It is well established that there are close interrelationships between productivity, equity returns, and inflation. Consequently, when determining these parameters in the context of setting a price control, it is important to recognise these relationships to ensure that they reflect an internally consistent view of the UK economy over the relevant time period (as reflected in how independent bodies, such as the OBR, derive their economic forecasts). Ofwat's position at IAP, however, does not appear to reflect these connections. Specifically, there is a clear tension between Ofwat simultaneously arguing that total equity market returns will be 'low' (due it placing most weight on the recent past and future returns, and assuming low productivity), whilst also suggesting that, for the purpose of setting 'frontier shift', productivity gains will be abnormally high. There is a further related tension in suggesting that real price effects will be zero for the industry (which also has a time period dimension). Both theory and empirical evidence show that this issue arises at both an economy and industry level, and so the interdependencies cannot be 'dismissed' in the context of PR19. In relation to frontier shift, there is furthermore a clear 'double counting' risk, relating to assumed outcomes performance for the industry. These tensions are in addition to a more general concern that Ofwat has adopted unduly 'aggressive' assumptions on each parameter – and more specific concerns we have regarding the method and evidence relied upon by Ofwat.

1.   Introduction and executive summary

When making its determinations at PR19, Ofwat must ultimately set a large number of parameters. Several of these are closely interrelated - and are materially driven by one's view of the wider UK economic context over the time period in question (either directly, or indirectly). Therefore, it is essential to ensure that, when setting such parameters, Ofwat (and companies) adopt a holistic approach that reflects an internally consistent view of the UK economy – thus, the water sector. This report, developed for Wessex Water (Wessex), focuses on three such parameters:

- – equity returns and the cost of capital;
- – productivity (frontier shift); and
- – inflation (real price effects).

The key findings from our analysis of the above issues are as follows:

- Ofwat's position, as clarified at IAP, on the above parameters appears to reflect an internally inconsistent view of the UK macroeconomy over PR19. On the one

hand, Ofwat assumes high productivity growth over PR19, with 'bullish' frontier shift of 1.5% p.a. Such high productivity growth would be justified if Ofwat expected robust economic growth over PR19. On the other hand, Ofwat only allows low equity returns and assumes zero real price effects – a view that embodies a low growth environment.

- The above seems to have arisen because Ofwat has generally selected 'extreme' positions on these matters, without due consideration of the interconnections. For example, in setting equity returns Ofwat leans heavily on more recent data and forward-looking estimates (and in doing so, Ofwat repeatedly refers to expected low productivity). However, Ofwat's position on frontier shift ignores the UK's poor recent productivity performance, and instead relies on longer-term historical data.

- In addition, in relation to both real price effects (RPEs) and frontier shift, our view is that Ofwat's position is not objectively supportable and the evidence it relies upon has substantial shortcomings. Thus, the values it has selected are outside of a plausible, credible, range.

The remainder of this paper is structured as follows:

- We firstly set out the 'in principle' relationships between equity returns, productivity and real price effects – reviewing both the relevant academic literature and empirical evidence.

- We then summarise Ofwat's position on these issues, as clarified at IAP, with reference to the range of evidence available to the regulator.

- We briefly summarise Wessex's Plan assumptions regarding these parameters.

- Finally, we set out our key conclusions.

A separate appendix contains further details of our literature review.

2. The interrelationships between equity returns, productivity and real price effects

In this section we describe the expected relationships between the above parameters. In turn we provide an overview of the relevant literature, before then summarising the empirical evidence.

2.1 Summary of economic theory and literature review

There is a wide range of literature that explores the relationship between equity returns, productivity and inflation - both theoretically and empirically. In the following, we summarise the key points that arise from this (full details of the literature we have reviewed are contained in the annex to this paper).

2.1.1 Theoretical literature

Overall, the evidence suggests strong interconnections across the three variables. Theoretically, the Ramsey[1] and Cass[2] general equilibrium model builds upon the key condition that the risk-free rate equals the sustainable growth rate, absent population growth. Similarly, the Gordon Growth Model relates components of the cost of capital to economic growth.[3] Thus it is not hard to see, intuitively, that the rate of return on equity will naturally depend on the level of economic activity (i.e. therefore, productivity). This positive theoretical relationship between productivity and equity returns is non-contentious and is supported by a range of further authors, including: Gordon (1959) and Baker, De Long and Krugman (2005).

The nature of the theoretical relationships between the above two parameters and *inflation*, is more complex, however. For example, the literature includes theoretical models in which a positive relationship between inflation and productivity / equity returns is expected. However, similarly, the literature also includes models in which an inverse relationship with inflation may exist. In early Keynesian macroeconomic models, there is an inherent output-inflation trade-off, the existence of which (in the long-run, at least) was challenged by neoclassical 'rational expectations' models. The existence of a short-run trade-off, however, still underlies the 'Taylor rule' for inflation targeting. See Briault (1995) and Walsh (1998) for more detail on these various models.[4]

These differing theoretical models with regard to inflation also reflect real world examples in which historically, one can observe both 'high inflation' at a time of poor economic performance (notably during the period of 'stagflation' in the 1970s); but also 'low inflation' at a time of robust economic performance (for example, as observed in the UK prior to the financial crisis). Consequently, to appropriately capture the interconnections with inflation, it is important to think carefully about the current context in the UK, in order to identify which theoretical model is most likely to capture reality. Moreover, in determining whether there is more likely a 'positive' or 'negative' inflationary association in the UK at PR19, this also suggests that empirical evidence is likely important (i.e. weight should be placed on what the relationship <u>has</u>

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[1] Ramsey, F.P. (1928), "A mathematical theory of saving", Economic Journal, 38, 152, pp543–559.

[2] Cass, D. (1965), "Optimum Growth in an Aggregative Model of Capital Accumulation", Review of Economic Studies, 37 (3), pp233–240.

[3] Gordon, M.J. (1959), "Dividends, Earnings and Stock Prices". Review of Economics and Statistics, 41 (2), pp99–105

[4] Briault, Clive. 1995. 'The costs of inflation.' Bank of England quarterly bulletin. Walsh, Carl E. 1998. 'The new output-inflation trade-off.' Federal Reserve Bank of San Francisco Economic Letter.

been in the UK). What is uncontroversial, however, is that there are theoretical interdependencies between inflation and productivity / equity returns. For example, a paper by Davis et al. (1997)[5] shows that forecasting GDP growth and inflation for the UK improved when the yield curve was used.

2.1.2   Empirical literature

There have also been several published empirical investigations exploring the relationships between equity returns, productivity and inflation, which further support the existence of correlation between the variables. Importantly, this seems to hold at both the economy-wide and industry level. For example, a paper by Europe Economics (2012)[6] finds a high correlation between movements in UK index-linked gilts and average GDP growth. In response to the findings of the paper, the OBR downgraded its estimate of the economic growth rate. The literature also looks at the relationship between the variables at the industry level. For example, a paper by Li et al. (2010)[7] looks at the relationship between inflation and stock returns for 10 UK industries across different time horizons and inflationary regimes - and reaches the conclusion that there is a positive relationship between expected inflation announcements and stock returns. The positive relationship between inflation and stock returns also holds at the aggregate level in the UK, as evidenced by Firth (1979)[8].

Looking at the interrelationship between stock returns, real economic performance and inflation, Fame (1981)[9] concludes that the relationship is negative between stock returns and inflation and positive between real return of stocks and bonds and real economic activity.

The fact that the theory postulates that interdependencies exist at both the economy and industry level is, of course, highly relevant to PR19. In particular, ultimately Ofwat is primarily reaching a view on parameters with respect to the water industry. Consequently, the point to highlight here is that interdependencies cannot be dismissed as being a 'macro phenomena', nor, moreover, does the distinction between whether productivity performance is generally economy, or sector, driven, diminish the importance of this issue and the need to duly consider it.

2.2   Empirical evidence on the interrelationships

Further to the literature summarised above, we have examined the relevant data ourselves to explore the empirical evidence of relevance. Accordingly, the following figure shows the relationship between growth in multi-factor productivity (i.e. changes in productivity that are not due to changes in inputs) and quarterly equity returns (for the FTSE 100). Both of these measures are expressed as rolling 12-month averages of quarter-on-quarter changes. As expected, whilst there are some periods in which market returns diverge from productivity growth, overall there is a strong, positive, association between the two. For example, over the entire time period from

[5] Davis, E.P. and Fagan, G., 1997. Are financial spreads useful indicators of future inflation and output growth in EU countries?. Journal of applied econometrics, 12(6), pp.701-714.

[6] Europe Economics (2012), "The Relationship between Sustainable Growth and the Risk-free Rate: Evidence from UK Government Gilts"

[7] Li, L., Narayan, P.K. and Zheng, X., 2010. An analysis of inflation and stock returns for the UK. Journal of international financial markets, institutions and money, 20(5), pp.519-532.

[8] Firth, M., 1979. The relationship between stock market returns and rates of inflation. The Journal of Finance, 34(3), pp.743-749.

[9] Fama, E.F., 1981. Stock returns, real activity, inflation, and money. The American economic review, 71(4), pp.545-565.

1997 to 2018, the correlation coefficient is 0.27.   The only notable period of divergence in the data seems to relate to the period of negative returns, starting around the year 2000. However, it should be noted that the fall in returns was related to the burst of the dot-com bubble (where underlying productivity growth in the real economy remained more robust). Accordingly, if we focus on the last decade (from 2008), we find the correlation coefficient to be 0.39. As we note elsewhere, when setting equity returns, recall that Ofwat places most weight on more recent data / forward-looking approaches.

Figure 1: Time series of UK MFP and FTSE returns
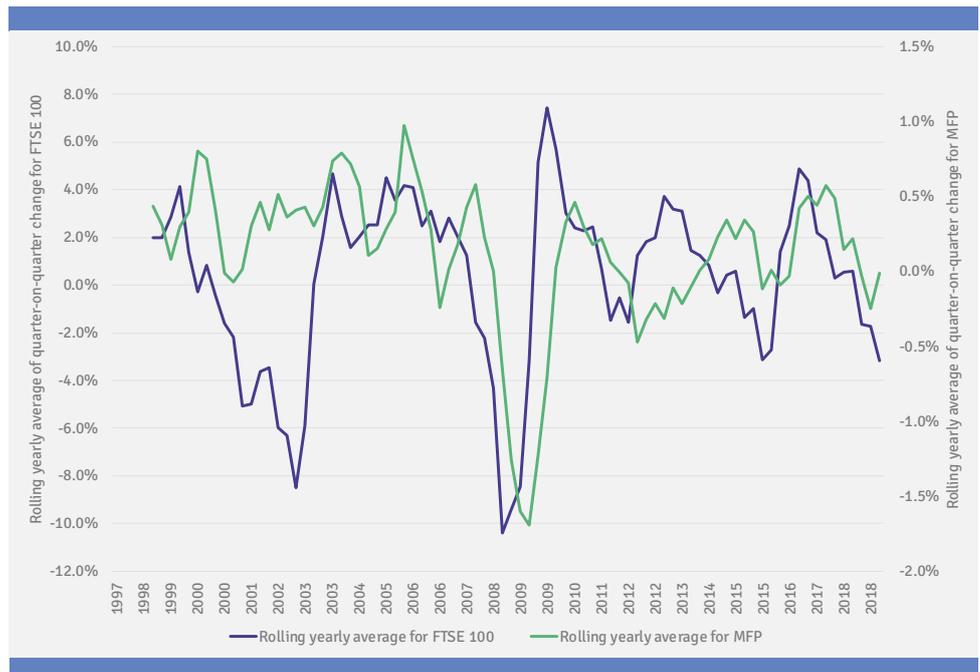
Source: Economic Insight calculations using ONS and LSE data

As set out above, there are also strong reasons to expect the above relationship to hold at the industry level. We show this in the subsequent figure, which plots year-on-year changes in MFP for the water supply and waste management industry against a measure of returns on water industry stocks. The latter measures the average year-on-year price change for two listed water companies (Severn Trent and United Utilities). Again, there is a clear, positive, correlation between the two measures, with large changes in MFP being matched by large changes in stock returns, most obviously around the period from 2007 to 2009. Indeed, over the ten-year period from 2008 to 2018, we find a positive correlation coefficient of 0.66.

Figure 2: Time series of MFP for the water supply and waste management industry and returns on water industry stocks
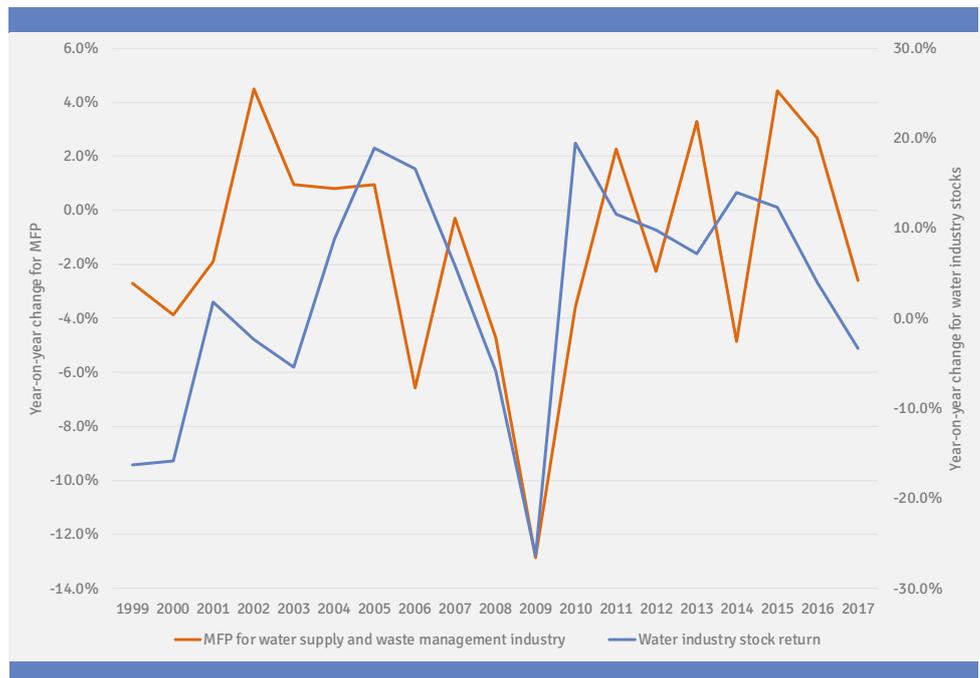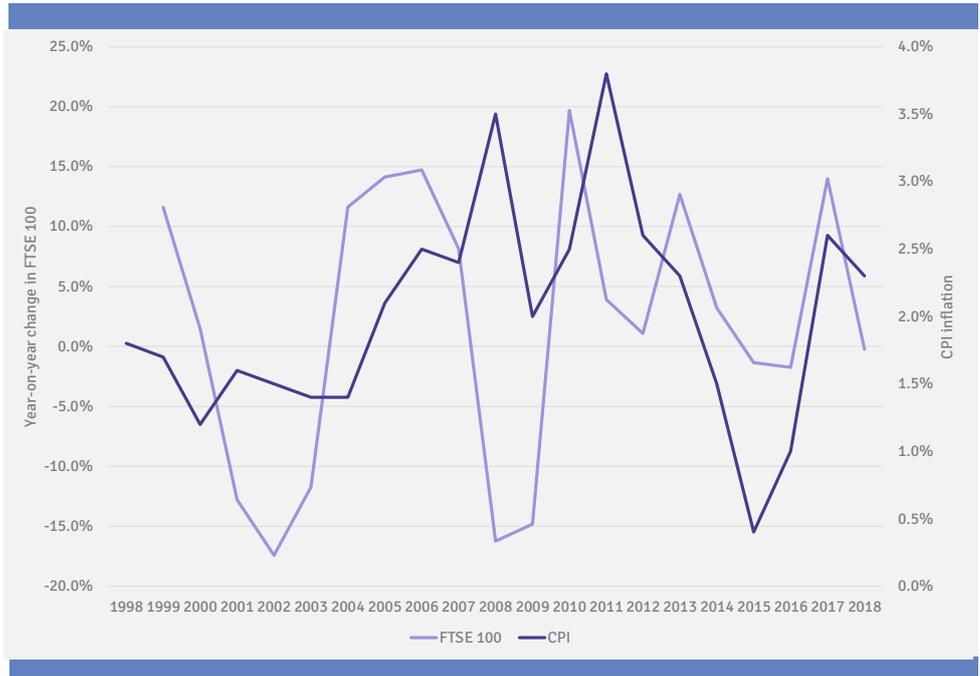

Source: Economic Insight calculations using ONS and LSE data

We also explored the relationship between CPI inflation and UK equity returns. The figure overleaf shows year-on-year changes in the FTSE 100 and annual CPI inflation. Consistent with our literature review and the underlying theory, the relationship between the two is not as strong as for the other measures examined. In particular, over the whole time period, we find a correlation coefficient of 0.16. Over the last ten years, we find a correlation coefficient of 0.03. We should note that in some cases, where the measures move in different directions, this may be due to lag effects. For instance, while the measures move in opposite directions in 2008, this appears to be 'corrected' for the following year. This, then, is consistent with the theory summarised previously, which suggests that the relationship between the above parameters and inflation, is more complex. Here, however, it is important to distinguish between:

- – determining the likely 'rate of change' in inflation; and
- – whether water industry inflation is distinct from CPIH.

The evidence explored in this paper is strictly relevant only to the first of the above matters. It is, therefore, broadly consistent with it being appropriate to assume (modestly) 'more positive' inflation growth in circumstances where one expects equity returns and productivity to be higher (and vice versa). It does not, however, provide information as to whether industry inflation in the sector is likely to be above or below CPIH.

Figure 3: Time series of UK equity returns and inflation

Source: Economic Insight calculations using ONS and LSE data

2.3 Summary of empirical evidence

The table below summarises correlation coefficients between the various measures we have examined in this section. Our main conclusions are as follows.

- Consistent with other theoretical and empirical literature, evidence is strongest that there is a positive relationship between productivity and equity returns.

- In addition, evidence suggest that the correlation between sector-level MFP and equity returns is stronger in the water sector than for the relationship in the economy as a whole.

- The empirical evidence on the correlation between inflation and equity returns is less strong, though correlations are still positive (but low).

Table 1: Summary of correlation coefficients

Measure	Correlation coefficient (whole time period)	Correlation coefficient (10 years from 2008)
UK MFP and FTSE	*0.27*	*0.39*
MFP for water supply industry and water sector equity returns	*0.41*	*0.66*
CPI and FTSE	*0.16*	*0.03*

Source: Economic Insight analysis

2.5   How theory is applied in macro forecasting

The established theoretical and empirical interrelationships between the variables mean that it is essential to take these into account when developing forecasts, in order to produce robust estimates and guard against issues such as omitted variable bias. Consistent with this, macroeconomic forecasters, such as the OBR, Bank of England, HM Treasury etc. explicitly model these interdependencies. For example, in describing their macroeconomic model, the OBR states that:

"The model is principally a model of the economic activity described and recorded in the National Accounts published by the ONS. It is a set of relationships between various economic variables. Some of these relationships are accounting identities, some are technical relationships and the rest are behavioural (or econometric) equations. The behavioural equations are based on economic theory and statistical analyses of how the economy has behaved in the past." [10]

In the OBR's case, trend growth depends on productivity growth (in terms of output per hour) alongside other variables (hours growth, employment rate growth and population growth).[11] Projections for trend productivity growth are determined by assessments of available evidence, alongside judgements about factors such as the rate of capital deepening, which are relevant to the outlook for productivity over the period.[12] These projections, in turn, are reflected in the OBR's approach to forecasting equity prices. The OBR takes a measure of share prices to date, and then assumes that prices grow in line with its nominal GDP forecast.[13] As such, a relationship between productivity growth and equity prices is 'hard wired' into the OBR's forecasting. Additionally, in setting out their approach to forecasting inflation, the OBR states that it is forecasted based *on "the past relationship between these prices, import prices and productivity".*[14]

The OBR's forecasts cannot be used directly for the parameters under consideration here. While the OBR forecasts labour productivity growth (growth in output per hour), we require forecasts of growth in total factor productivity (TFP). Inferences can be drawn, however, using historical data on the 'wedge' between labour productivity growth and TFP growth. Our analysis suggests that, since 2001, labour productivity growth has exceeded TFP growth by an average of 0.7% per year. So, starting from the OBR's official labour productivity forecast for the UK, if we subtract this wedge, this suggests TFP growth of 0.2% p.a. to 0.6% p.a. across 2020-2023, as summarised in the figure overleaf. As shown, Ofwat's frontier shift assumption is therefore significantly above the numbers consistent with the OBR's view.

[10]   *'Forecasting the economy' Office for Budget Responsibility (October 2011); page 7.*
[11]   *'Forecasting the economy' Office for Budget Responsibility (October 2011); page 16-17.*
[12]   *'Forecasting the economy' Office for Budget Responsibility (October 2011); page 17.*
[13]   *'Forecasting the economy' Office for Budget Responsibility (October 2011); page 12.*
[14]   *https://obr.uk/forecasts-in-depth/the-economy-forecast/inflation/*

Figure 4: OBR-consistent TFP growth forecast
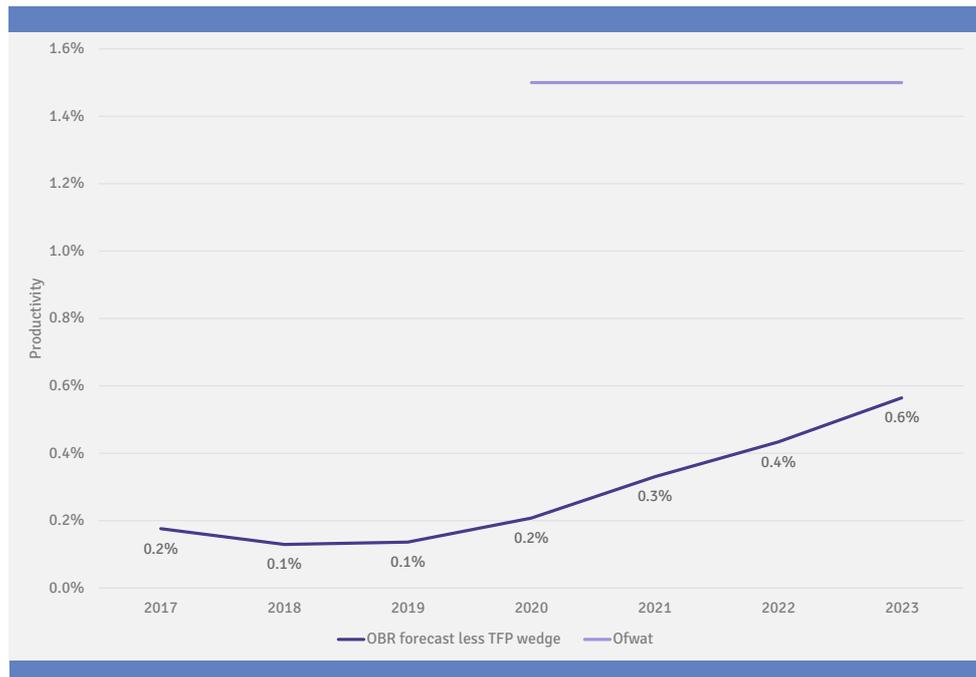
Source: Economic Insight calculations based on OBR forecasts and ONS and KLEMS

2.6 Implications for best practice at PR19

The evidence set out here strongly points to the need to for an internally consistent approach to setting the frontier shift; the cost of capital; and inflation at PR19. Most obviously, it clearly means it is essential to ensure that a consistent view of the relevant time horizon used should be applied. For example, if one is seeking to set parameters specifically reflecting performance over the 5-year period of PR19, then one should draw on data for the parameters that are most reflective of that. On the other hand, if one wished to take a longer-term view (which may reflect the need to balance current and future welfare in the water industry, where investments are long-lived), one would place more weight on data that was most reflective of that. The key point, however, is that one should not 'mix and match' – as, for the reasons described here, that would give rise to an internal inconsistency.

3. Ofwat's current position

3.1 Productivity (frontier shift)

At IAP, Ofwat selected a frontier shift figure of 1.5% per annum. Its estimate incorporates a 'premium' attributable to additional productivity gains due to the outcomes and totex framework.

The figure below summarises the evidence on frontier shift presented to Ofwat. We draw attention to the following.

- KPMG provided separate estimates for productivity frontier shift and for additional gains attributable to the totex and outcomes framework. They estimated a range of 0.4% to 1.3% for productivity, rising to 0.6% to 2.5% including their estimate of the totex and outcomes premium.

- In their advice to Ofwat, Europe Economics suggested higher ranges of 0.6% to 1.2% for total wholesale expenditure and 0.6% to 1.4% for base expenditure. Europe Economics did not comment on any potential additional premium on account of totex and the outcomes framework.

- In their advice to companies, Oxera and NERA suggested broadly similar range for frontier shift of 0.6% to 0.8% and 0.6% to 0.7% respectively. Economic Insight suggested ranges of 0.0% to 1.1% for opex and -0.3% to 0.6% for capex.

The following figure summarises the full range of evidence available to Ofwat.

Figure 5: Evidence on frontier shift
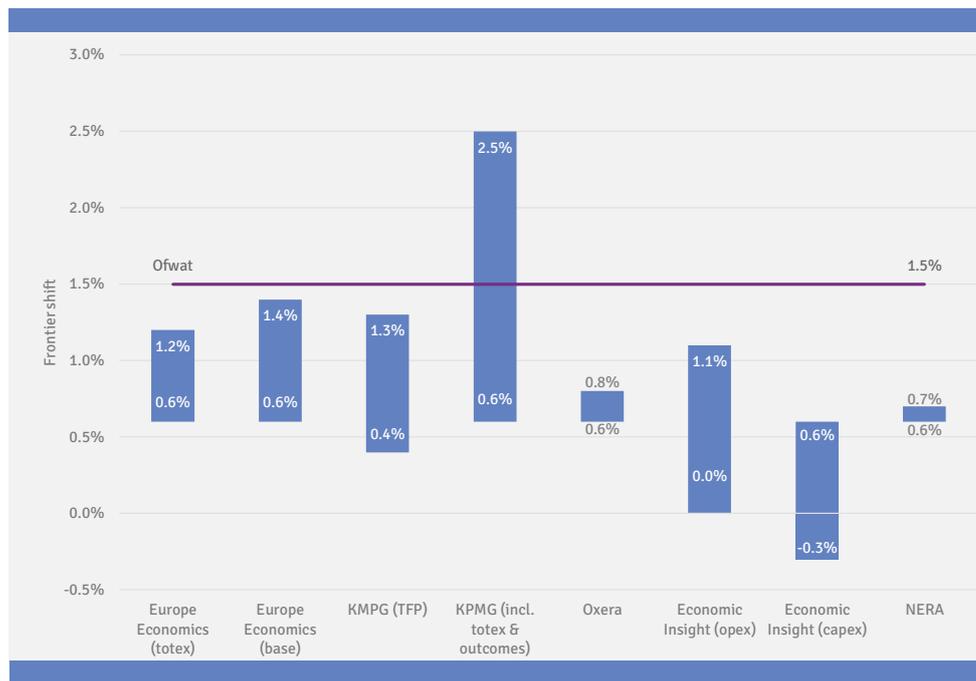
Source: Economic Insight analysis of Ofwat, technical appendix 2

3.1.1   Observations on Ofwat's approach to frontier shift

As noted above, at IAP, Ofwat has indicated that it will set a frontier efficiency shift value of 1.5% pa. There are, however, some important shortcomings with Ofwat's approach and the evidence on which it chose to rely upon. These are as follows:

- In the Europe Economics' report for Ofwat on real price effects and frontier shift, the consultants recommend a range for frontier shift from 0.6% to 1.2% pa in relation to wholesale totex. Part of the difference in the 'low' and 'high' estimates is due to Europe Economics estimating productivity using two alternative measures: (i) gross output based; and (ii) gross value added. On this issue, Europe Economics state: *"In our view, the most appropriate measure of TFP growth for the regulatory purpose of estimating frontier shift is TFP growth in gross output terms."*[15] Europe Economics also note that: *"the differences between the two measures can be quite significant, with the value added measure systematically higher in magnitude than the gross output measure."* [16] Following from this, we note that, at IAP, Ofwat has selected figures towards the upper bound of the range

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[15] *'Real Price Effects and Frontier Shift.' Europe Economics (January 2019); page 74.*
[16] *'Real Price Effects and Frontier Shift.' Europe Economics (January 2019); page 73.*

reported by Europe Economics, and so is placing weight on the value added measure – despite the fact that the consultants state that, objectively, the gross output approach is preferred.

- Relating to the above, a further factor affecting the range reported by Europe Economics is the time periods on which its analysis is based. Specifically, the consultancy makes use of two datasets, which it labels 'NACE 1' and 'NACE 2'. The former <u>completely excludes</u> the post-financial crisis period in the UK. Using the latter, Europe Economics examine TFP performance over three time periods: 1999-2014; 1999-2007 (labelled pre-crisis); and 2010-2014 (labelled post-crisis). It should, however, be highlighted that whilst Europe Economics report results from all three time periods, its preferred estimates from pre-crisis and post-crisis omit the years 2008 and 2009, when UK TFP was at its lowest. Specifically, the data shows that TFP in 2008 and 2009 was -0.4% and -2.8% (all industries); or -0.7% and -4.2% (market economy). Notwithstanding the above (which results in all estimates being higher than they otherwise would be), Europe Economics' lower bound estimate of 0.6% pa relates to the post-crisis era; whereas their higher bound estimate of 1.2% pa relates to the pre-crisis era.[17] Consequently, in selecting the upper bound from the range, Ofwat is explicitly placing most weight on the pre-crisis period (1999-2007 in NACE 2). This choice by Ofwat is in addition to, as noted above, entirely omitting the impact of the two most severe years of the crisis (as a consequence of those years not being included in the Europe Economics analysis).

- Relating to the above, Ofwat's justification for placing more weight on 'historical' periods of time when setting frontier shift appears to contradict its own position and logic with regard to the cost of equity and inflation. We address the more fundamental theoretical issue of the need for internal consistency on regulatory assumptions relating to the macroeconomy more fully elsewhere. However, <u>specifically in terms of the contradiction in Ofwat's own methodology</u>, we note that when determining an appropriate assumption for estimating total market equity returns, Ofwat states the following: *"our point estimate is focused on the basis that, as with other allowances (such as that for totex and the cost of debt), our aim is to allow for efficient costs over the period 2020-25. In section 5.4.1 we set out evidence that interest rates are extremely low in historical terms, and are forecast to remain so beyond the midpoint of the forthcoming price control. Given the historical relationship between interest rates and equity returns (Figure 6), this suggests that long-run averages of realised equity returns from years that have featured higher interest rates are likely to prove a poor guide to actual returns in 2020-25."*[18] Ofwat goes on to state: *"Recent evidence that required equity returns have fallen below their long-term average, together with __expectations of weak productivity growth__ and subdued interest rate rises, imply that relying too heavily on long term averages is likely to overstate actual TMR in 2020-25."*[19] Ofwat uses the above arguments to support basing its assumed total market equity returns figure on more recent / forward-looking analyses (i.e. Ofwat explicitly relies upon the post-crisis era when setting a 'low' cost of equity; and further explicitly ties this to low

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[17] *'Real Price Effects and Frontier Shift.'* Europe Economics (January 2019); page 77.
[18] *'Delivering Water 2020: Our methodology for the 2019 price review Appendix 12: Aligning risk and return.'* Ofwat (2018); page 33.
[19] *'Delivering Water 2020: Our methodology for the 2019 price review Appendix 12: Aligning risk and return.'* Ofwat (2018); page 37.

productivity growth being assumed – thus recognising that the two should be connected).

- Ofwat partly justifies its assumed 1.5% frontier shift figure by arguing that the introduction of totex and the outcomes framework at PR14 will have helped the sector achieve higher productivity gains. It is argued that this is the case because the reform: *"allows companies greater flexibility to move away from a list of specific schemes agreed by the Regulator towards an approach that allows them to consider alternatives that can deliver the same or better service performance in line with customer preferences."*[20] This, in turn, is based on a report by KPMG, which suggested that the combination of totex and outcomes could result in an incremental frontier shift gain of 0.2 – 1.2% pa. However, the entire logic underpinning KPMG's findings is flawed. In particular, when assessing frontier shift, one typically seeks to determine the scope for productivity gains in the water sector with reference to comparators. In that context, and as noted in our report for Yorkshire Water,[21] the UK's overall TFP has averaged -0.3% pa since 2008 (the post crisis period). The longer-term average over 16 years (8 years pre-crisis and 8 years post-crisis) has been 0.4% pa. Critically, this measure for the overall UK economy includes firms operating in competitive markets, that are already able to substitute freely between opex and capex and are free to provide the 'outcomes' most wanted by customers. As such, Ofwat's argument that the 'totex' and 'outcomes' approach to regulation allows that water sector to achieve greater productivity gains is being erroneously presented. Specifically:

  - » Whilst it is 'possible' that by reforming the regulatory approach, Ofwat may have increased the potential for productivity gains, it provides no basis to explain why the sector should be able to outperform overall UK TFP, or the TFP of other relevant comparators.
  - » Indeed, to the extent that Ofwat argues that its 'new' approach to regulation gives water companies increased flexibility on the choice between opex / capex and outcomes, the logical implication is that productivity growth for the water sector should remain **below UK TFP** or other comparators that have even more flexibility in these dimensions. In simple terms, as most sectors of the UK economy are not subject to price control regulation at all, the argument that the water sector being 'less regulated' or 'better regulated' than in the past provides no basis whatsoever to suppose it can outperform the UK economy overall as a result. We are therefore surprised that this argument has been made.

- Notwithstanding the fundamental flaw in the underlying logic contained in the KPMG report for Ofwat, the analysis itself is partial because i) it attaches more weight to evidence from the first business cycle than the third business cycle when arriving at a view of an appropriate TFP growth range, which departs from a standard forecasting approach that would attach more weight to the latest evidence; and ii) it does not take account of the real possibility that TFP growth could be zero or negative during PR19. Additionally, the analysis does not provide robust evidence of the impact of the move to 'totex' and 'outcomes' based regulation on productivity.

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[20] *'Innovation and efficiency gains from the totex and outcomes framework.'* KPMG & aqua consultants (2018); page 131.
[21] *'The scope for frontier shift at PR19: a report for Yorkshire Water.'* Economic Insight (2018).

- Finally, there appears to be a 'double counting' risk in Ofwat's approach to frontier shift. Firstly, recall that TFP captures a change in total output for a change in total input. Consequently, the % growth in TFP for the UK economy or any comparator reflects the combination of both: (i) achieved £s cost efficiencies in the production process; and (ii) increases in the 'value' of any outputs being created. Consequently, if when setting outcomes targets for the industry, Ofwat suggests that this is related to firms doing *"more for less"* (which it refers to frequently), it would appear to be referring to the concept of frontier shift (i.e. the production possibility frontier moving out over time, due to productivity gains). However, in practice, having determined the totality of frontier shift Ofwat considers appropriate (the 1.5% pa), the regulator is applying <u>the whole of that as a saving on company baseline costs</u>. The regulator then also appears, however, to be justifying 'stretching' outcomes targets using the same *"more for less"* argument – thus double counting the frontier shift. If this is the rationale for the outcomes targets, Ofwat would need to start from its view of overall frontier shift for the industry, and then attribute that between cost reduction and improved outcomes, so that the sum of both does not add up to more than the total. It is not clear, in either its assessment of outcomes or frontier shift, that Ofwat has taken this into account.

3.2   Equity returns

Ofwat set out an estimate of the cost of equity in its 'early view' of the cost of capital in its PR19 methodology.[22] Ofwat estimated the nominal cost of equity for PR19 to be 7.13%, with the real cost of equity being 5.03% (CPIH) and 4.01% (RPI). This compares with ranges from its advisers of 6.4% to 7.3% from Europe Economics, and 6.7% to 7.4% from PwC.

Figure 6: Evidence on nominal cost of equity
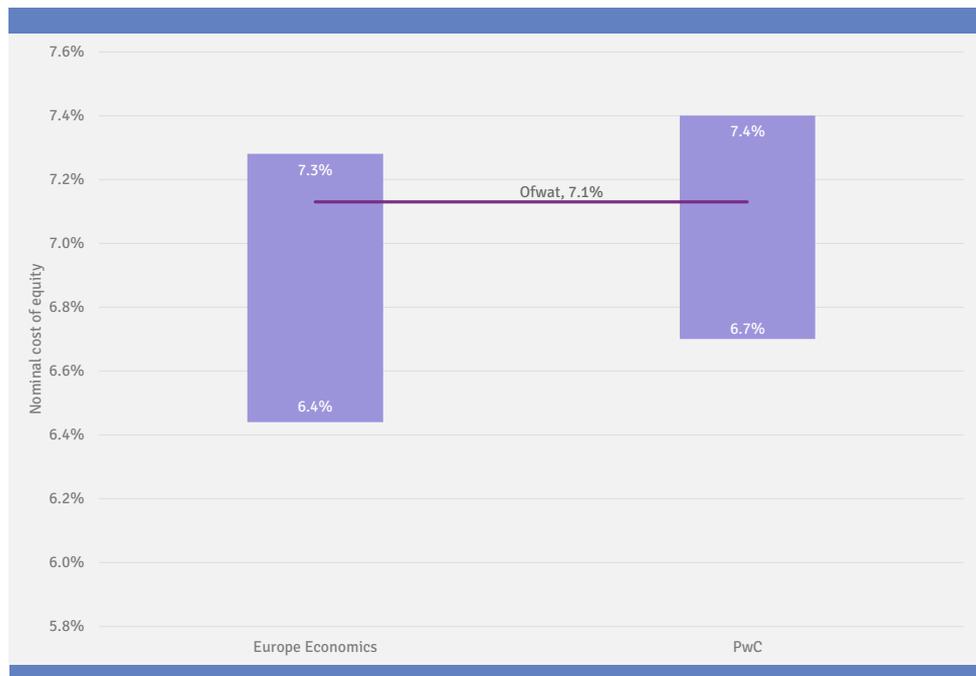
Source: Ofwat Risk and Reward Guidance, Europe Economics & PwC reports

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[22] *'Delivering Water 2020: Our methodology for the 2019 price review.'* *Appendix 12: Aligning risk and return. Ofwat (2017).*

3.2.1   Observations on Ofwat's approach to equity returns

We do not comment in detail on Ofwat's approach to equity returns within the WACC. However, of relevance to this paper, it is important to highlight the nature of the evidence relied upon by Ofwat and the 'time horizons' to which that evidence applies. Here, the key points are as follows:

- Ofwat uses three approaches to estimate total market returns: (i) ex-post approaches, that are based on long-run historical returns; (ii) ex-ante approaches, which decompose historical returns into investor expectations and non-repeatable elements (good or bad luck); and (iii) forward looking approaches, such as the dividend discount model and market to asset ratios (MAR). All three approaches have relative pros and cons. However, it is generally considered to be 'best practice' to primarily rely upon the first approach, with more forward-looking methods used as a cross check. In that context, we note that Ofwat has, in fact, chosen to place less weight on the first approach (long run historical data) and most weight on the latter approaches (which are based on recent or future data).

- Within the second two approaches, Ofwat leaned more heavily on those suggesting lower total market returns, as we show in the figure below comparing implied real total returns across the methodologies that Ofwat cited.

Figure 7: Evidence on real total market returns
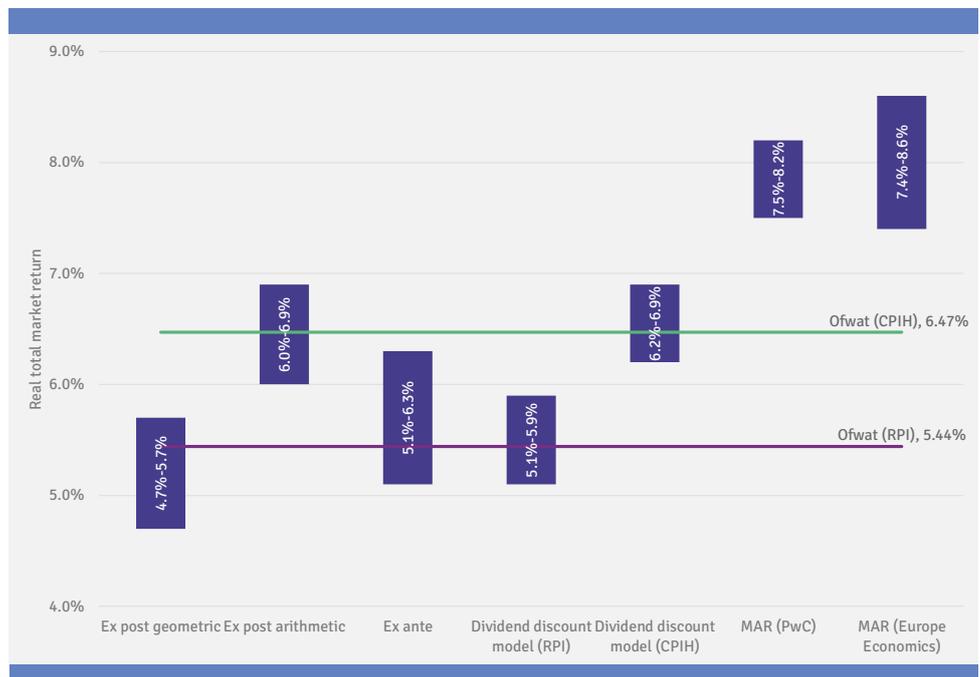
Source: Ofwat Risk and Reward Guidance

In explaining 'why' it has placed weight on more recent data in reaching a view on total market equity returns, Ofwat frequently emphasises that it is because it considers this will best reflect the prospects for the UK economy over the PR19 period. In doing so, it further emphasises that this is because it considered the UK macroeconomic context will continue to be 'poor'. Ofwat further repeatedly references the likelihood of persistent low productivity. Key statements made by Ofwat relating to total market equity returns in this context include the following:

"The latest medium-term forecasts for the UK economy support the view that prospects for future growth will remain weak, decreasing the probability that interest rates and returns will normalise to the higher rates seen in the last few decades. In November, The Office for Budget Responsibility downgraded its growth forecasts from its March 2017 publication. **This was due to persistent weakness in productivity growth and its view that this phenomenon will continue at least until 2022**.*"*[23]

"Our point estimate is focused on the basis that, as with other allowances (such as that for totex and the cost of debt), our aim is to allow for efficient costs over the period 2020-25. In section 5.4.1 we set out evidence that interest rates are extremely low in historical terms, and are forecast to remain so beyond the midpoint of the forthcoming price control. Given the historical relationship between interest rates and equity returns (Figure 6), this suggests that long-run averages of realised equity returns from years that have featured higher interest rates are likely to prove a poor guide to actual returns in 2020-25."[24]

3.3   Real price effects

Ofwat has allowed for zero real price effects in its IAP, effectively concluding that CPIH is sufficient to compensate companies for input price inflation. This was based mainly on a report from Europe Economics that assesses RPEs against a series of tests that are intended to determine whether any cost allowance is required. As we show in the figure below, for each cost category this is consistently below the average level of RPEs that companies estimated.

Figure 8: Evidence on real price effects (% per year)
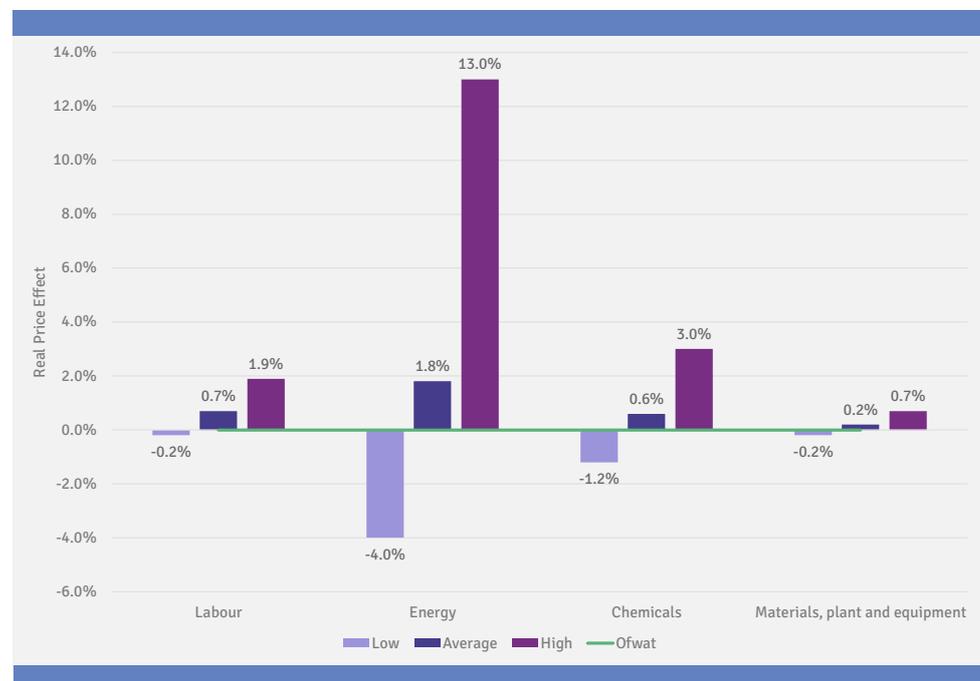
Source: Ofwat, Securing cost efficiency technical appendix

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[23]   *'Delivering Water 2020: Our methodology for the 2019 price review Appendix 12: Aligning risk and return.' Ofwat (2018); page 27*

[24]   *'Delivering Water 2020: Our methodology for the 2019 price review Appendix 12: Aligning risk and return.' Ofwat (2018); page 33.*

3.3.1   Observations on Ofwat's approach to real price effects

As noted above, Ofwat's position is that real price effects will be 'zero' for the water industry at PR19. We think there are a number of problems with Ofwat's approach and the evidence upon which it has relied to reach this finding.

- The Europe Economics report that addresses RPEs starts by setting out a framework for determining 'whether' an allowance for RPEs is required. This framework is flawed in some important respects. Specifically: (i) the 'materiality' test is arbitrary, as the % of costs an input item accounts for is irrelevant to the fact that, if its inflation is not allowed for, the notionally efficient firm will be under-funded; (ii) the criterion relating to whether the 'wedge' is statistically different from zero over time is irrelevant – this is just a measure of probability and ignores the key issue as to whether one would 'expect' the input inflation in question to be above or below CPIH during PR19; and (iii) the test as to whether the input cost is 'outside of management control' is wholly irrelevant. In particular, whilst the principle that only 'efficient' costs should be funded is clearly correct (and so, only inflation net of efficiency savings should be allowed), the PR19 regulatory framework separately makes deductions for efficiency for all companies. Hence, once 'efficiency' is accounted for, clearly all underlying inflation is outside of management control.

- In explaining its philosophy to approach RPEs, Ofwat makes the following statement: *"There needs to be a compelling case for making an allowance for real price effects. Water companies already benefit from a range of protections not provided to companies that operate in other parts of the economy. These include CPIH indexation of revenues, cost sharing with customers, five yearly price control reviews, interim determinations and substantial effects provisions."*[25] This statement is problematic for two reasons. Firstly, the assertion that a compelling case is required for RPEs ignores the fact that the null hypothesis should logically be that the 'true' inflation faced by water companies will not be exactly the same as CPIH – and so objectively, the null hypothesis is precisely the opposite – from which point, one should follow the evidence. Secondly, Ofwat appears to be suggesting that the design of the regulatory regime is beneficial to water companies in a way that is 'unfair', relative to firms in unregulated markets. This is disingenuous. The role of any regulatory framework is to strike the right 'balance of risk' so as to incentivise economic efficiency in a way that increases overall welfare. In that context, the inclusion of indexation, cost sharing and five-yearly price determinations (as referred to by Ofwat) are simply 'choices' that collectively determine the allocation of risk, which as a package give rise to a certain profile of expected returns. Clearly unregulated sectors do not have revenues subject to indexation. Nor however, are their revenues 'capped' – and so rates of return can be significantly higher. It is concerning, therefore, that such thinking seems to have influenced Ofwat's decision not to allow RPEs.

- Ofwat does not appear to have attempted to forecast relevant inflation over the PR19 period. This is despite the fact that it is fundamentally connected to expected economic performance and so, without developing a forward-looking view that ensures Ofwat's determinations embed a holistic approach, there is a high risk of error.

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[25] *Technical appendix 2 Securing cost efficiency.' Ofwat (2018); page 44.*

3.4 The internal inconsistency problem with Ofwat's approach

Overall, then, there is a problem of internal inconsistency in Ofwat's approach across the three issues of productivity growth, equity returns and real price effects. Specifically, Ofwat's approach appears to assume a 'high growth' scenario on the issue of frontier shift, but on both equity returns and real price effects assumes a 'low growth' scenario. As we set out in the table below, a 'low growth' view of the world would imply 'low' values for frontier shift, equity returns and real price effects, while a 'high growth' view would suggest 'high' values for these parameters. Ofwat's choices are more consistent with achieving low costs across all of these parameters, at the expense of a consistent assessment of the state of the economy across PR19.

Table 2: Consistency across parameters

Issue	Impact on costs	Low growth world	High growth world	Ofwat's view
Frontier shift	Downward	Low	High	High
Equity returns	Upward	Low	High	Low
Real price effects	Upward	Low	High	Low

Source: Economic Insight

The reason for Ofwat's inconsistent choices across these parameters is due in the first instance to the use of inconsistent time periods in its assessments. For instance, in assessing equity returns, Ofwat places most weight on the recent past. Due to low equity returns in the period following the financial crisis, this results in a low value. On productivity, however, Ofwat discounts the post-crisis period, placing more weight on long term values, leading to a high number. The inconsistency in Ofwat's position further arises because: (i) the regulator in each case appears to select relatively 'extreme' positions, relative to the range of evidence available to it; and (ii) in some specific cases, the regulator makes questionable methodological adjustments, such as the 'premium' on frontier shift associated with totex and the outcomes framework.

4. Wessex Water's PR19 Business Plan

In its PR19 Business Plan, Wessex selected a more consistent set of figures for productivity, equity returns and real price effects, consistent with a somewhat 'higher growth' world. We summarise these in the table below.

- Wessex proposed lower frontier shift of 1.0% p.a., compared to Ofwat's assumption of 1.5%.

- Wessex proposed a higher cost of capital, at 2.7% (appointee Vanilla WACC, RPI), compared to Ofwat's 'early view' point estimate of 2.4%.

- Wessex also proposed positive real price effects across PR19.

Table 3: Comparison of Wessex's Business Plan assumptions and Ofwat parameters

Parameter	Ofwat	Wessex
Frontier shift	1.5%	1.0%
Cost of capital (appointee Vanilla WACC, RPI)	2.4%	2.7%
Real price effects	None	Positive across PR19

Source: Ofwat IAP and Wessex PR19 Business Plan tables

We note that, while Wessex's proposed frontier shift figure lies below Ofwat's, it is towards the upper end of the available evidence on future productivity gains (and well above current UK productivity performance) once Ofwat's questionable premium for the totex and outcomes framework is excluded. We understand that Wessex's use of a WACC of 2.7% explicitly included Ofwat's uplift for exceptional plans. Even without this justification, it could be argued that Wessex's higher WACC is consistent with its relatively bullish productivity assumptions (and its inclusion of positive real price effects).

Given that Wessex's numbers already appear to be internally consistent, this implies that any change to one of the figures in Wessex's Plan would imply the need for further changes across the board. This is especially important when one considers the reasons for having a WACC uplift for exceptional plans. Wessex's proposed WACC reflected higher systematic risk because of its wider range on return on regulated equity (RoRE) due to its limited use of ODI collars and deadbands.

As a consequence, if a lower cost of capital were to be proposed, this would point to making adjustments across other parameters. It could be consistent with a 'lower growth' view of the world, with internal consistency therefore requiring Wessex to use a lower frontier shift figure alongside this. Alternatively, it could be consistent with a 'lower risk' view of the world. As such, internal consistency would require Wessex to reconsider its outcomes packages to limit the extent of systematic risk that is included within it, for example through the introduction of additional caps and collars. In addition, it could be consistent with a combination of 'lower growth' and 'lower risk' views.

5. Key conclusions

To summarise, our overall conclusions are as follows.

- Ofwat's approach to the key parameters of frontier shift, equity returns and real price effects is flawed. It ignores interconnections between the parameters, and as a consequence its productivity assumptions appear to assume a 'higher growth' world, whereas its equity return and real price effect assumptions embody a 'lower growth' view.

- The values for frontier shift, equity returns and real price effects set out in Wessex's business plan are internally consistent. They accord with a 'higher

growth' world, while Wessex's assumed WACC also reflects additional systematic risk in its business plan.

- As a consequence, any changes to the cost of capital in Wessex's plan would point to a reassessment of the parameters in Wessex's plan across the board. A lower cost of capital could be consistent with: (i) a 'lower growth' view of the world, thereby requiring a less aggressive frontier shift assumption; (ii) a 'lower risk' view of the world, implying the need for changes to reduce systematic risk in Wessex's plan; or (iii) a combination of these.

6. Annex – literature review on the interrelationships between productivity, equity returns and real price effects

The following table sets out a review of the academic literature exploring the interconnections between the above parameters.

Table 4: Literature review

Title	Author	Publication	Key points
Productivity and stock prices	Avouyi-Dovi, Sanvi and Matheron, Julien.	Financial Stability Review	• The paper looks at the correlation between productivity and stock prices at different levels for the US and the Euro area over the period 1972 to 2002. • Two different approaches were used: i) a statistical analysis of the correlation between the components of the variables (cyclical and long-term) and ii) a study of how the correlations vary according to the different frequencies exemplifying the variables. • A combination of GMM and VAR models are used to test for correlations. • The results show that for both the US and the Euro area, there is a strong and statistically significant positive correlation between the cyclical component of productivity growth rate and stock returns.
Productivity growth and stock returns: firm-and aggregate-level analyses	Chun, Hyunbae, Jung-Wook Kim, and Randall Morck.	Applied Economics	• The authors look at the relationship between i) firm-level stock returns and their own productivity and ii) firm-level stock price and aggregate productivity. • The study is based on a sample of US firm data between 1970 and 2006, sourced from the Centre for Research in Security Prices and Compustat. • The paper follows an econometric approach and estimates a panel regression analysis for the firms. • Results show that firms' stock returns correlate positively with their own productivity growth and negatively with aggregate productivity growth. • Several reasonings are given to explain the inconsistency of the results. For example, one argument is that a firm's stock return is a function of the innovative activity of other firms as well as its own. Another argument is in relation to time-varying discount rates where investors' discount rates rise considerably in the case of rising corporate earnings leading to a net effect of lower stock market valuations.
Asset returns and economic growth	Baker, Dean, J. Bradford De Long, and Paul R. Krugman.	Brookings Papers on Economic Activity	• The paper sets out various theoretical and arithmetical approaches to support the argument that there is a positive correlation between economic growth and real rates of return. • The authors start with the algebra of the production function and capital accumulation to show that rates of return and rates of growth are strongly linked. • Subsequently, they look at the macrobehavioural models (Diamond; Ramsey and the Solow model) and also find a strong positive relationship between economic growth and asset returns.

			• Lastly, they also look at the relationship arithmetically and find it challenging to construct scenarios where economic growth and asset returns are not correlated. • The authors conclude that the rate of returns on assets and rates of economic growth are causally connected and positively correlated.
The relationship between stock market returns and rates of inflation	Firth, Michael	The Journal of Finance	• The paper sets out to study the relationship between inflation and the rates of return on common stocks. • The study is based on regression analysis of British stock data between 1955 and 1976. • The paper examines whether the 'Fisher effect' holds, which states that 'expected rates of return on common stocks consist of a "real" return plus the expected rate of inflation and that the real rate of return is independent of the expected rate of inflation'. • The regression results show positive coefficients in line with the 'Fisher effect'. Additionally, the coefficients were generally greater than 1 for the whole of the time period of the analysis, indicating that investors were more than compensated for the expected rate of inflation.
Productivity and equity market fundamentals: 80 years of evidence for eleven OECD countries	Davis, E. Philip, and Jakob B. Madsen	Journal of International Money and Finance	• The paper argues that capital productivity is a better measure for share prices than is labour productivity. • The analysis is based on data for G7, Australia, Netherlands, Sweden and Denmark for the time period 1920-1999. • The authors implement a combination of statistical techniques to study the relationship between productivity and equity return given that equity return reflect the present value of expected earnings. • Granger causality test between equity returns and productivity growth shows that returns are a leading indicator of productivity growth, but the case is not the other way around for productivity growth. • A VAR system and a cointegration analysis also shows that equity prices are strongly related to capital productivity.
A mathematical theory of saving	Ramsey, Frank Plumpton	The Economic Journal	• The author presents a theoretical model for the equilibrium level of saving in the economy. • To get to equilibrium, an important condition of the model is that the risk-free rate equals the sustainable growth rate absent population growth.
Optimum growth in an aggregative model of capital accumulation	Cass, David	The Review of Economic Studies	• A theoretical model that looks at the growth path and optimum saving rate in a closed economy when social welfare is maximised, building upon Ramsey's model. • To get to equilibrium, an important condition of the model is that the risk-free rate equals the sustainable growth rate absent population growth.

Dividends, earning, and stock Prices	Gordon, Myron J.	The Review of Economic Studies	• The paper sets out to test the hypotheses that when an investor acquires a common stock they are buying: i) both the dividends and the earnings; ii) the dividends; and iii) the earnings. • The analysis is based on data collected for four industries for the years 1951 and 1954 in the US. • The author concludes with a model for explaining the variation in price among stocks. The model includes growth and retained earnings as independent variables.
Stock returns, real activity, inflation, and money	Fama, Eugene F.	The American Economic Review	• The paper tests the relationship between stock return and inflation. In particular, it sets out to explain the negative relationship between stock returns and inflation. • The steps that are carried out in the paper to explain this negative relationship are as follows: i) the author first documents the negative relations between inflation and real activity, consistent with the quantity theory of money; ii) subsequently, the author documents the positive empirical relationship between economic growth and real rates of return; iii) finally, relating the real stock returns to other real variables and from then on to inflation measure. • The paper concludes that the expected real return for both stocks and bonds is a function of the 'real sector' in the economy.
The Effect of Macroeconomic Variables on Market Risk Premium	Tahmidi, Arad, Dmytro Sheludchenko, and Samira Allahyari Westlund	Mälardalen University	• The paper studies the impact that macroeconomic variables have on market risk premium. • The study is based on data from the time period 1992 to 2007 for Sweden, Germany and Canada. • The analysis runs an ordinary least square model for each of the countries separately with the following independent variables: forecasted GDP growth; government net lending/borrowing; and money supply. • Several robustness checks are done including the Ljung-Box to test for autocorrelations of residual, and the Lilliefors to test for normality of the residuals. • The empirical results show that the coefficient on projected GDP growth is positive and statistically significant for all of the countries in the sample. Specifically, the model shows that projected GDP affects market risk premium 95% of the times.
Are financial spreads useful indicators of future inflation and output growth in EU countries?	Davis, E. Philip, and Gabriel Fagan	Journal of applied econometric	• The paper sets to provide evidence on whether financial spread variables are useful in forecasting inflation and output growth in the EU. The intuition behind the test is that yield spreads reflect the perceptions of investors and the market regarding the future development of the economy. • The study covers the time period between 1970 and 1992 for seven European countries including the UK.

			• A combination of VAR and RMSE models are employed to test the forecasting performance of financial indicators. The forecasted variables are GDP growth and inflation. • The results are not conclusive for all of the European countries included in the sample. In the case of the UK, forecasting GDP growth and inflation improved when the yield curve was used.
Predicting real growth and inflation with the yield spread	Kozicki, Sharon	Economic Review- Federal Reserve Bank of Kansas City	• The paper sets out to test the time horizons at which the yield of government bonds can predict real economic growth and inflation. • The analysis is based on data over the time period 1970 to 1996 for ten industrialised countries including the UK. • A combination of regression models looking at the relationship between yield spread and GDP growth and yield spread and inflation are run for each of the countries in the sample. • Results show that yield spread has predictive power for real GDP growth over one year or so. Whereas yield spread has maximum predictive power for inflation for about three years. For example, regression output shows that a 100-basis-point decrease in the UK yield spread leads to a 1.26 percentage point decrease in predicted inflation at a four-year time horizon.
Inflation and economic growth	Barro, Robert J.	National Bureau of Economic Research	• The paper tests empirically the effect of inflation on economic performance. • The analysis is based on data for 100 countries for the time-period 1960 to 1990. • A system of regression equation is employed, and several other determinants of economic growth are controlled for. • To establish a causal relation between inflation and economic growth, an instrumental variable approach is implemented to take account of the possible endogeneity of inflation. • Results show that higher long-term inflation has a negative effect on growth and investment. For example, regression coefficients show that an increase in inflation rate by 10 percentage point per year lowers growth rate of GDP by 0.2 to 0.3 percentage points annually.
An analysis of inflation and stock returns for the UK	Li, L., Narayan, P.K. and Zheng, X.	Journal of international financial markets, institutions and money	• The paper examines the relationship between inflation and stock returns in the UK market. In particular, the relationship is examined over two periods: i) short term which is an announcement-based (of inflation) analysis; and ii) medium term which is over short horizons. Additionally, the paper looks at the relationship across different inflationary regimes, low inflation economy and high inflation economy. • The study covers data for 10 industries over the time period 1962 to 2007. • The paper uses a combination of OLS and TSLS methods. • Results show that in the short term, unexpected inflation announcements have a negative effect on stock returns, whereas expected inflation

			announcements have a very little impact on stock returns. In the medium term, there is a positive relationship between expected inflation announcements and stock returns and a negative relationship between unexpected inflation announcements and stock returns. Results also show that the inflationary regime also has an impact on the relationship between inflation and stock returns.
The Relationship between Sustainable Growth and the Risk-free Rate: Evidence from UK Government Gilts	Lilico, Andrew and Ficco, Stefano	Europe Economics	• The paper explores the relationship between index-linked government bond yields and medium-term GDP growth rates in the UK. • The study covers data from the time period 1985 to 2001. • The analysis runs a least square model and takes into account the structural break in the time series in 1992. • Consistent with theoretical predictions, the paper finds that there is high correlation between movements in UK index-linked gilts and average GDP growth rates. The paper concludes that based on the findings, it is possible to derive a very good forecast for the ten-year ahead growth economy from the returns on index-linked bonds.

Source: Economic Insight

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