causing the slowdown in the UK's productivity post 2008 applied to the water sector. The report concluded that there was no change to the recommended range (above). In addition, the report found that, whilst the factors causing the UK productivity slowdown might affect some industries more than others, in general they were economy-wide, meaning the water industry was not immune from them.

02.03 Submissions by Ofwat's economic advisors

In its DDs, Ofwat has proposed a materially higher frontier shift challenge of 1.0% pa, which the regulator states is in the middle of the range identified by its consultants, CEPA, (0.8% - 1.2% pa).[10] In addition to the CEPA estimates, Ofwat's DD position on frontier shift was informed by a report by Europe Economics (EE): *'Europe Economics' critique of Economic Insight reports on productivity and frontier shift at PR24'*.

Key reasons cited by Ofwat in its DDs to support its proposed target are:

[7] *"PR24 Draft Determinations: Expenditure Allowances", page 137, Ofwat (July 2024).*
[8] *"Productivity and frontier shift at PR24", Economic Insight (April 2023).*
[9] *"Further evidence on frontier shift at PR24", Economic Insight (March 2024).*
[10] *"PR24 Draft Determinations: Expenditure Allowances", page 138, Ofwat (July 2024).*

- The reasons suggested in the academic literature for low economy-wide productivity growth in the UK since the financial crisis do not apply to the water sector.
- There are reasons to expect that economy-wide productivity growth will accelerate going forward (Ofwat specifically refers to the wider use of artificial intelligence; big data; and robotics in the water sector and economy as a whole).
- Ofwat's innovation fund has the potential to help companies realise productivity gains (including through AI and robotics, as above).
- The 'step-change' in enhancement investment at PR24 should further boost productivity potential, by facilitating 'learning by doing'.

Additionally, in its critique report, EE set out some further reasoning (in addition to the factors highlighted by Ofwat in its DDs, as noted above) supportive of a *'higher'* frontier shift challenge. In summary terms, the most material of these are:

- The previous Economic Insight reports place insufficient weight on the possibility that productivity growth may revert to pre-crisis levels (arguing that there are *"strong reasons"* to expect productivity growth to be higher over PR24).[11]
- There is considerable scope for transformative technologies within the water sector (and relatedly, that the water sector is likely to have *greater* scope for embodied technical change than other sectors).[12]
- A suggestion that catch up efficiency has been *negative* since the financial crisis, meaning that benchmarked TFP data will *understate* the potential for frontier shift at PR24.[13]

[11] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 15-16, Europe Economics (July 2024).*
[12] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 8-9; 13; 45, Europe Economics (July 2024).*
[13] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 11-12, Europe Economics (July 2024).*

03

WATER INDUSTRY TFP GROWTH VS FS TARGETS

We find that Ofwat's frontier shift targets have been set materially higher than the actual TFP growth achieved by the water sector. Further to this, expectations of improvements in productivity growth that regulators and their advisers relied upon in setting previous frontier shift targets have failed to materialise.

03.01 Chapter structure

In the context of the low, near-zero productivity growth observed in the wider UK economy, Ofwat has, in part, supported setting materially higher frontier shift targets for the water industry by suggesting that: (a) the water sector will outperform the slow productivity growth observed in the rest of the UK; (b) Ofwat's comparators for the water sector have significantly outperformed the UK overall in relation to productivity growth; and (c) UK-wide productivity may improve (fully revert to pre-crisis levels) over the price control period.

In this chapter, we consider how each of these arguments compare to the most up-to-date data on productivity growth. We address the following in turn:

- How the productivity growth actually achieved by the water sector compares to Ofwat's previous frontier shift targets and the low productivity observed in the wider UK economy.
- Whether Ofwat's comparators for the water sector have significantly outperformed the low productivity growth observed in the wider UK economy.
- If regulator-assumed improvements in productivity growth have materialised over previous AMPs.

03.02 Comparison of actual water industry productivity growth to frontier shift targets

In **Figure 4**, we present data on the actual productivity achieved by the water industry,[14] using the EU KLEMS dataset (including a comparison with the frontier shift targets set previously by Ofwat).

Our first observation is that the data shows that the water industry has, over recent decades, delivered low productivity growth, in-line with the low and flat productivity performance of the UK. This evidence is in contrast to statements made by Ofwat at PR19 Final Determinations, where it "*reject[ed] the company argument that water sector productivity should reflect recent low growth across the economy as a whole*"[15] and stated that it "*expect[s] productivity growth of the water and comparator sectors to outstrip that of the economy as a whole over a full economic cycle*"[16]. Moreover, it is notable that the data shows that water industry productivity declined (along with the wider economy) sharply following the financial crisis. Seen in context of a range of evidence we have now identified,[17] this is clearly consistent with the industry being affected by the drivers of the UK productivity slowdown.

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[14] We use data for the NACE Rev. 2 industry, 'Water supply; sewerage, waste management and remediation activities' because this is the closest industry classification to the regulated water sector within the EU KLEMs data set. We acknowledge that this industry classification includes companies other than the regulated water companies, such as water retailers and waste management companies. However, the results are likely representative of the regulated water companies because: (a) the results are consistent with the 2017 Frontier Economics study that focused specifically on regulated water companies; and (b) the majority of the largest firms within the industry classification are the regulated water companies.

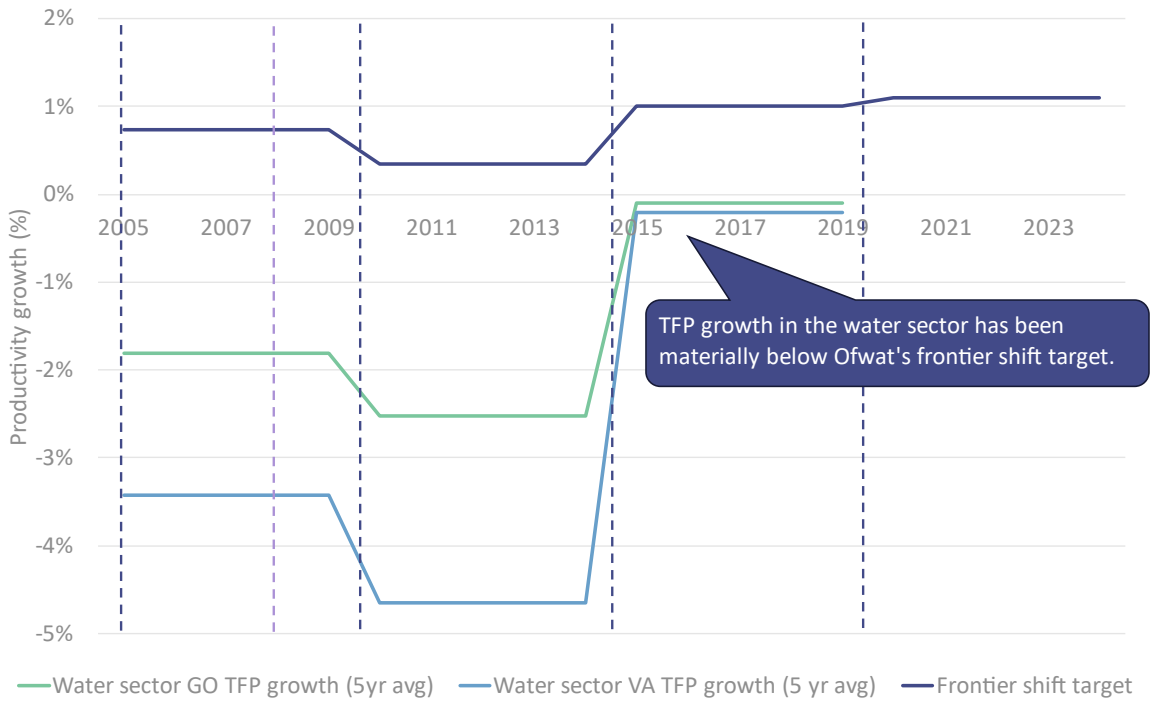
[15] "PR19 final determinations: Overall stretch on costs, outcomes and cost of capital policy appendix", pages 17-18, Ofwat (December 2019).

[16] "Reference of the PR19 final determinations: Costs and outcomes – Ofwat December response", paragraph 5.6, Ofwat (December 2020).

[17] In our previous report ('Further evidence on frontier shift'), we identified the main reasons for the productivity slowdown in the opinion of leading academic experts in the field of productivity. We then examined each factor in turn and found that, in principle,

Our second observation is that the average productivity growth achieved by the water sector has been significantly below the frontier shift targets Ofwat has set in each of the most recent price control periods (AMP4, AMP5, AMP6), for which EU KLEMS data is available. This is true across both measures of productivity growth shown in the chart: (a) gross output; and (b) value added.[18] The large difference between realised productivity growth and Ofwat's frontier shift targets suggests that said targets have been set materially too high in recent price controls. As a result, it is likely that the water industry has been underfunded over previous AMPs. The below data will necessarily *underestimate* the discrepancy between the efficiency challenge determined by Ofwat at its price controls and outturn industry performance, because it is comparing: (i) Ofwat's frontier shift target only (excluding Ofwat's catch-up efficiency challenge); with (ii) outturn TFP that reflects the *totality* of efficiency gains made by the industry (i.e. frontier shift and catch-up efficiency combined).

Figure 4: Water sector productivity growth (%) is especially low when compared to frontier shift target.



Source: Economic Insight analysis of EU KLEMS data and Ofwat's frontier shift targets.

Note: The purple vertical line represents the start of the global financial crisis. The darker blue vertical lines mark the start / end of each price control period. The figure shows the five year average productivity growth over each price control period so that it can be easily compared to Ofwat's frontier shift target.

only one of the factors (underinvestment) might be mitigated by regulation. However, in practice, the data suggests that regulation has not mitigated underinvestment in the water sector. Therefore, consistent with the outturn data on water productivity growth presented in this section, we concluded that there are limited reasons to believe that regulation mitigates against the productivity slowdown. See the following report for more detail: "Further evidence on frontier shift at PR24", Economic Insight (March 2024).

[18] We include value added TFP in the figure because Ofwat has previously used it to inform the frontier shift target. However, we consider that gross output more appropriately reflects the scope for achievable frontier shift in the water industry. We set out the reasons for this in our previous report: "Productivity and Frontier Shift at PR24", page 28, Economic Insight (April 2023).

The above observations are based on data for the 'Water supply; sewerage, waste management and remediation activities' sector, which includes firms other than just the regulated water companies. However, Frontier Economics reached similar conclusions specifically regarding regulated water companies in its 2017 study. It reported that "*[p]roductivity growth was high during the immediate post-privatisation period, then followed a period of intermediate growth in the first five years of the 2000s, with a significant drop in growth since 2007 following the Global Financial Crisis (GFC)*"[19]. This provides a further indication that the regulated water sector specifically was greatly affected by the wider productivity slowdown.

We should clarify that, in presenting the above, we are not suggesting that Ofwat should use actual water industry productivity performance in order to set a forward-looking frontier shift target. For example, it is important to avoid creating any perverse incentives or circularity. However, it is now increasingly striking how great a gap there is between the targets Ofwat has set, and delivered productivity performance by the water companies themselves (in the context of water companies being heavily incentivised to achieve the strongest efficiency performance possible). At some point, actual productivity performance must become a relevant source of information, which further points to the need for a recalibration.

It is now increasingly striking how great a gap there is between the targets Ofwat has set, and delivered productivity performance by the water companies themselves (in the context of water companies being heavily incentivised to achieve the strongest efficiency performance possible). At some point, actual productivity performance must become a relevant source of information, which further points to the need for a recalibration.

03.03 Productivity growth of Ofwat's comparators for the water sector

Related to the above, Ofwat has previously suggested that its preferred comparator sectors for the water industry are significantly outperforming the UK average, and has used this to further support a 'higher' productivity target. For example, at the PR19 Final Determinations Ofwat argued that "*we consider that the best comparator sectors for the water sector are the manufacturing sector… construction…transport and storage…and support services…Post the financial crisis productivity growth in these sectors has been an average of 0.6% per year (as shown in Table 2 below…)*".[20]

Since the PR19 Final Determinations, however, the EU KLEMS data has been revised and additional years of data have been released. To be of assistance, we have therefore updated the results that Ofwat referred to in the quote above to use this revised data and additional years that are now available. We use the same comparators and productivity measure used by Ofwat in making the above statement. We expand Ofwat's post-crisis period (2010-2014) and its full period average (1999-2014) to include the additional years of data. These periods become 2010-2019 and 1999-2019 respectively.

[19] *"Productivity improvement in the water and sewerage industry in England since privatisation", page 2, Frontier Economics (2017).*

[20] *"PR19 final determinations: Overall stretch on costs, outcomes and cost of capital policy appendix", page 16, Ofwat (December 2019).*

The updated results are shown in the following table. As can be seen, using the revised EU KLEMS data, and the same calculations that Ofwat relied upon, the average productivity growth for Ofwat's comparators now varies between 0.04% and 0.21% over the three time periods. This is much lower than both the 0.6% quoted by Ofwat and the frontier shift targets Ofwat has set for the water sector. Instead, the average productivity growth of Ofwat's comparators is more in-line with the low productivity growth exhibited by most other UK industries, and the UK as a whole. In fact, the average productivity growth of Ofwat's comparators is actually materially *worse* than the UK as a whole for each of the three time periods. Notably, it is also significantly below the mid-point of our own recommended frontier shift range for PR24.

Table 1: Gross output TFP growth (%) for Ofwat's preferred comparators.

	Latest EU KLEMS data			Old EU KLEMS data (as previously presented by Ofwat)		
Time	Full period average (1999-2019)	Average pre-crisis (1999-2007)	Average post-crisis (2010-2019)	Full period average (1999-2014)	Average pre-crisis (1999-2007)	Average post-crisis (2010-2014)
Manufacturing	1.16%	2.10%	0.47%	0.60%	0.90%	0.30%
Construction	-0.38%	-0.77%	0.63%	-0.10%	0.20%	0.70%
Transport and storage	-0.37%	-0.12%	-0.22%	0.00%	0.20%	0.50%
Professional, scientific, technical, administrative and support service activities	-0.26%	-0.50%	-0.02%	0.90%	1.10%	1.50%
Market economy	0.34%	0.84%	0.20%	0.20%	0.70%	0.00%
Total industries	0.21%	0.44%	0.25%	-	-	-
Average for comparators quoted by Ofwat	**0.04%**	**0.18%**	**0.21%**	0.35%	0.60%	0.75%

Source: Economic Insight analysis of EU KLEMS data and "PR19 Final Determinations: Overall stretch on costs, outcomes and cost of capital policy appendix", page 16, Ofwat (December 2019).

03.04 Have the forecast improvements in productivity growth materialised?

Another factor identified by Ofwat (and the CMA) for setting a higher frontier shift at previous price controls was an expectation that productivity growth would improve over said price control periods. For example, at PR19, Ofwat's advisors (EE) raised the question: "*Do we expect economy-wide productivity to rise to its pre-crisis levels over the course of the next control period, do we expect it to stay at the new lower post-crisis levels, or do we expect it to be somewhere in between? In other words, which past is a better predictor for the future over the period of AMP7.*"[21] EE concluded that whether productivity growth would improve was uncertain and, therefore, it did not need to completely take the productivity slowdown into account. Specifically it stated that *"[i]n the light of this uncertainty, we take a cautious approach and do not limit our analysis to only one period (be it post-crisis or pre-crisis). Instead, we look at data over various periods and take account of the above considerations in interpreting the data*."[22] Similarly, at the PR19 redeterminations, the CMA noted that "*some forecasts have indicated that UK wide productivity growth may begin to rise over the next five years.*"[23] The CMA also reached similar conclusions at the RIIO-GD2 and T2 appeal, where it stated that "*BoE and OBR data do not conclusively show that productivity growth will continue to be low*"[24].

In practice, the expectations of improvements in productivity growth that regulators and their advisers relied upon in making previous decisions have simply not materialised. Instead, UK-wide productivity growth has remained near zero for the last 15 years. This strongly suggests regulators should not now continue to make frontier shift decisions based on expectations that improved growth will occur. It also raises legitimate concerns regarding the likelihood that companies have been materially underfunded due to this reason at PR14 and PR19 and the impact of that on customers.

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[21] *"Real Price Effects and Frontier Shift", page 71, Europe Economics (January 2018).*

[22] *"Real Price Effects and Frontier Shift", page 71. Europe Economics (January 2018).*

[23] *"Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final report", paragraph 4.537, CMA (March 2021).*

[24] *"Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority - Final determination Volume 2B: Joined Grounds B, C and D", paragraph 7.84, CMA (October 2021).*

Further to this, because investment is a key driver of productivity growth, any past underfunding in the water industry could itself already have been an impediment to historical productivity performance in the sector, in addition to impeding future performance over PR24. This provides further rationale for a recalibration of the fronter shift target at this time.

We should also highlight that our recommended ranges for frontier shift at PR24 (as set out in our previous two reports) already embed a material improvement in productivity from current (near-zero) levels. The pertinent issue is that previous frontier shift targets set by regulators imply a 'full reversion' from the prevailing near-zero levels to *much higher* performance, not observed since pre-2008 (and that this 'full revision' occurs on 'day-one' of the AMP).

04

INVESTMENT TRENDS IN THE UK AND THE WATER SECTOR

We find evidence that: (i) the water sector is not immune from the underinvestment problem observed in the wider UK economy; (ii) the water sector and the UK economy share the same negative investment trajectory; (iii) water sector investment per capita has declined; and (iv) the growth in water sector investment since the financial crisis has been slower than comparable countries.

04.01 Chapter structure

In this chapter, we examine whether the water sector has been protected from underinvestment, relative to the wider UK economy. The structure of this chapter is as follows:

- Firstly, we summarise the relevant evidence presented in our previous reports and EE's critique.
- Secondly, we present additional evidence on the extent of underinvestment in both the water sector and the wider UK economy.

04.02 Summary of previous evidence presented by Economic Insight and Europe Economics

In our 'Further evidence on frontier shift at PR24' report, we set out that (based on a range of evidence and in the view of independent expert academics on productivity) underinvestment was one of the main factors driving the productivity slowdown in the UK.[25] We further explained that, of the main factors driving the slowdown, this was the *only* factor whereby (intuitively) the regulatory framework that applies to water companies *might* have some mitigating effect. However, we found that, on the data, the mitigation appeared limited.

EE disputed our conclusion on mitigation in its critique report, proposing that the water sector had, in fact, been protected (by regulation) from underinvestment. EE sought to evidence this by comparing investment[26] as a proportion of gross value added for the water and sewerage sector to the UK as a whole (Figure 10.2 of its critique[27]). EE commented that the proportion of investment to gross value added was higher in the water and sewerage sector than the UK as a whole. It suggested that this meant that water and sewerage companies had been protected from underinvestment.

The above referenced analysis, however, merely demonstrates that the water sector is more capital intensive than the UK as a whole, which is unremarkable. The purpose of comparing the UK and the water sector should instead be to see if the *trend* in investment has been similar. The point being that if, in recent decades, the trend in overall UK investment has been deemed to be consistent with an underinvestment problem, then should the water sector exhibit a similar trend, it would similarly indicate that an underinvestment concern arises. Said underinvestment problem has been highlighted by the OECD, amongst other organisations, and means that investment levels are insufficient to maintain critical services; drive productivity; in-line with peers. Therefore, in actual fact, (and as we explain further subsequently) Figure 10.2 in EE's critique report is entirely consistent with the water industry exhibiting an underinvestment problem of a similar order of magnitude to that of the UK as a whole. We present further evidence relevant to this conclusion below.

[25] In contrast to the views of leading experts on productivity, EE contend this point, instead suggesting that underinvestment has not been a contributing factor to the wider productivity slowdown.

[26] Measured in terms of gross fixed capital formation.

[27] "Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", Figure 10.2, Europe Economics (2024).

04.03 Comparison of water industry and UK investment trends

To investigate whether the water sector has been protected from the underinvestment observed in the wider UK economy, we examine the evidencing relating to two key questions in turn:

(a) **Does the UK have an underinvestment problem?** We set out below that the UK has an underinvestment problem and that this is widely accepted. The UK has materially lower investment levels than comparable economies and investment growth has slowed significantly since 2008.

(b) **Does the water sector exhibit the same problem?** We first provide evidence that investment in the water sector has followed a similar *trend* to the UK. Therefore, given that the UK as a whole has suffered from underinvestment, it is likely that the water sector has experienced the same problem. We then investigate the extent of underinvestment in the water sector further and show: (i) investment in the UK's water sector has fallen on a per capita basis; and (ii) investment in the UK's water sector has not grown as quickly as most comparable countries since the financial crisis. Although, it is challenging to determine what the 'right' level of investment in the UK's water sector should be, these metrics provide evidence that regulation has not materially mitigated the underinvestment problem observed in the rest of the UK.

Does the UK have an underinvestment problem?

As we set out in our 'Further evidence on frontier shift at PR24' report,[28] it is widely accepted that underinvestment in the UK is a longstanding problem that is broad-based across industries.[29] For instance, this problem has been identified by the OECD (2015)[30] and in the House of Commons Infrastructure policies and investment report (2021).[31] We illustrate the extent of the UK's investment problem in the figure below, which shows that: (i) the UK is investing significantly less than comparator countries[32] as a proportion of GDP (where investment is measured by gross fixed capital formation – GFCF); and (ii) UK investment as a proportion of GDP is trending down at a faster rate than the comparators i.e. the UK's relative position is getting worse over time.

[28] *"Further evidence on frontier shift at PR24", page 41, Economic Insight (March 2024).*

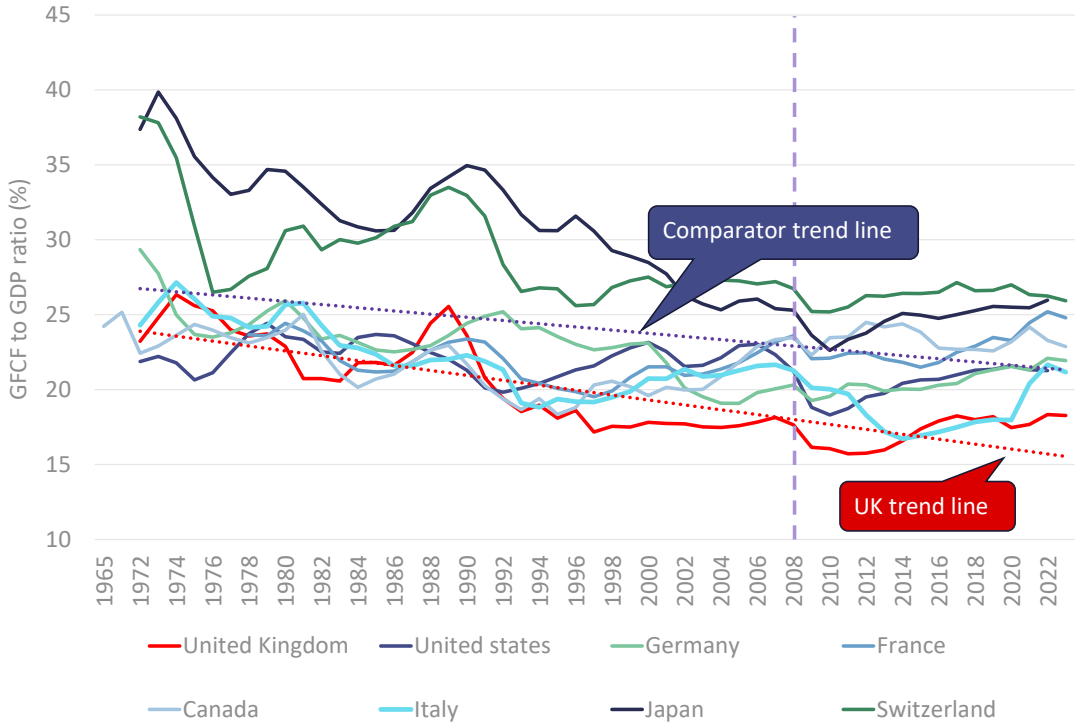
[29] *"The Productivity Agenda", page 9, The Productivity Institute (2023).*

[30] *"Improving Infrastructure in the United Kingdom", page 8, OECD Economics Working Papers No. 1244 (2015).*

[31] *"Infrastructure policies and investment: House of Commons Briefing Paper", House of Commons (March 2021).*

[32] *We include the G7 countries, and Switzerland because it was included in the OECD's 2015 report.*

Figure 5: Investment (measured by GFCF) as a percentage of GDP.

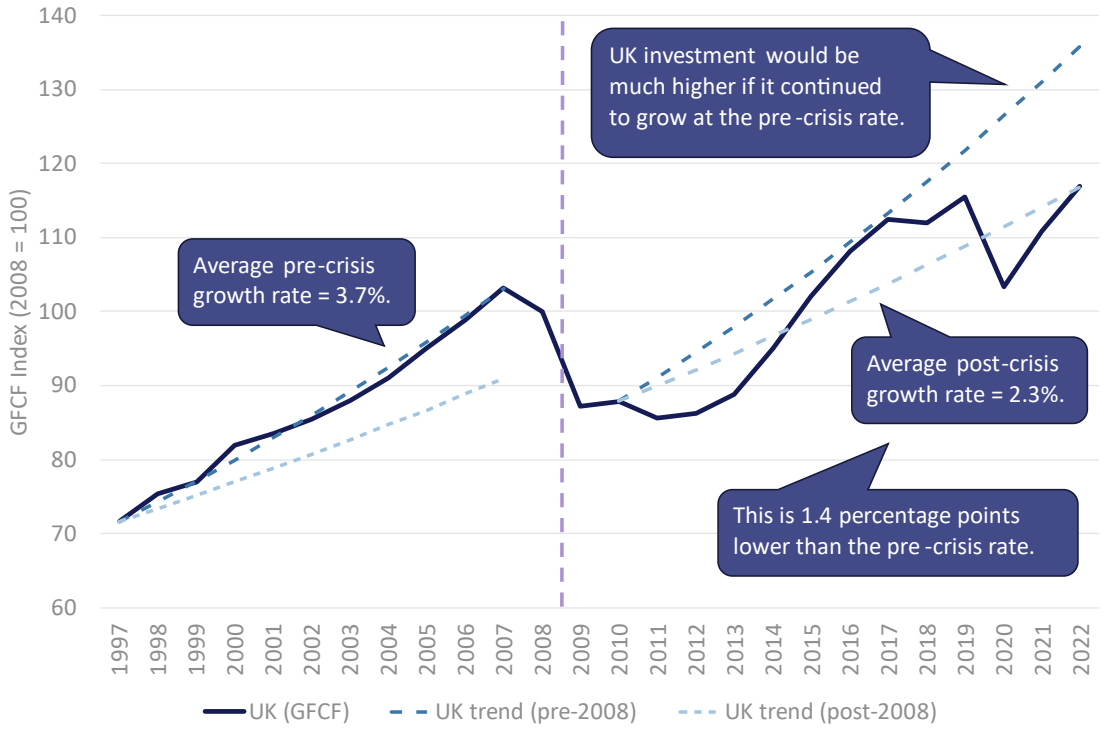


Source: Economic Insight analysis of OECD data.

Note: The comparator trend line represents the average trend of the comparator countries included in the chart.

Further to the above, there has been a marked slowdown in UK investment growth since the financial crisis. This is evident in the following figure, which shows that investment growth (measured in terms of GFCF) in the UK was substantially higher before the financial crisis than it has been since. Indeed, the average pre-crisis growth rate was 3.7%, but this has fallen by 1.4 percentage points to just 2.3% since the crisis. This means that investment levels in the UK would be considerably higher today, if investment had continued to grow at the pre-crisis rate (notwithstanding the fact that, as shown in the above figure, even the pre-crisis trajectory would seem to imply an underinvestment problem).

Figure 6: UK investment (measured by GFCF) index (2008 = 100).



Source: Economic Insight analysis of ONS data.

Note: the GFCF series has been inflated into March 23/24 prices using the ONS CPIH index. The post-crisis growth rates are shown from 2010 onwards to exclude the immediate after-effect of the financial crisis in 2008 and 2009.

Does the water sector exhibit the same problem?

The above evidence indicates that the UK has an underinvestment problem and that this is broadly accepted. We now examine whether this problem has also been observed in the water sector (and, if so, to the same, or similar, degree).

In **Figure 5** above, we present the ratio of GFCF to GDP for the UK and note that the trend in UK investment (as highlighted by the OECD) has been deemed to be consistent with an underinvestment problem. We now compare the aforementioned series for the UK to the corresponding GFCF to GVA (gross value added) ratio for the water sector, where the water sector is represented by the SIC code for 'Water supply, sewerage, waste management and remediation' (hereafter referred to as 'the Water SIC code').[33]

ONS data on GFCF to GVA for the water sector is only available from 1998 onwards, so it is not possible to compare the trends between the UK and the water sector all the way back to 1970 (as in **Figure 5**). Therefore, we compare the trend for the water sector from 1998 to 2022 (the entire period for which data is available) with the UK trend over two different periods: (a) 1998 onwards to match

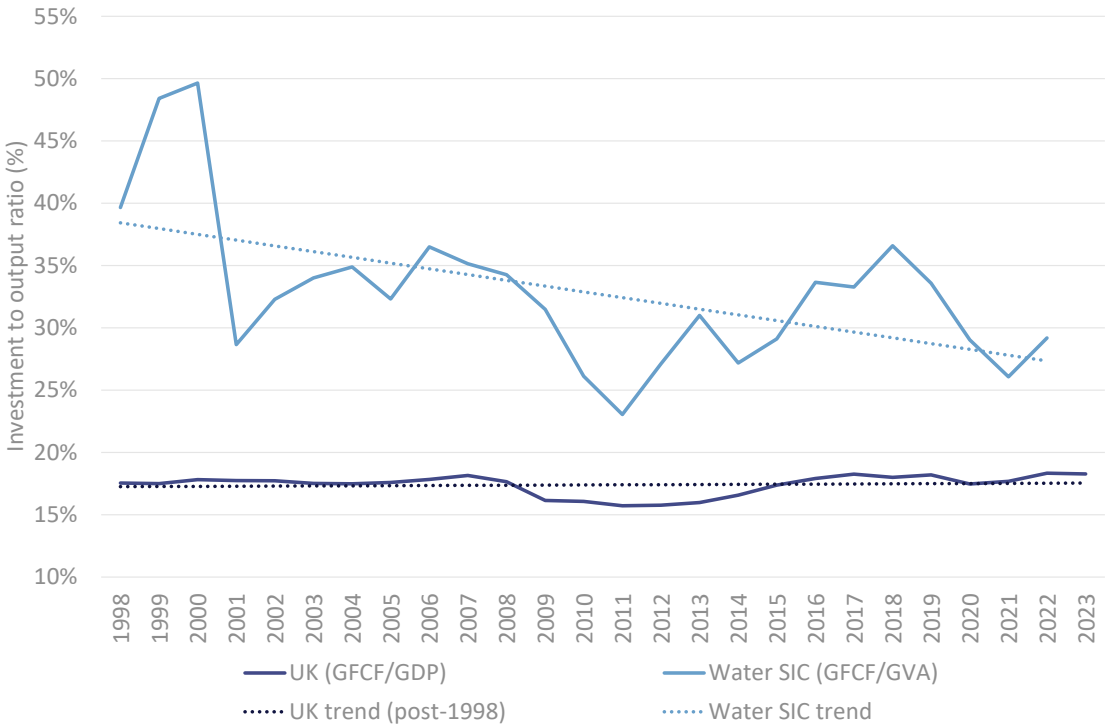
[33] *As for the corresponding NACE Rev 2. classification, we acknowledge that the Water SIC code includes companies other than the regulated water companies, such as water retailers and waste management companies. We use it because it is the closest industry classification to the regulated water sector for which ONS data is available. This allow us to draw comparisons between the water sector and the UK economy as a whole. Where possible, we have also included comparable metrics specifically for regulated water companies to ensure that the data is representative.*

the water sector data (shown in **Figure 7** below); and (b) 1990 onwards, because we consider it important to draw a comparison over the entire post-privatisation period (as shown in **Figure 8** below).

The analysis indicates that investment in the water sector (as a proportion of GVA) is declining even more sharply than the UK overall (for both time periods). This is concerning, given that the OECD (and other organisations) have highlighted that the trend in the UK investment is consistent with an underinvestment problem. This not only indicates that the water sector has not been immune from the underinvestment problem observed in the wider economy, but that it may have been impacted *to an even greater degree*.

We note that **Figure 7** is the same as Figure 10.2 in EE's critique report. However, as we explained above, the figure should be interpreted by comparing the *trends* in investment (relative to output size) between the UK and the water sector, as we have done, rather than focusing on *levels*, which was EE's approach (as differences in levels are driven by inherent differences in capital intensity, which are irrelevant to underinvestment – i.e. the water sector 'inherently' needs more investment than many sectors – the issue is, in relative terms, *is there underinvestment?*).

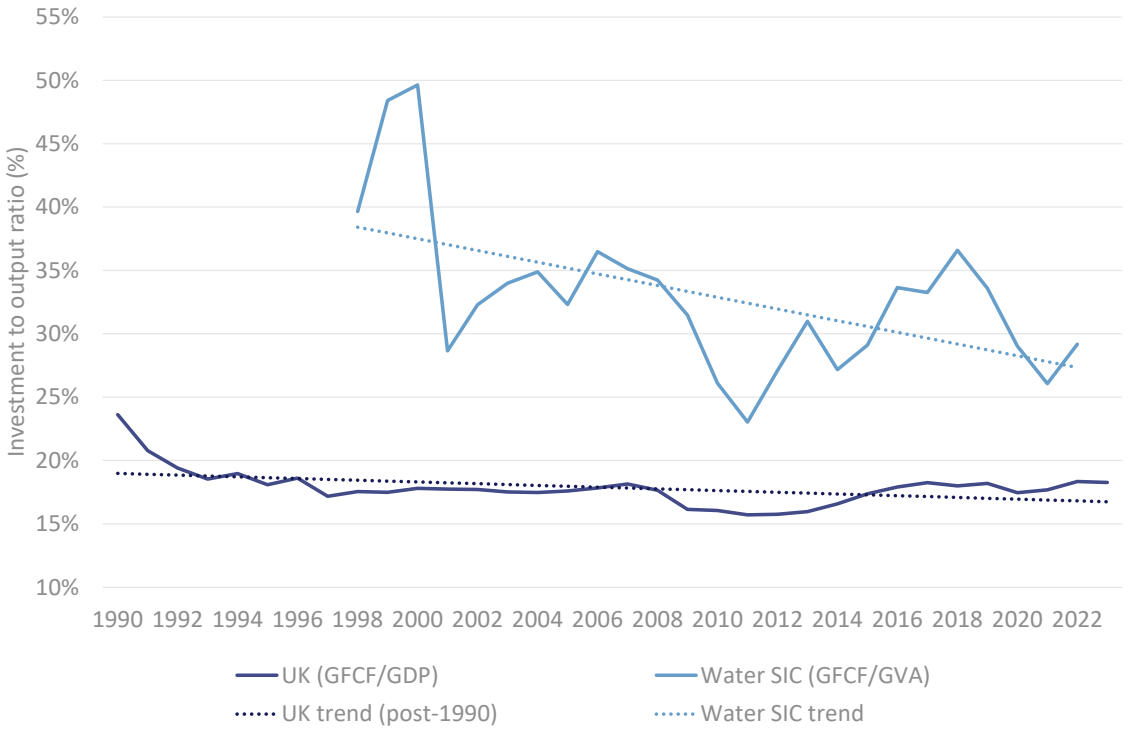
Figure 7: Investment as a proportion of output for the UK compared to the water sector (1998 onwards).



Source: Economic Insight analysis of ONS and OECD data.

Note: This figure is illustrated over a shorter time period than Figure 5. This is because GVA for the water sector is only available from 1998 onwards for the ONS series used in the figure. GVA refers to gross value added.

Figure 8: Investment as a proportion of output for the UK compared to the water sector (post-privatisation period).



Source: Economic Insight analysis of ONS and OECD data.

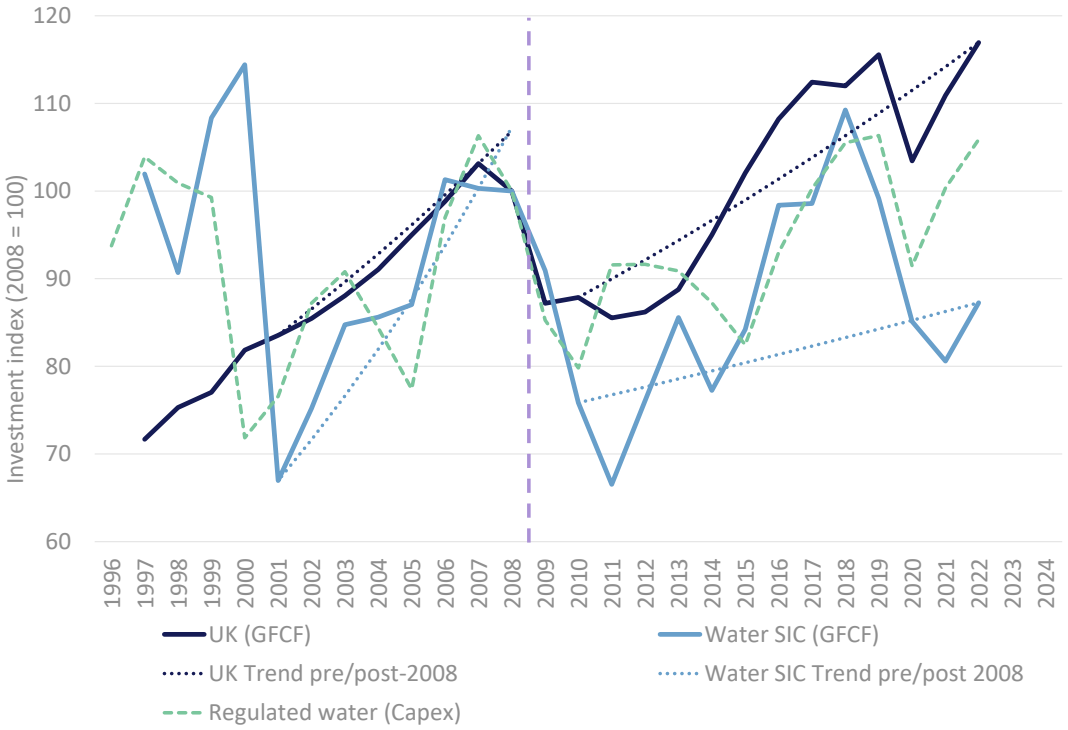
Note: This figure is illustrated over a shorter time period than Figure 5. This is because GVA for the water sector is only available from 1998 onwards for the ONS series used in the figure.

We also find results consistent with the above analysis, when we compare investment trends in *levels* (as measured by GFCF) for the water sector to the UK as a whole, as illustrated in **Figure 9**. Both series are presented as index numbers using 2008 as the base year, to allow for an easy comparison of the trends and growth rates since the financial crisis. The figure shows that investment for the water sector (shown by the light blue line) follows a similar trend to the UK overall (shown by the dark blue line) since around 2001. Therefore, given that the trend in UK investment is consistent with an underinvestment problem, this suggests that the water sector has also been affected.

It is important to note that the Water SIC code contains firms beyond just the regulated water companies, such as water retailers. To provide a more focused analysis, we also include a measure of investment specifically for regulated water companies (capital expenditure), presented by the dotted green line in the figure below. While capital expenditure is not directly comparable to GFCF,[34] the similar trends observed between the two measures suggests that the conclusions drawn from the Water SIC code likely apply to regulated water firms (and are not just driven by non-regulated firms within the Water SIC code sector).

[34] *For example, Capex does not include intangibles which are included in GFCF.*

Figure 9: Investment (as measured by GFCF) index for the UK and the water sector (2008 = 100).



Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

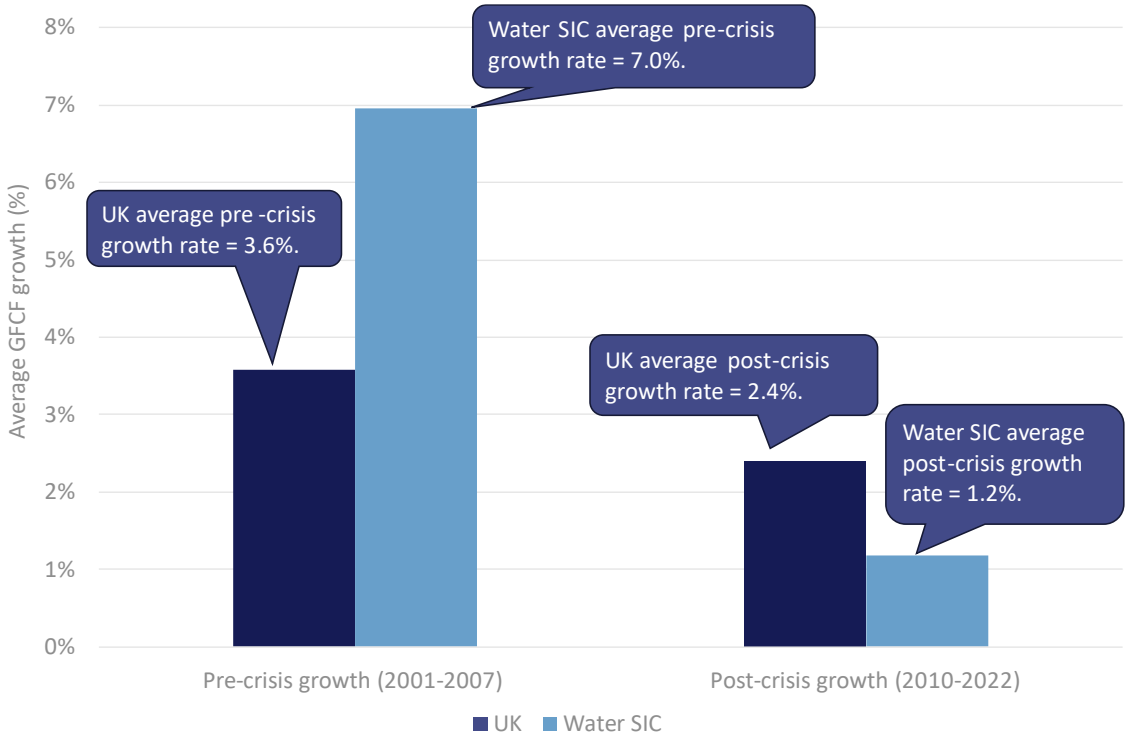
Note: All series have been inflated into March 23/24 prices using the ONS CPIH index. The pre-crisis trends are shown from 2001 to 2007 because investment in the UK and the water sector have trended together since 2001. Using the pre-crisis trend for the water sector since 2001 also avoids the trend being mainly driven by the dip in investment from 2000 to 2001. The post-crisis trends are shown from 2010 onwards to exclude the immediate after-effect of the financial crisis.

It is notable that post-crisis investment growth in the water sector (from 2010 to 2022)[35] has only been around half that of UK investment growth over the same period. This is illustrated in **Figure 10** below, which shows the average pre- and post-crisis investment growth rates (corresponding to the trendlines in **Figure 9**) for the UK and the Water sector. We also observe that average investment growth in the water sector decreased significantly (by 5.8 percentage points) when comparing the post-crisis period to the period immediately prior to the financial crisis (2001-2007)[36]. This further suggests that the water sector has not been protected from the underinvestment (or post-financial crisis slowdown) observed in the rest of the UK. In the Annex (Section 08.02), we also present evidence that the ratio of water sector investment to total UK investment has declined over time, which further supports this conclusion.

[35] *We use this period because it avoids the post-crisis growth rate being influenced by the large dip during the crisis in 2008 and 2009.*

[36] *We use this period because it avoids the water sector pre-crisis rate being largely driven by the large dip from 2000 to 2001 and UK and water sector investment have trended together since 2001.*

Figure 10: Average investment growth for the UK compared to the water sector (pre-crisis vs post-crisis).



Source: Economic Insight analysis of ONS data

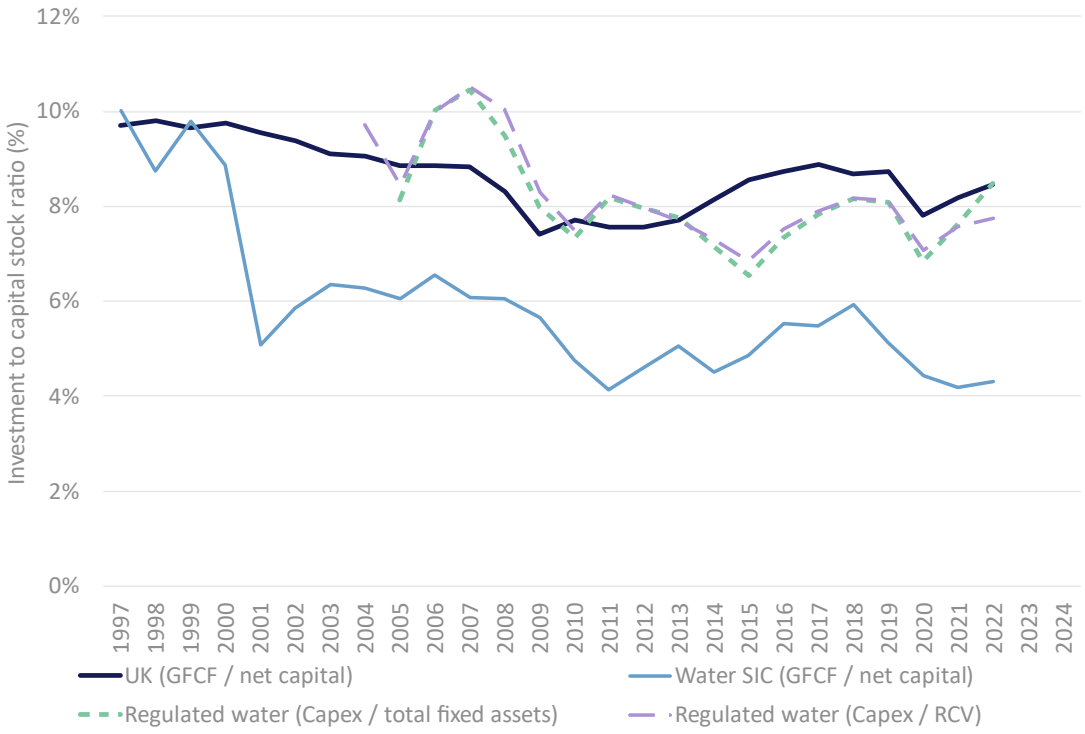
Note: : All series have been inflated into March 23/24 prices using the ONS CPIH index. The pre-crisis growth rates are shown from 2001 to 2007 because investment in the UK and the water sector have trended together since 2001. Using the pre-crisis growth rate for the water sector since 2001 also avoids the pre-crisis average being mainly driven by the dip in investment from 2000 to 2001. The post-crisis growth rates are shown from 2010 onwards to exclude the immediate after-effect of the financial crisis.

We again reach similar conclusions (to those set out above) when we measure investment as a proportion of the total asset base (or capital stock). As shown in **Figure 11**, the ratio of GFCF to net capital stock has followed a similar trajectory in both the water sector and the UK as a whole since the financial crisis. Notably, it can also be observed that, whilst at the start of the period, the water sector's investment as a ratio of its asset base (capital stock), was similar to that for the UK as a whole, this quickly trends down, such that the industry is now investing a much smaller amount than the wider economy, relative to its capital stock. This analysis further suggests that the water sector has not been immune to the broader underinvestment affecting the rest of the UK. In the Annex, (Section 08.02) we show that these conclusions hold under alternative measures of investment relative to capital stock.

Whilst at the start of the period, the water sector's investment as a ratio of its asset base (capital stock), was similar to that for the UK as a whole, this quickly trends down, such that the industry is now investing a much smaller amount than the wider economy, relative to its capital stock.

The figure below also includes alternative measures of the investment to total asset base ratio, specifically for regulated water firms (represented by the dotted lines). These measures are the ratio of capex to total fixed assets and capex to RCV. Although these ratios are not directly comparable to the GFCF to net capital stock ratio, the similarity in trends between the series reinforces the conclusion that the findings apply to the regulated water sector (and are not just driven by other firms within the Water SIC code).

Figure 11: Investment to Net capital stock ratio.

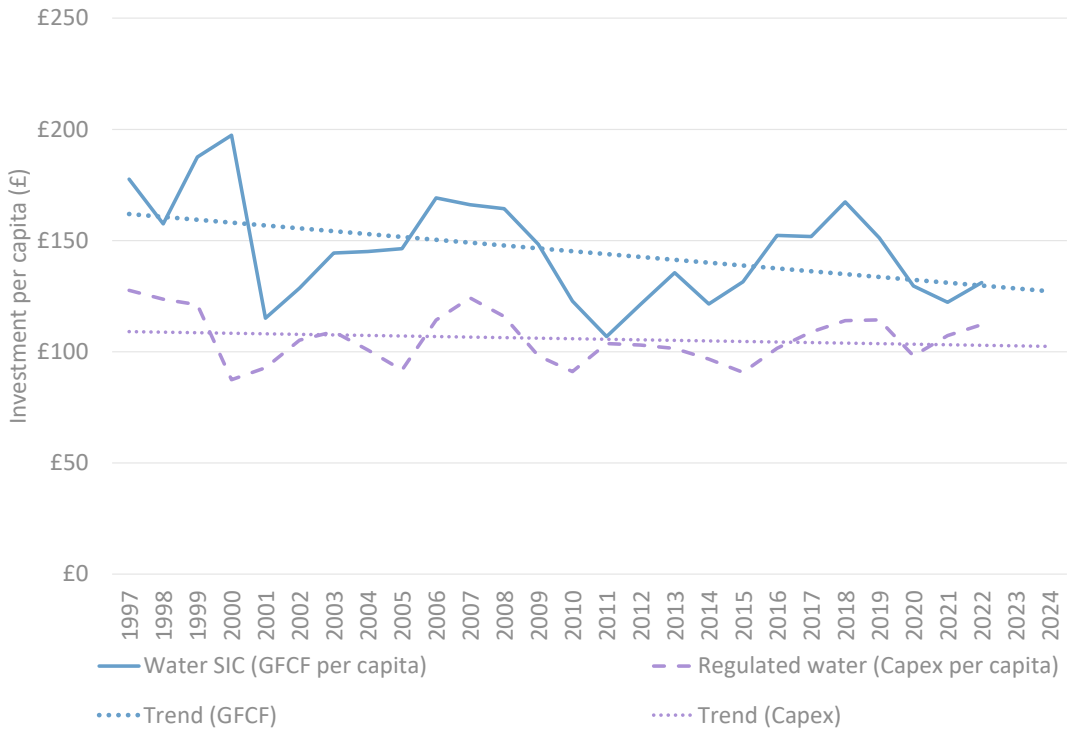


Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

Note: All series have been inflated into March 23/24 prices using the ONS CPIH index.

Another way to assess whether the water sector is underinvesting is by examining per capita investment levels. To maintain water sector investment at a comparatively consistent level over time, one would expect the ratio of investment to population to remain constant (in real terms). If this ratio remains steady as the population grows, it may indicate that investment is broadly 'keeping up' with said population growth, thereby supporting the sector's increasing output. However, the figure below shows that the ratio of investment (measured by GFCF and capex) to population for the water sector is declining over time. This provides a further indication that there has been underinvestment in the water sector in recent decades. This should be cause for concern.

Figure 12: Investment per capita (£).

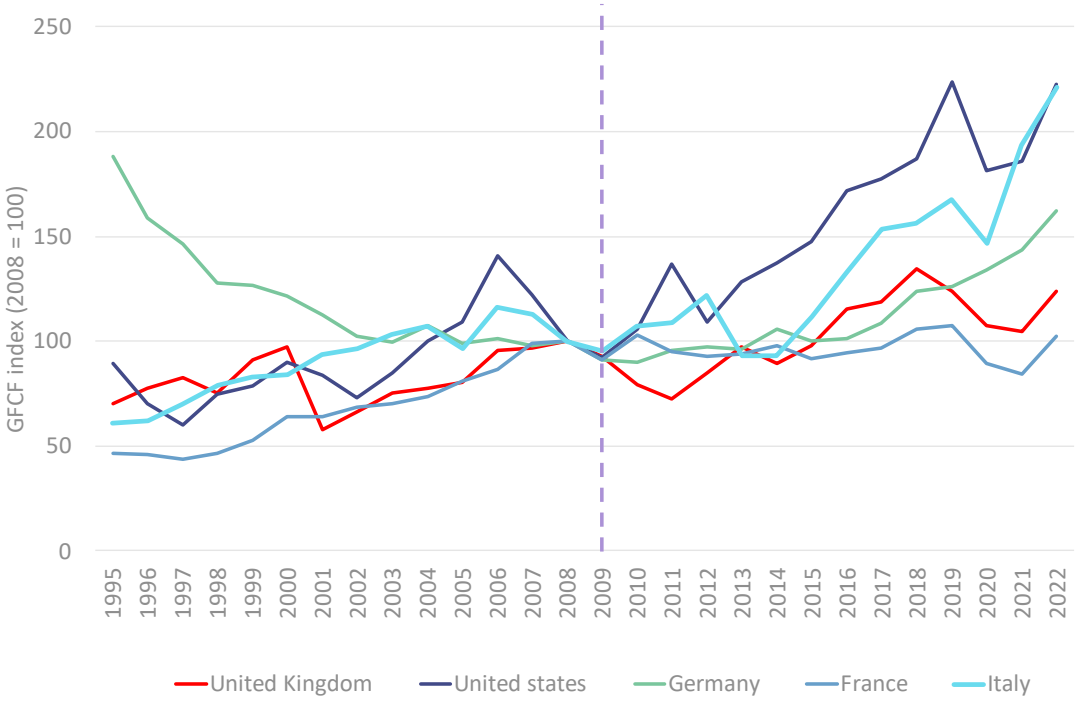


Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

Note: GFCF has been inflated into March 23/24 prices using the ONS CPIH index.

Finally, we compare the growth in investment in the UK's water sector to water sectors in the other comparable countries (as in **Figure 5**) for which OECD data is available (which is relevant, given their statements regarding the UK's underinvestment problem). The figure below illustrates that water sector investment in most comparable countries (with the exception of France) has grown significantly faster than in the UK since the financial crisis. For instance, water sector investment in the USA and Italy has increased by over 100% since 2008, and has increased by over 60% in Germany. In contrast, investment in the UK's water sector has risen by just 24% over the same period. Prior to the financial crisis, the growth rate in investment was more comparable. For example, from 1995-2007, water sector investment grew by 38% in the UK and by 37% in the US (the best performing country post-crisis).

Figure 13: Investment (measured by GFCF) index for the UK water sector compared to other countries (2008 = 100).



Source: Economic Insight analysis of OECD data.

In summary, there is a body of credible evidence that the water sector is not immune from the underinvestment problem observed in the UK more broadly. Investment trends in both the water sector and the UK economy as a whole are broadly similar over time, and investment in the water sector, as a proportion of its total asset base, is even lower than the UK economy as a whole. Further to this, water sector investment per capita has declined over time and the growth in water sector investment since the financial crisis has been slower than comparable countries.

The above evidence should further be seen in the context of: (a) the literature, wider evidence, and UK's leading experts on productivity, all cite underinvestment as being a contributor to the UK's wider productivity slowdown; and (b) the data for the water industry shows that, in fact, its productivity (like the UK's) *has* declined significantly since the financial crisis; and (c) underinvestment is one of a number of factors contributing to the slowdown and it is unclear how regulation can materially mitigate those other factors, even in principle.[37]

[37] *It is also worth noting that the nature of investment is important, not just the volume. Improving output quality, rather than cost reduction, is a key driver of water sector investment. This type of investment could actually give rise to greater costs (rather than reducing them) because water companies have to run and maintain the new assets in the future. Ofwat's frontier shift challenge is only applied to costs and therefore investment targeted at improving output quality should not be taken into account as a reason for setting a higher frontier shift challenge.*

05

THE WATER INDUSTRY IS INTRINSICALLY NOT HIGH-TECH

While we consider this point to be self-evident, we use publicly available data to demonstrate that the water industry is (objectively, and for intrinsic reasons) not high-tech. Furthermore, industries typically associated with high rates of technological change (e.g. semiconductor manufacturing, pharmaceuticals) predictably appear to be so in this data.

05.01 Chapter structure

In our previous report we highlighted that, as one would intuitively expect:

- the water industry is relatively 'low-tech' and does not utilise technologies that are "*extremely advanced and highly sophisticated*"[38]; and
- the water industry is unlikely to be able to achieve high productivity growth due to embodied change.

These two points are related because 'high-tech' industries tend to be amongst the higher performing ones in productivity terms, *in part* due to high rates of productivity growth from embodied change.[39,40]

We consider that it is entirely self-evident that the water sector is not a "high-tech" industry, in contrast to EE's claim in their report[41]. However, to assist Ofwat, we provide the following evidence on this issue:

- The 'Electricity, gas & water supply, waste management' industry reports a low rate of technological innovation, relative to other industries.
- The water and wastewater industry contributes a very small proportion of UK spending on R&D and employment in R&D.
- The 'Electricity, gas & water supply, waste management' industry has the lowest ratio of R&D spending and R&D employment to turnover of any UK industry.
- The intrinsic features of the water industry differ substantively from high-tech industries.

05.02 Evidence on how 'high-tech' the water industry is, relative to other UK industries

Firstly, analysis of the UK Innovation Survey (UKIS) 2023, the main data source for business innovation in the UK[42], shows that 36% of companies surveyed in the 'Electricity, gas & water supply, waste management' sector reported actively innovating in 2020-22, relative to a national average of 43%. Industries such as computer manufacturing (62%), ICT (60%) and engineering (55%) (i.e. industries most people might identify as being 'high tech') top the list, with a large majority of companies reporting that they are actively innovating, almost double that of the 'Electricity, gas & water supply, waste management' sector.

[38] *Collins dictionary definition of 'high-tech', see: https://www.collinsdictionary.com/dictionary/english/high-tech.*

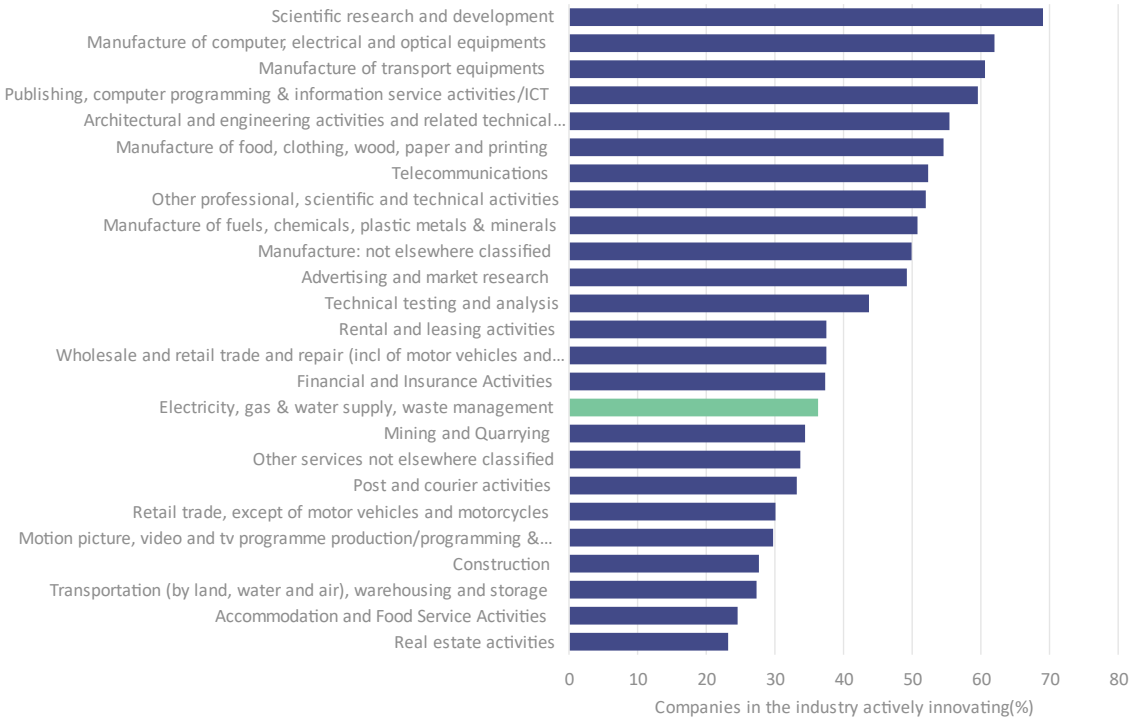
[39] *"Productivity and frontier shift at PR24", pages 6; 20; 94, Economic Insight (April 2023).*

[40] *"Further evidence on frontier shift at PR24", pages 47-49; 51, Economic Insight (March 2024).*

[41] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 17, Europe Economics (July 2024).*

[42] *"UKIS 2023", Department for Business and Trade (May 2024).*

Figure 14: A low proportion of firms in the 'Electricity, gas & water supply, waste management' sector report actively innovating.

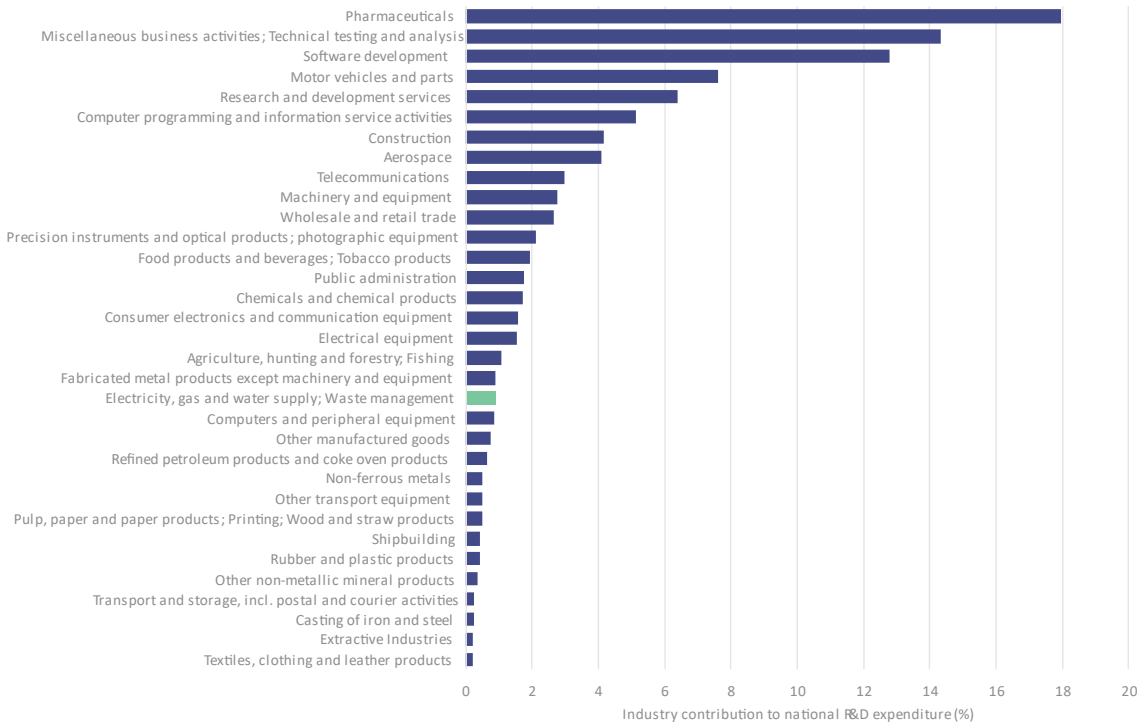


Source: Economic Insight analysis of UKIS 2023 data.

Secondly, the ONS Business Enterprise Research and Development dataset[43] reports the proportion of national R&D spending and employment that are generated by different product groups. The picture created by this data is much the same: conventionally 'high-tech' industries, such as pharmaceuticals and software development, contribute heavily to R&D spending and R&D employment, while the 'Electricity, gas & water supply, waste management' sector does not. Specifically, the sector contributes only 0.9% to national R&D spending and 0.6% to R&D employment.

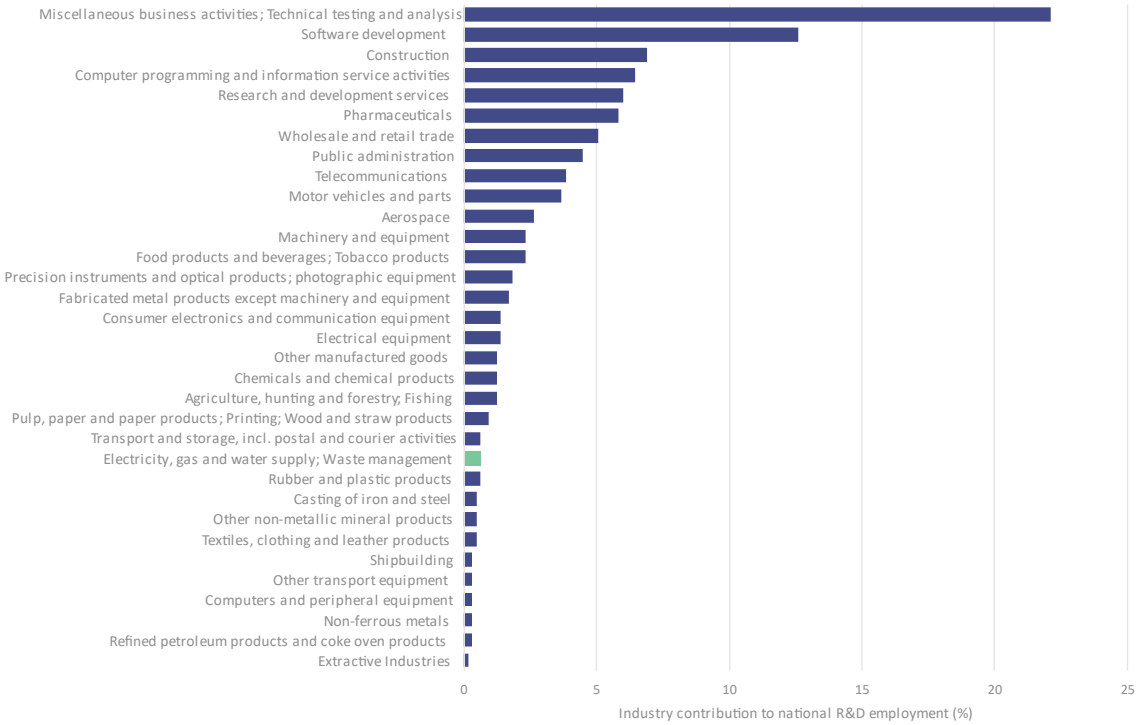
[43] *"Business enterprise research and development, UK", Office of National Statistics (February 2024).*

Figure 15: The 'Electricity, gas and water supply; Waste management' industry contributes little to the UK's total R&D spending.



Source: Economic Insight analysis of ONS data.

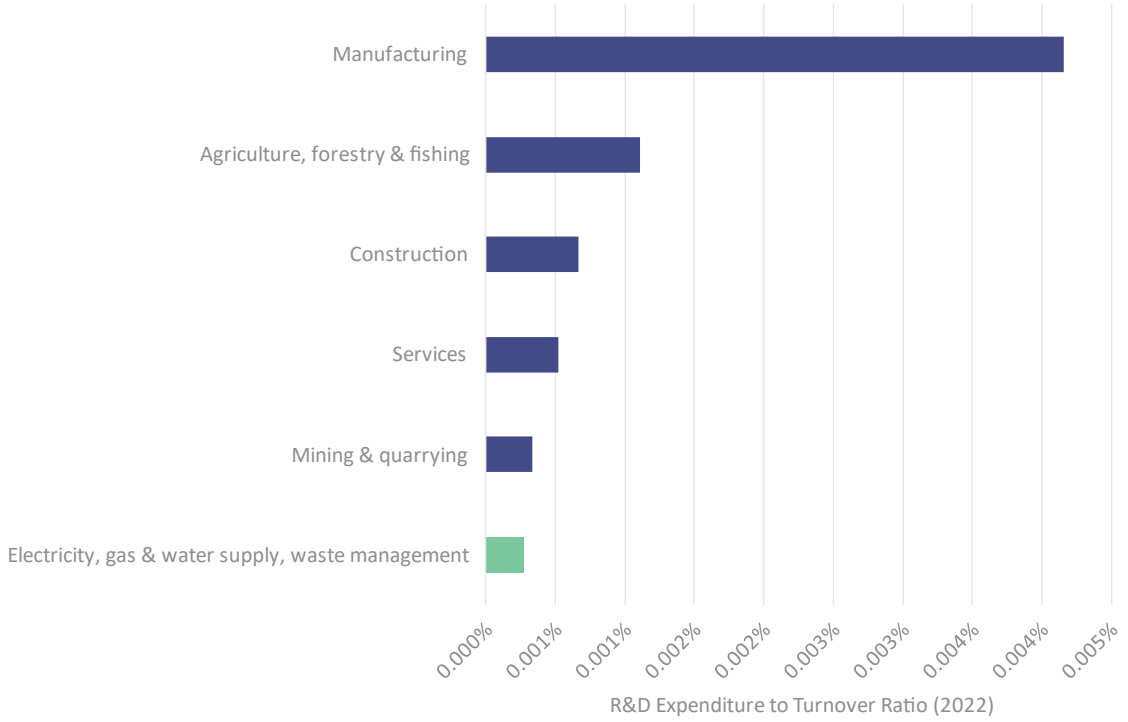
Figure 16: The 'Electricity, gas and water supply; Waste management' industry contributes little to the UK's total R&D employment.



Source: Economic Insight analysis of ONS data.

We note that that **Figure 15** and **Figure 16** do not scale for industry size (despite demonstrating the industry's very limited contribution to national R&D). Therefore, we also present these figures, scaling for the turnover of the respective industries. We find identical results: the water industry appears to have a very low propensity to invest and hire in R&D, which is at odds with the idea that the water industry is 'high-tech'.

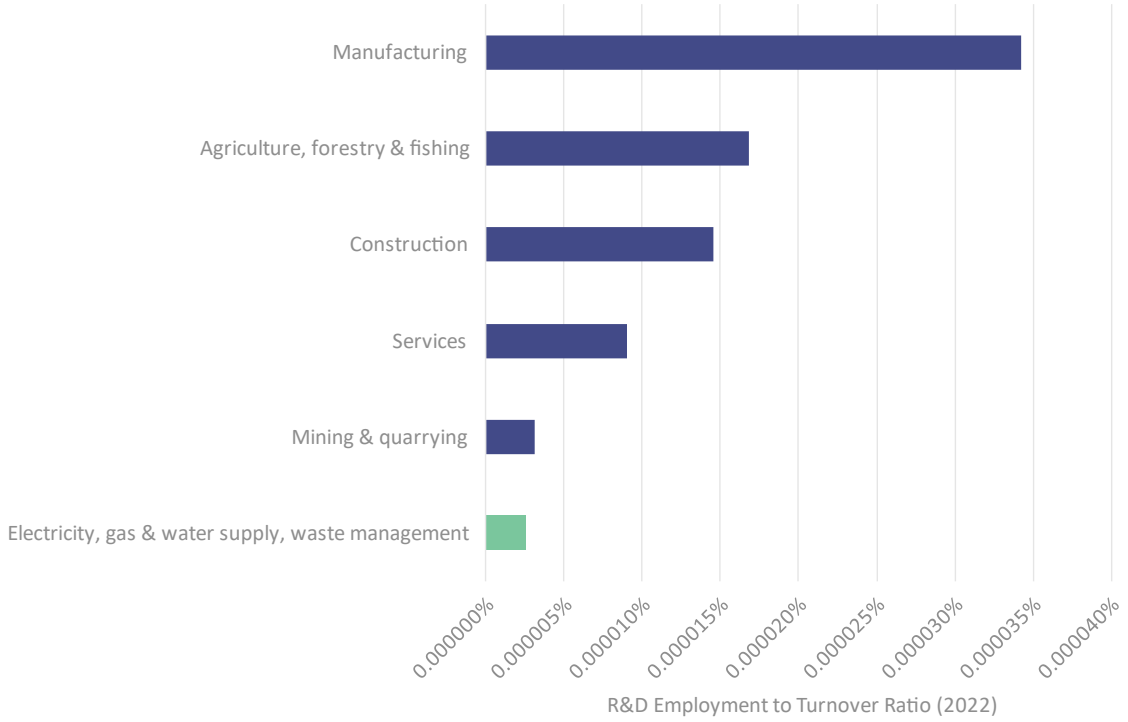
Figure 17: The 'Electricity, gas and water supply; waste management' industry spends the least on R&D of any industry in the UK when accounting for industry size.



Source: Economic Insight analysis of ONS data.

Note: R&D spending and employment statistics are only provided at the 'detailed product group' classification. This means that they cannot be directly mapped to industry SIC codes (the level at which revenue is reported) without aggregating to a higher level of 'product group' and SIC code.

Figure 18: The 'Electricity, gas and water supply; waste management' industry employs the fewest FTEs in R&D of any industry in the UK when accounting for industry size.



Source: Economic Insight analysis of ONS data.

Note: R&D spending and employment statistics are only provided at the 'detailed product group' classification. This means that they cannot be directly mapped to industry SIC codes (the level at which revenue is reported) without aggregating to a higher level of 'product group' and SIC code.

There may be multiple explanations for why the water industry exhibits low rates of innovation and investment in R&D. In broad terms, one might characterise possible explanations as falling between:

- Evidence that the water sector as a whole should be 'doing more' or 'performing better' (i.e. the low innovation / low investment reflects decisions by companies and / or underfunding under regulatory determinations).
- Evidence that the water industry has features that intrinsically make it 'low tech' (i.e. making it either impossible, and / or illogical and inefficient to innovate and invest at a materially higher rate than seen in the data).

05.03 The water industry does not exhibit features of high-tech industries

We consider that the above evidence, i.e. that the water industry reports *comparatively* low rates of innovation and R&D investment, is unsurprising when considering the features of the industry and the forces of demand and supply that apply to it. We set out several features below which would indicate that an industry is 'high-tech' and has scope to utilise and make productivity gains from new technologies.

Table 2: Features of high-tech industries.

Industry Feature	Relevance	Examples of industries with these features	Water industry
The industry faces continuous, rapid and large changes in demand from customers.	Industries with materially changing patterns of demand must innovate to both: (i) develop new products and services; and (ii) refine and improve existing products and services.	The pharmaceuticals industry is required to continuously develop new and innovative drugs and treatments to address new diseases/viruses etc. In addition, there are constant demands for existing treatments to have higher efficacy. The computer manufacturing industry must constantly innovate to reflect changing consumer and business demand. For example: ever faster processors to accommodate a shift from accessing information locally (on hard drives) to demand for real-time processing of cloud based data; the need to meet demand for ever more portable/multi-use computers, without reducing performance (leading to a fundamental shift from 'tower' to 'laptop' to 'tablet' and 'phone' computers). The car manufacturing industry is facing a material shift in consumer demand towards greater autonomy; hybrid and electrical powertrains; and shared use (over ownership).	At a fundamental level, the 'product / service' water customers demand (supply of clean potable drinking water and the treatment of wastewater) has remained largely unchanged for centuries (and will continue to be so). Unlike pharmaceuticals, for instance, there is no demand to create the 'new water'.
There is scope for (or a need to) the industry materially change its model of supply.	Where industries can fundamentally alter their supply model, they can (or may need to) explore and invest in innovations that make this possible.	The software development industry has been able to fundamentally change how it delivers its product (shifting from physical content such as CD-ROM) to download only. Wholesale and retail trade (for example, clothing retail) has been able to shift to more online supply model (e.g. removing physical stores), including: (i) direct delivery to customers; (ii) allowing customers to 'experience/view' products online; and (iii) facilitating returns and refunds.	The fundamental means by which the water industry delivers its products (clean potable drinking water and treated wastewater) cannot realistically change. Water and wastewater must be moved around a network of underground pipes within a specified region.

Relatively short asset lives.	All else equal (i.e. controlling for the above features) industries with a higher turnover of assets with generally benefit from new technologies more rapidly than industries with a slower turnover of assets.	High tech industries typically have short lived assets which are quickly replaced with new and better technology. For example, asset lives in 'Information and communication', 'Computer, electronic, optical products; electrical equipment' and 'Chemicals; basic pharmaceutical products' are just four, five and, seven years respectively.	The water industry is characterised by long-lived assets. The average asset life in the 'Water supply; sewerage, waste management and remediation activities' sector is 16 years.[44]
There are high returns to R&D investment.	In industries where the returns to R&D investment are higher, it is rational for companies to invest more heavily in cutting-edge technology.	High-tech industries typically face significant returns to investment in new technology, typically through 'winner-takes-all' market dynamics. For example: -The pharmaceutical sector rewards successful innovation with high profits from patented drugs.[45] -The ICT industry rewards successful innovation with 'market tipping' where positive network externalities cause buyers to follow each other to the same platform.[46]	The rate of return in the water industry is determined by the regulatory framework, and is generally calibrated around a 'low-risk/low-return' model. Although there are financial upsides from innovating, these are more limited than in industries where one typically observes higher rates of innovation.

Source: Economic Insight analysis.

[44] We calculate this for each NACE Rev.2 industry from FAME data using the following formula: asset life = value of tangible fixed assets / annual depreciation. This gives the implied asset life in years, if we assume a linear rate of depreciation. We calculate the asset life for each of the most recent 10 years for which data is available (2013-2022) and take the average across all years.

[45] "Strategic Patenting by Pharmaceutical Companies – Should Competition Law Intervene?", Gurluga, O.; National Library of Medicine (October 2020).

[46] "Ensuring effective competition in digital markets, for people, businesses and the economy", Competition and Markets Authority (April 2023).

06

CATCH UP EFFICIENCY AT PR24

We assess the evidence that EE has presented to Ofwat in their reply report and do not consider it gives reason to think that our estimates of frontier shift, based on our TFP benchmarking approach, are upwards biased in the period since the 2008-09 financial crisis.

06.01 Chapter structure

We have reviewed the evidence that EE presents to Ofwat on the risk that catch up efficiency might *upwards* bias estimates of frontier shift based on TFP data.

In this chapter we set out:

- As stated in our April 2023 report, the economic intuition behind catch up efficiency actually implies a *negative* bias in frontier shift estimates that are based on TFP.
- EE's arguments are not valid to our comparators or TFP estimates and ignore wider conceptual issues.
- The evidence that EE relies upon to come to the conclusion that "*since the 2008-09 financial crisis, catch-up efficiency has been negative*"[47] and why it does not support their conclusion.

06.02 The economic intuition behind the proposed negative bias

Catch up efficiency growth is one component of TFP growth in any industry, along with frontier shift. Companies on the frontier enjoy efficiency growth from frontier shift alone, while "laggard" firms (those that are less efficient than the frontier firms) enjoy catch up efficiency growth (in addition to frontier shift). Roughly speaking, the TFP growth rate of an industry will be the weighted (by proportion of frontier and laggard firms) average of frontier shift and catch up efficiency growth[48].

In general, economic theory predicts that catch up efficiency will be greater than frontier shift[49] (as in Case 1 in the table below), causing an *upwards* bias in the estimate of frontier shift based on TFP growth. That is to say, firms further behind the frontier should grow faster, given the larger stock of unexploited technologies and knowledge that they can readily implement. In this setting, TFP will *overestimate* frontier shift.

Abstracting away from other components of TFP growth for the purpose of considering this specific issue, TFP growth will be an unbiased estimator of frontier shift if:

- there are no laggard firms[50], meaning that all TFP growth for the industry comprises of frontier shift (Case 2); or
- laggard firms enjoy catch up efficiency growth at the same rate as frontier shift (Case 3).

We demonstrate these points with an illustrative example below.

[47] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 11, Europe Economics (July 2024)*

[48] *Abstracting away from other components of TFP growth, such as growth through economies of scale and scope.*

[49] *For example, see Neo-Schumpeterian growth theory (Aghion and Howitt, 2006; Acemoglu, Aghion and Zilibotti, 2006) and models of competitive diffusion (Jovanovic and MacDonald, 1994).*

[50] *This is what we seek to achieve through our sole use of highly competitive comparator industries, where all firms must operate at or very close to the frontier in order to survive (see Criteria 2 of our April 2023 report).*

Table 3: Illustrative example of how bias can arise in estimates of frontier shift based on TFP.

	Case 1	Case 2	Case 3
Proportion of firms in the industry on the frontier (A)	20%	100%	20%
Productivity growth from frontier shift (B)	1%	1%	1%
Proportion of firms in the industry that are laggards (C)	80%	0%	80%
Productivity growth from catch up (D)	2%	2%	1%
Industry TFP (E) = A*B + C*D	1.8%	1%	1%
Bias in TFP as an estimate of frontier shift (F) = E-B	0.8%	0%	0%

Source: Economic Insight analysis.

Note: Note that the Bias (F) only applies to the final frontier shift estimate if the specific industry is in the final comparator set.

The possibility that EE appears to allude to in their report[51] is where the laggards have productivity growth less than frontier shift. This can also include negative catch up efficiency growth (e.g. 0.5% or -0.5% as in Case 4 and 5 below). In such a situation, although not the conventional prediction of economic theory, an estimate of frontier shift based on TFP would be *downwards* biased.

[51] EE refers only to "negative" catch up efficiency, which appears to be a short hand for 'catch up efficiency growth that is slower than frontier shift'. Although they do not make their meaning clear, this is the only theoretically sound interpretation of their argument.

Table 4: Illustrative example of how bias can arise in estimates of frontier shift based on TFP.

	Case 4	Case 5
Proportion of firms in the industry on the frontier (A)	20%	20%
Productivity growth from frontier shift (B)	1%	1%
Proportion of firms in the industry that are laggards (C)	80%	80%
Productivity growth from catch up (D)	0.5%	-0.5%
Industry TFP (E) = A*B + C*D	0.6%	-0.2%
Bias in TFP as an estimate of frontier shift (F) = E-B	-0.4%	-1.2%

Source: Economic Insight analysis.

Note: Note that the Bias (F) only applies to the final frontier shift estimate if the specific industry is in the final comparator set.

While we acknowledge the *theoretical* possibility of a downwards bias in estimates of frontier shift based on TFP data, we do not consider that EE's arguments on this point are conceptually sound, nor that the evidence that they rely upon supports their conclusions. We elaborate on these points in the sections below.

06.03 EE's arguments are not valid to our comparators or TFP estimates and ignore wider conceptual issues

EE conclude in their report that "*[s]ince the 2008-09 financial crisis, catch-up efficiency has been negative, meaning that TFP growth understates frontier shift*"[52]. We do not consider that EE's conclusion, or evidence, give reason to think that our estimates of frontier shift, based on our TFP benchmarking approach, are upwards biased in the period since the 2008-09 financial crisis. This is because:

- **Our data driven comparator selection criteria are specifically designed to ensure that few firms in our chosen industries are "laggard" firms** that are benefiting (or otherwise) from catch up efficiency. This means, regardless of *how negative* catch up efficiency might be, it is small as a proportion of total TFP growth for the industry (as the firms must all operate close to the frontier in order to survive). Our comparator approach is used to ensure that bias is minimised (to the extent possible), regardless of whether catch up efficiency growth is positive or negative (see Case 2). We have already covered this issue extensively in Chapter 5 of our April 2023 report.

[52] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 11, Europe Economics (July 2024).*

- **EE's evidence does not show that catch up efficiency has been negative in our (or Ofwat's) chosen comparator industries**. If catch up efficiency has not been shown to be negative in these specific industries used to determine the frontier shift benchmark, then EE cannot conclude that there is bias in said frontier shift estimates (see Case 3). We discuss EE's evidence in detail in Section 06.04 below.

- **EE's evidence is reliant on (increasing) productivity dispersion in an industry being a proxy for (slowing) catch up efficiency growth.** We consider that productivity dispersion is not a reliable proxy for catch up efficiency. Rather, it could result from: (i) widely defined industries experiencing changes in the relative size of their sub-industries over time (for example, 'Agriculture, forestry and fishing'); (ii) a high rate of firm entry, where highly inefficient new firms catch up quickly; or (iii) large differences in company size prompting dispersion in efficiencies enjoyed as a result of economies of scale.

In addition, even if a bias was found, there are a number of wider conceptual problems to consider:

- Irresolvable technical details, such as the size and direction of bias resulting from catch up efficiency growth, if deemed to be material would seem to call into question the purpose of TFP benchmarking as a means of setting frontier shift in the first place. Rather than try to estimate the size of the bias through proxies (such as EE's efficiency dispersion measure) or by undertaking the highly technical task of decomposing TFP data, it is best to avoid the bias in the first place, for example through rigorous and data driven comparator selection (as we do in our April 2023 report[53]).

- As stated in Chapter 1, EE has not considered whether *increases* in catch up efficiency over time might mean that TFP has overstated frontier shift potential (particularly over previous AMPs). They conclude from their analysis that a negative correction is required for the 2010-2019 TFP data used in our 'PR24 focused range' (when dispersion was high), but seemingly that a positive adjustment is somehow not required for the 1970-2009 period (when dispersion was low). To this extent, at *worst*, EE's report is unbalanced as it fails to consider that companies may have been penalised when catch up efficiency growth is large, including at prior price controls. At *best*, EE's arguments are simply unhelpful – EE do not propose any sort of systematic way to address the potential bias arising from catch up across price controls, they simply raise the point that the bias could mean a higher frontier shift targeted is required *right now*. By contrast, our comparator selection method, which aims to eliminate catch up efficiency from TFP estimates (to the extent possible) through Criteria 2, has scope to be applied consistently across price controls.

EE do not propose any sort of systematic way to address the potential bias arising from catch up across price controls.

06.04 Our assessment of EE's evidence

As discussed in Section 06.03, EE use the dispersion of productivity in an industry as an indicator for catch up efficiency growth being negative (and therefore whether it causes a negative bias in estimates of frontier shift derived from TFP). As explained, we disagree with the use of productivity

[53] *Criteria 2 of our comparator selection process aims to replicate Case 2 in* ***Table 3****.*

dispersion as a proxy.[54] However, as detailed below, we consider that EE's evidence does not even show that productivity dispersion has increased (regardless of its merits, or otherwise, as a proxy). EE examine a number of papers which examine:

- estimated efficiency dispersion within industries; and
- the number of zombie firms, which is a proxy for dispersion (an increase in zombie firms indicates an increase in dispersion because they have poor productivity growth).

Contrary to their claims, however, the evidence that EE presents to Ofwat does not show that estimated efficiency dispersion, nor the number of zombie firms, has increased *in our comparator industries*[55]. As we briefly referenced in Chapter 1, we are concerned that this may call into question the balance with which they have presented their arguments to Ofwat. In particular:

- Andrews et al (2016) heavily caveats their findings of "*rising MFP divergence between frontier and laggard firms across a panel of 24 OECD countries*"[56] by stating that "*the increase in the MFP gap is not uniform across sectors*"[57] and that the increase in the MFP gap was driven by the service sector[58] and "*industries that had the most rapid increase in the use of ICT*"[59]. This finding is mirrored by Faggio et al (2007)[60] who state "*the increase in the productivity dispersion…is mainly in the service sector of the economy*"[61]. Plainly, this is not applicable to our comparator set which are industries that are based on "*extraction and processing of a resource; operation and maintenance of a complex network; and the construction of major infrastructure*"[62].

- Decker et al. (2016), Berlingieri et al. (2017) and Gamberoni et al. (2016) do not use data from the UK in their research, let alone data on our specific comparator industries. Banerjee and Hoffman (2018) similarly use data from a large number of countries and do not specifically discuss our comparator industries.

- EE describe the findings of McGowan et al (2017) as "*the prevalence of and resources sunk in zombie firms across nine OECD countries (again including the UK) have risen since the mid-2000s*"[63]. This is factually incorrect. McGowan et al (2017) finds that the UK is unique amongst the nine countries studied because they experienced a *decline* in the number of zombie firms, a *decline* in the proportion of employment tied up in zombie firms and a *decline* in the proportion of the capital stock tied up in zombie firms in the period after the financial crisis. For example,

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*[54] Note that, in any case, EE appears to have misunderstood the relationship between productivity dispersion and catch up efficiency growth. For instance, they state that sectors "experience negative catch up efficiency due to increased productivity dispersion". This gets the order of causality the wrong way around. A decrease in (unobserved) catch up efficiency will **cause** an increase in (observed) efficiency dispersion. If we observe an increase in efficiency dispersion, we could then infer that catch up has decreased. However, as discussed in this Chapter, there are a number of reasons other than a decrease in catch up that could explain an increase in observed efficiency dispersion.*

[55] Which is a necessary component of a test of bias in our frontier shift estimates.

[56] "Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 11, Europe Economics (July 2024).

[57] "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", page 31, Andrews, D; Criscuolo, C; Gal, P; OECD (2016).

[58] "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", page 31, Andrews, D; Criscuolo, C; Gal, P; OECD (2016).

[59] "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", page 26, Andrews, D; Criscuolo, C; Gal, P; OECD (2016).

[60] Note that EE refer to this paper as Faggio et al (2010).

[61] "The Evolution of Inequality in Productivity and Wages: Panel Data Evidence", page 5, Faggio, G; Salvanes, K; Van Reenen, J; NBER (2007).

[62] "Productivity and frontier shift at PR24", page 52, Economic Insight (April 2023).

[63] "Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 12, Europe Economics (July 2024).

they write "*good news in the United Kingdom, however, where the decline in the zombie share after 2007 … boosted investment by 1.5%, relative to a counterfactual where the zombie share had stayed at its 2007 level*"[64]. This evidence is bolstered by Faggio et al (2007) who describes the "*cleaning effect of recessions"* where*"[t]he least productive firms are more likely to exit … and this effect is likely to be particularly strong during cyclical downturns"*[65] and Haldane (2017), saying that in the UK "*the tail of low-productivity companies today is, if anything, smaller than it was pre-crisis*"[66].

- As discussed in Section 06.03, we have chosen our comparators, using Criteria 2 in our April 2023 report, to be the most competitive industries. Economic theory predicts that productivity dispersion will be significantly less likely in highly competitive industries. This is because the majority of companies must be operating at, or close to, the frontier in order to survive. In line with this, papers cited by EE specifically state that dispersion is most prevalent in industries with low competition (or that dispersion has increased in industries with declining competition). For example, Andrews et al (2016) write:
  - "*the stagnation in the MFP growth of laggard firms may be connected to … a decline in the contestability or competitiveness of markets*"[67];
  - *"we find MFP divergence to be much more extreme in sectors where pro-competitive product market reforms … were least extensive"*[68]*;* and
  - *"[t]he productivity divergence patterns unveiled … partly reflect the increasing potential for digital technologies to unleash winner takes all dynamics …, which allows the technological leaders to increase their MFP gap with laggard firms"*[69].

We find further evidence of a decline (rather than increase) in zombie firms following the financial crisis in the House of Commons' analysis of ONS Business Demography data[70]. They show a spike in firm deaths in the period following the financial crisis, followed by a boom in firm births before business birth and death rates return to their long-run trend. This data does not relate specifically to our comparator industries, but is at odds with EE's wider assessment that catch up efficiency is negative in the post-crisis period in the UK.

[64] *"The Walking Dead? Zombie Firms and Productivity Performance in OECD Countries", page 27, McGowan, M; Andrews, D; Millot, V; OECD (2017).*

[65] *"The Evolution of Inequality in Productivity and Wages: Panel Data Evidence", page 13, Faggio, G; Salvanes, K; Van Reenen, J; NBER (2007).*

[66] *"Productivity Puzzles", page 15, Haldane, A; Bank of England (2017).*

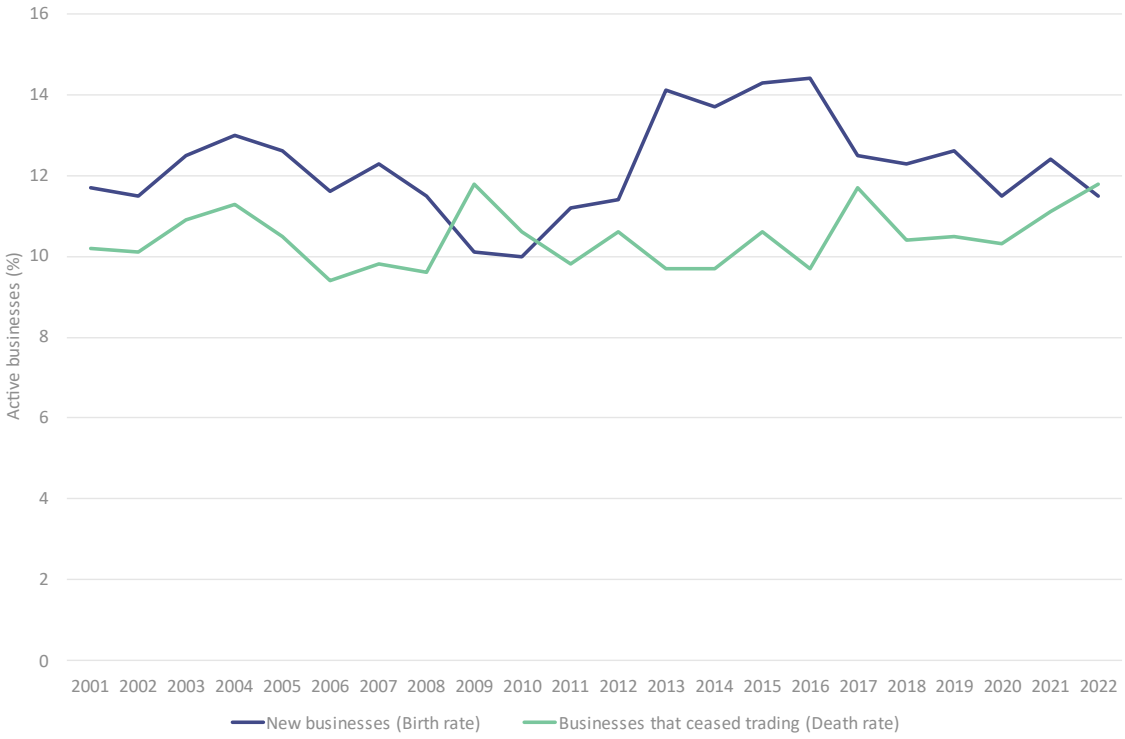
[67] *"The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", page 7, Andrews, D; Criscuolo, C; Gal, P; OECD (2016).*

[68] *"The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", page 7, Andrews, D; Criscuolo, C; Gal, P; OECD (2016).*

[69] *"The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", page 25, Andrews, D; Criscuolo, C; Gal, P; OECD (2016).*

[70] *"Business Statistics: Research Briefing", page 19, Hutton, G; House of Commons Library (2024).*

Figure 19: Business birth and death rates show evidence of "creative destruction" and the "cleaning effect of recessions".



Source: House of Commons' analysis of ONS Business Demography data.

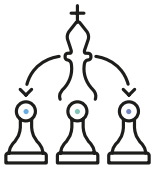
07

CONCLUSIONS

07.01 Chapter structure

In this chapter, we conclude our assessment of the evidence presented by Ofwat's economic advisers and set out our view that a balanced appraisal of the information supports our recommended frontier shift ranges for PR24.

07.02 Conclusions



In the context of: (i) PR14 representing a breakpoint in regulatory method, whereby Ofwat set a materially higher frontier shift challenge than it had done up until then (i.e. at PR99; PR04; and PR09); (ii) the UK's well-documented flat and near-zero productivity performance since 2008; and (iii) the water industry's actual productivity performance similarly flatlining over that time period and being well-below Ofwat's frontier shift targets, it is important to reappraise the approach to, and level of, frontier shift at PR24 (in order to avoid underfunding efficient companies, to the detriment of customers and the environment).

We would encourage a careful and balanced appraisal of the evidence, whereby weight and attention is placed on the key intuition and substantive evidential points, rather than more detailed technical issues. Too great a focus on points of detail may ultimately lead to one rationalising either adjustments to raw benchmarked TFP data, and/or certain interpretations of said TFP data that fundamentally call into question the merit of TFP benchmarking as a means of setting frontier shift in the first place (i.e. because it allows one to support any given frontier shift number from one price control to the next, undermining stability and predictability).

The additional evidence set out in this report provides no basis for us to revise our recommended (focused) range for frontier shift at PR24 of 0.3%-0.7% pa. A frontier shift challenge of 1.0% pa assumes the water sector will outperform anything that the UK water industry (including unregulated firms) has been able to achieve at any point in the last 20 years by more than an entire percentage point (as can be seen in **Figure 4**).

08

ANNEXES

08.01 Chapter structure

In this chapter we set out:

- An analysis of alternative measures of underinvestment in the water sector and wider UK economy (to those presented in Chapter 4).
- An 'agree-disagree' table that provides a summary of where our views differ from those of Ofwat's advisers.

08.02 Alternative investment measures

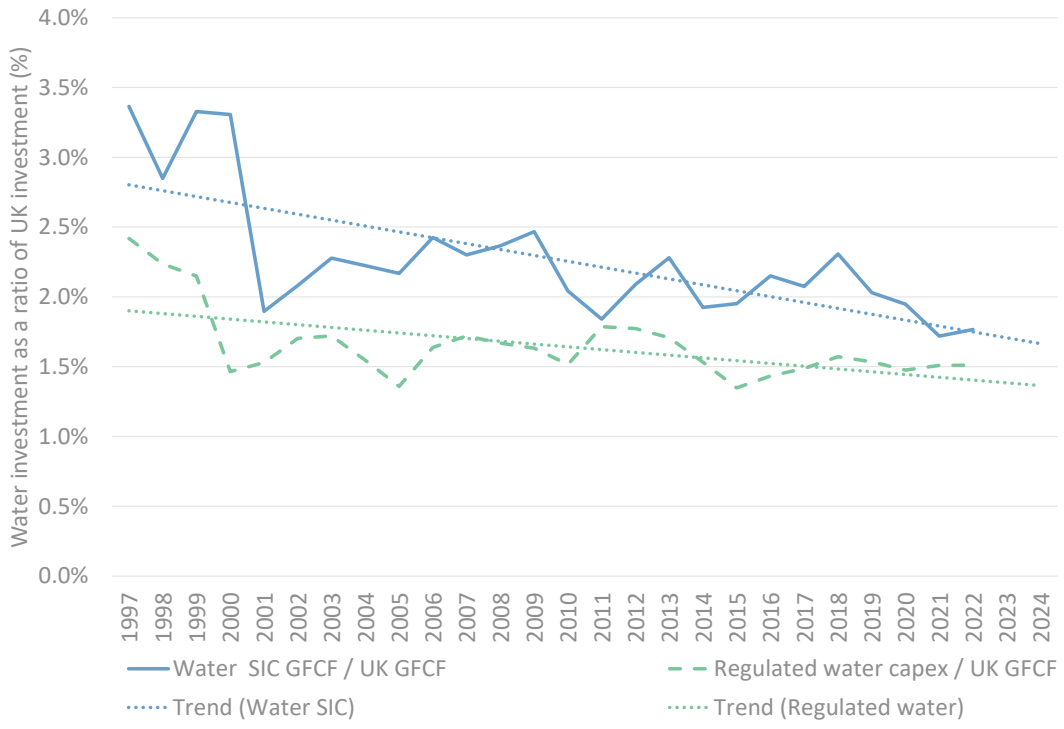
In this annex we present comparisons of water sector investment with that of the overall UK economy using alternative metrics to those shown in Section 04.02. We examine the following metrics in turn:

- The ratio of water investment to UK investment.
- The GFCF to gross capital stock ratio.
- The growth rate of net capital stock and the growth rate of gross capital stock.

The ratio of water investment to UK investment

The figure below illustrates that water sector investment as a proportion of UK investment (as measured by GFCF) is declining over time. This trend also holds for the capital expenditure series, which only includes regulated water companies. This suggests that the water sector is contributing relatively less to total UK investment over time. There are a number of reasons this could have happened (other than the water sector underinvesting), however this provides another indication that the water sector is not immune from the underinvestment observed for the UK economy as a whole.

Figure 20: Water sector investment as a proportion of UK investment (as measured by GFCF).



Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

Note: All series have been inflated into March 23/24 prices using the ONS CPIH index.

GFCF to net capital stock ratio

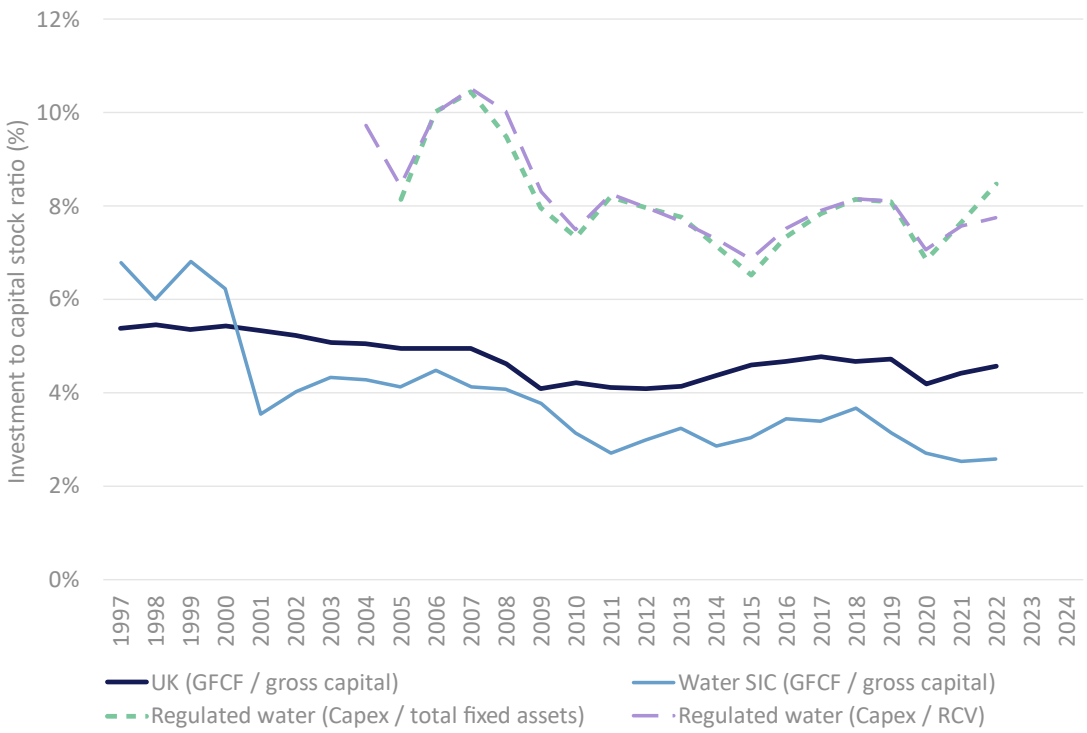
Capital stock is "*the quantity of produced non-financial assets with a lifespan of more than a year (for example, buildings and machinery), which contribute to the production of goods and services, without being completely used up or transformed in the process.*"[71] Capital stock estimates are published in gross and net values, where:

- Gross capital stock is defined as "the value of all fixed assets still in use at a point in time"[72]; and
- Net capital stock is the "gross capital stock, less the consumption of fixed capital accrued up to that point. It takes into account the depreciation of the assets through time as a result of physical deterioration, foreseeable obsolescence or normal accidental damage".[73]

In Section 04.02, we compared the GFCF to the *net* capital stock ratio for the UK and the water sector. Below we present this analysis for the *gross* capital stock instead. We find that similar conclusions hold: (a) the trend in investment in the UK and the water sector are similar over time; and (b) the water sector is investing a lower proportion relative to its capital stock than the UK as a whole. As for net capital stock, we also include the ratio of capex to total fixed assets (and RCV) on the same chart to show that the trend also holds for the regulated water companies (even if these metrics are not directly comparable to GFCF and capital stock). We present this analysis in **Figure 21** overleaf.

[71] *"Capital stocks and fixed capital consumption, UK: 2023", ONS (2023).*
[72] *"Capital stocks and fixed capital consumption, UK: 2023", ONS (2023).*
[73] *"Capital stocks and fixed capital consumption, UK: 2023", ONS (2023).*

Figure 21: GFCF to Gross capital stock ratio.



Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

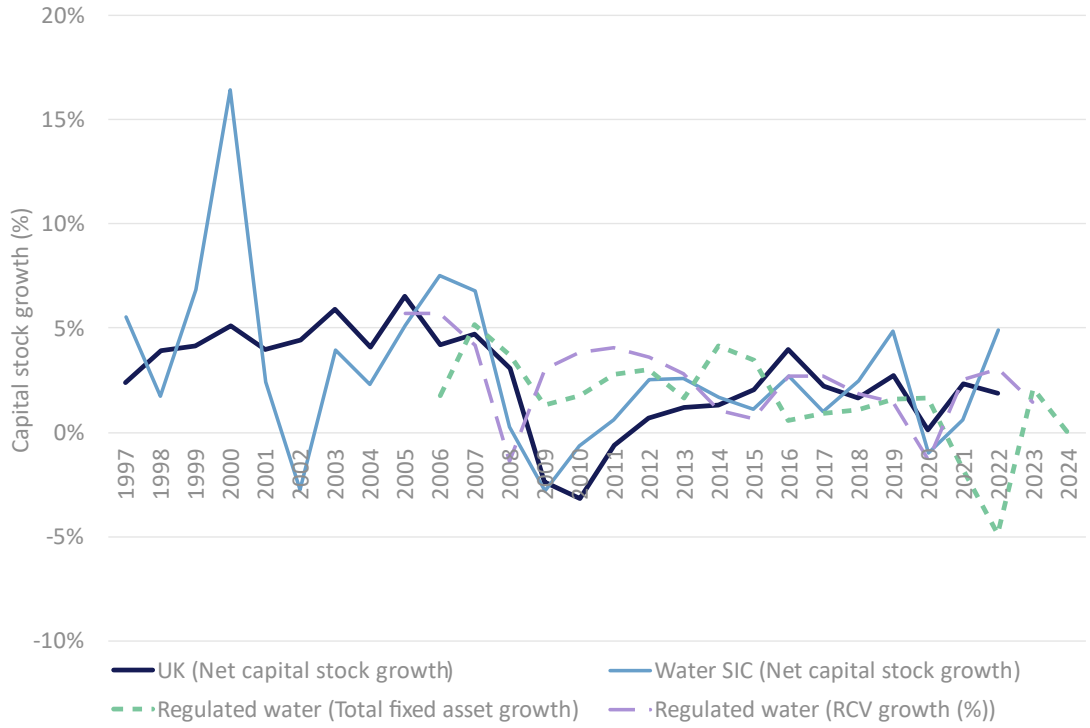
Note: All series have been inflated into March 23/24 prices using the ONS CPIH index.

Capital stock growth rate

An alternative way of comparing investment growth in the UK as a whole and the water sector over time is the growth rate in the capital stock. These comparisons for net and gross capital stock are illustrated in **Figure 22** and **Figure 23** respectively. As can be seen, the growth rate of investment under both measures follows a similar trend in the water sector and the UK over time. This provides further evidence that investment in the water sector has not grown significantly faster than the UK as a whole, and thus indicates that the water sector has not been completely immune to the wider underinvestment problem.

As for the other investment measures in this report, we also include measures of capital stock growth rate specifically for the regulated water companies in these graphs. These measures are total fixed asset growth and RCV growth. These series follow a similar trend to the capital stock growth for the Water SIC code, providing further evidence that these conclusions apply to the regulated water sector and not just the non-regulated firms in this industry classification.

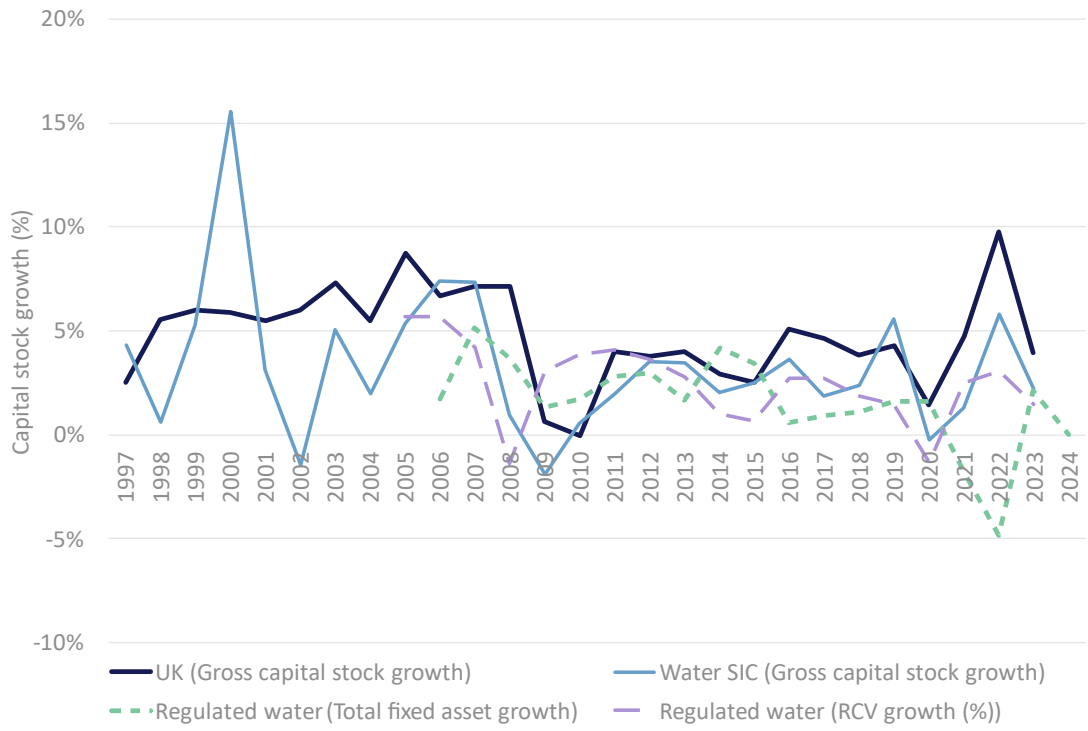
Figure 22: Net capital stock growth rate (%).



Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

Note: All series have been inflated into March 23/24 prices using the ONS CPIH index.

Figure 23: : Gross capital stock growth (%).



Source: Economic Insight analysis of ONS data and Ofwat's long-run costs dataset.

Note: All series have been inflated into March 23/24 prices using the ONS CPIH index.

08.03 Summary of areas of agreement / disagreement between the advisors

The table overleaf provides a summary of where our views differ from those of Ofwat's advisers.

Table 5: Areas of agreement / disagreement between Economic Insight and Ofwat's advisers.

Subtopic	EE view / CEPA view	Economic Insight view
Topic 1: Measured TFP and implied adjustments to the benchmarking range		
1.1 Overall adjustment to benchmarking approach	EE argues that the top end of the range provided by TFP growth data (or even above the top end should be chosen).[74]	Post-benchmarking adjustments should be avoided and point estimates from any benchmarked range should generally be taken from values 'towards the middle' of that range. The evidence is not strong enough to deviate from this when some factors imply an upward adjustment and some imply a downward adjustment, and the magnitudes of the adjustments are unknown.[75]
1.2. Catch-up efficiency	EE believes catch-up efficiency implies an upward adjustment to a TFP benchmarking approach, because it considers catch-up efficiency has been negative.[76]	Catch-up efficiency implies a downward adjustment to a TFP benchmarking approach. Catch-up efficiency is unlikely to be negative according to the evidence available.[77]
1.3 Embodied technical change	EE believes there should be a large upward adjustment to TFP estimates to take account of embodied change.[78] EE believes the water sector has considerable scope for technological change.[79] It believes that the innovation	It is not possible to conclusively say whether an upward or downward adjustment should be made to TFP estimates to take account of embodied change – a small upward adjustment is likely for our comparator set.[81] The water sector has limited scope for technological change. It is unlikely that a relatively small innovation

[74] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 22, Europe Economics (July 2024).*

[75] *For more detail, please see: "Productivity and frontier shift at PR24", page 88, Economic Insight (April 2023).*

[76] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 11, Europe Economics (July 2024).*

[77] *For more detail, please see Section 06 and: "Productivity and frontier shift at PR24", page 69, Economic Insight (April 2023).*

[78] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 25, Europe Economics (July 2024).*

[79] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 13, Europe Economics (July 2024).*

[81] *For more detail, please see: "Productivity and frontier shift at PR24", page 73, Economic Insight (April 2023).*

	fund could be transformative despite the small size of the fund.[80]	fund (only around 0.33% of totex) will have a material impact on the productivity growth of the water sector.[82]
1.4 Double count of quality improvements	EE believes Ofwat is not double-counting its efficiency challenge by asking companies to make quality improvements out of base funding as well as reducing costs through a frontier shift challenge.[83]	Ofwat is double-counting its efficiency challenge by asking companies to make quality improvements out of base funding as well as reducing costs through a frontier shift challenge. This is because the TFP of the *comparators* used contains quality improvements.[84]
1.5 RPEs and overlap with CPIH	EE believes there is no inconsistency between Ofwat's approach to frontier shift and RPEs.[85] CEPA also believes that no adjustment for CPIH is needed.[86]	The frontier shift challenge should be set as the extent to which industry specific frontier shift differ from the gains implicitly captured in CPIH. Inflation measures (such as CPIH) already have productivity gains 'built' into them. Therefore, some productivity improvement is already captured when indexing costs or RCV using CPIH.[87]
1.6 Productivity measure	CEPA believes both gross output and value added measures of TFP should be used.[88]	Only gross output measures of TFP should be used, because these are more reflective of the productivity gains achievable by the water sector. Value added measures are less appropriate as they fail to account for intermediate inputs. Using gross output is also aligned with Ofwat's PR19 position.[89]

[80] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 8, Europe Economics (July 2024).*

[82] *For more detail, please see: "Further evidence on frontier shift at PR24", page 48, Economic Insight (March 2024).*

[83] *"Frontier Shift and Outcomes Stretch at PR24", page 3, Europe Economics (March 2023).*

[84] *For more detail, please see: "Productivity and frontier shift at PR24", page 36-38, Economic Insight (April 2023).*

[85] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 13, Europe Economics (July 2024).*

[86] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 67, CEPA (June 2024).*

[87] *For more detail, please see: "Productivity and frontier shift at PR24", page 36, Economic Insight (April 2023).*

[88] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 75 , CEPA (June 2024).*

[89] *For more detail, please see: "Productivity and frontier shift at PR24", page 28, Economic Insight (April 2023).*

Topic 2: Extent to which the productivity slowdown should be taken into account		
2.1 Overall effect of productivity slowdown on water sector	CEPA believes that the "productivity puzzle" should not be fully reflected in the scope for productivity gains in regulated sectors.[90]	The productivity slowdown should be taken into account when setting the frontier shift challenge since there are limited reasons to believe that regulation mitigates the productivity slowdown. This is because the most important factors[91] in explaining the economy-wide slowdown (according to leading academic experts) are largely applicable to the water sector.[92] In addition, factually the water sector's TFP shows a large slow-down post-crisis, which is consistent with it being affected by the factors impacting the UK more broadly at that time.[93]
2.2 Factors explaining the productivity slowdown	EE believes that more than just the five most important factors presented by Economic Insight should be considered and that the five factors do not explain the slowdown.[94]	Other factors may have some relevance, but are less important than the top five factors. It is logical to focus on the factors considered to be most impactful. The factors we focus on reflect the independent views of leading academic experts in the field of productivity.[95]
2.3 Is underinvestment mitigated by regulation?	EE believes that there are strong reasons to believe that water sector regulation mitigates against any investment slowdown. [96]	In principle, economic regulation may mitigate the underinvestment factor (but not the other factors contributing to the slowdown). However, the null hypothesis is an 'ambiguous' impact, as it would turn the specifics of how each price control was set.

[90] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 72 , CEPA (June 2024).*

[91] *These are: (i) investment; (ii) infrastructure quality; (iii) quality of human capital stock; and (iv) management quality. For more detail, please see: "Further evidence on frontier shift at PR24", Chapter 3, Economic Insight (March 2024).*

[92] *For more detail, please see: "Further evidence on frontier shift at PR24", Chapter 3, Economic Insight (March 2024).*

[93] *For more detail, please see Section 3.02.*

[94] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 41-42, Europe Economics (July 2024).*

[95] *For more detail, please see: "Further evidence on frontier shift at PR24", Chapter 3, Economic Insight (March 2024).*

[96] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 42, Europe Economics (July 2024).*

		In practice, the data suggests that regulation has not mitigated underinvestment in the water sector.[97]
2.4 Relevance of the academic survey	EE believes the academic survey evidence on future productivity growth has limited relevance to setting a frontier shift challenge at PR24.[98]	The survey is relevant to the frontier shift challenge. It reflects independent views of leading academic experts in the field of productivity and the findings are published in a peer-reviewed journal.[99]
2.5 Historical frontier shift challenges vs outturn TFP	EE believes regulatory determinations of frontier shift are in line with outturn TFP estimates for several comparator sectors to the water industry.[100]	Ofwat's frontier shift targets have trended upwards over time, which is at odds with the slowdown in productivity growth observed across the UK economy as a whole and most sectors.[101] Ofwat's frontier shift targets are also far higher than the productivity growth actually achieved by the water sector itself.[102]
2.6 Likelihood of productivity slowdown underwinding over AMP8	EE believes that there are strong arguments for expecting faster economy-wide-productivity growth going forward (than has been observed in the period following the financial crisis).[103]	The expectations of improvements in productivity growth that regulators and their advisers relied upon in making previous decisions have simply not materialised. This suggests that regulators should not continue to set frontier shift based on an expectation that productivity growth will improve and raises concerns that the industry has been materially underfunded at previous price controls.[104]

[97] For more detail, please see Section 04 and: "Further evidence on frontier shift at PR24", pages 38-41, Economic Insight (March 2024).

[98] "Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 42, Europe Economics (July 2024).

[99] For more detail, please see Section 01.

[100] "Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", page 8, Europe Economics (July 2024).

[101] For more detail, please see: "Productivity and frontier shift at PR24", page 20, Economic Insight (April 2023).

[102] For more detail, please see Section 03.02.

[103] "Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 15-16, Europe Economics (July 2024).

[104] For more detail, please see Section 03.04.

Topic 3: Benchmarking choices		
3.1 Time period	CEPA use the time period 1996 to 2019.[105] EE believes Economic Insight places insufficient weight on pre-crisis productivity growth.[106]	The time period 2010 to 2019 gives the likely lower bound, while a longer-term time period (a weighted average of 1995-2019 and 1970-2007) gives the likely upper bound.[107] It is unlikely that the productivity puzzle fully unwinds so a partial unwinding provides the likely upper bound (any may overstate frontier shift).[108]
3.1 Comparator selection method	CEPA uses the same comparator set as PR19. These are sectors that were "*judged to be both competitive and similar in nature to the water sector*."[109]	Comparators should be chosen based on data-driven criteria that capture the nuances of sector similarity (not just surface-level similarity).[110]
3.2 Inclusion of total industries in comparator set	EE believes the inclusion of total industries in the comparator set is inappropriate.[111]	Total industries should be included in the comparator set to reflect changes in the entire UK on average.[112] TFP data for total industries is also less sensitive to revisions to the EU KLEMS data and exhibits lower annual variance than sectoral level data.

[105] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 72 , CEPA (June 2024).*

[106] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 15, Europe Economics (July 2024).*

[107] *For more detail, please see: "Productivity and frontier shift at PR24", page 45-46, Economic Insight (April 2023).*

[108] *For more detail, please see: "Productivity and frontier shift at PR24", page 45-46, Economic Insight (April 2023).*

[109] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 74 , CEPA (June 2024).*

[110] *For more detail on our approach, please see: "Productivity and frontier shift at PR24", Chapter 5, Economic Insight (April 2023).*

[111] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 20, Europe Economics (July 2024).*

[112] *For more detail on our approach, please see: "Productivity and frontier shift at PR24", page 59, Economic Insight (April 2023).*

Topic 4: Frontier shift benchmarking range		
4.1 Frontier shift range for total water value chain	CEPA suggests that considering all evidence in the round, a more plausible range lies between 0.8% and 1.2%.[113]	It is likely that frontier shift will be within the range 0.3%-0.7% over PR24 ('PR24 focused range'). It is implausible, but not impossible, for frontier shift to lie outside of the range 0.3%-0.8% ('plausible range'). These ranges are based on a benchmarking approach.[114]
4.2 Frontier shift range for retail	CEPA considers the range of 0.8% to 1.2% to be appropriate for retail too. It uses the range for wholesale water and cross-checks this against the rate of TFP GO growth achieved by the PR19 retail comparator set over 1996-2019 (1.1%).[115]	The plausible range for retail is 0.3% to 0.6%. This is based on a retail-specific benchmarking approach.[116]
4.3 Upper bound of benchmarking range	EE believes that the upper end of the benchmarking range should be informed by comparator sectors with the fastest TFP growth rates, not the average across all comparator sectors.[117]	The upper end of the benchmarking range should be informed by an average across comparator sectors because: (a) The TFP data for individual industries is not reliable enough to use a single industry as the benchmark; and (b) the purpose of choosing multiple industries as comparators is because we accept no single industry can be 'perfect' comparators for water - choosing a single industry to determine the upper bound ignores this.

Source: Economic Insight analysis.

[113] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 80 , CEPA (June 2024).*

[114] *For more detail please see: "Productivity and frontier shift at PR24", Chapter 7, Economic Insight (April 2023).*

[115] *"Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism", page 88 , CEPA (June 2024).*

[116] *For more detail please see: "Productivity and frontier shift at PR24", Chapter 8, Economic Insight (April 2023).*

[117] *"Critique of Economic Insight Reports on Productivity and Frontier Shift at PR24", pages 26, Europe Economics (July 2024).*

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