Oxera

Celebrating 25 years

Assessing approaches to expenditure and incentives

Prepared for Ofwat

October 2007

Executive summary

Introduction

In 'New Approaches to Expenditure and Incentives: A Discussion Paper' (May 2007), Ofwat put forward possible approaches to assessing companies' expenditure and setting expenditure assumptions for the forthcoming periodic review (PR09). The regulator's overall objective in reviewing the PR04 approach to efficiency and incentives is to place more emphasis on encouraging business plans that are well thought through and justified, and to provide companies with incentives to reveal their economic expenditure requirements.

The main three options considered by Ofwat are:

– menu regulation;
– incentive-based business planning;
– an evolution of its PR04 approach.

This report is designed to assist Ofwat to make decisions about which areas to take forward in its work programme for PR09 in developing its approach to expenditure and incentives. The particular focus here is on examining the menu regulation approach, including the development of a prototype menu model.

Objectives of the report

The key objectives are to:

– assess the financial incentives and practical implications of menu regulation, incentive-based business planning, and the evolution approach, with a focus on menu regulation;

– develop a prototype menu model for capital maintenance expenditure and produce outputs that allow an assessment of the properties of the menu approach;

– review models developed by Ofwat to underpin the analysis presented in the discussion paper for incentive-based business planning (for operating expenditure, OPEX, and capital maintenance expenditure) and the evolution approach (for capital maintenance expenditure).

The menu regulation approach

Under the menu regulation approach, unlike under standard RPI – X regulation, companies are no longer presented with a 'take it or leave it' regulatory offer regarding the allowed level of expenditure, but are given a range of options from which to choose.

The key elements of the menu approach to regulation are:

– a **baseline**, which represents the regulator's view of a company's requirement;

– a **business plan**, which sets out the projected expenditure from the point of view of the company;

– an **efficiency incentive rate** to address variations in outturn levels of expenditure—ie, a certain proportion of the net present value of outperformance of allowed costs is passed through to shareholders, driving efficiency and managerial effort. This incentive rate changes depending on how far a company's view of its expenditure requirement differs from the regulator's view (ie, the baseline);

– a level of **allowed expenditure** (similar to any regulatory model), which depends on a baseline estimate of expenditure and a range of alternatives around this. The regulator compares allowed expenditure with outturn or **actual expenditure** at the end of a price review in order to calculate companies' rewards;

– a **total reward**, which is the total value paid to companies for outperforming allowed expenditure, plus any additional income payments that result from companies accurately stating their expenditure requirements. The total reward is the amount that the company would earn beyond the allowed cost of capital.

One of the key characteristics of the menu approach is that companies are financially incentivised to submit business plans that represent their true expenditure requirements (or what the regulator expects them to be). The reward received by companies is largest when companies choose an option that represents the expenditure level they expect to incur over the regulatory period.

Strengths and weaknesses of menu regulation

An assessment of the menu approach reveals the following strengths and potential weaknesses.

Strengths

– Firms are induced to provide accurate forecasts of their expected expenditure, and their optimal choice does not depend on other firms' decisions. This reduces the scope for gaming and promotes ownership of business plans.

– The regulator has flexibility in setting the menu elements. For example, on the one hand, with a sharply declining efficiency incentive rate, the regulator may reduce the variability in firms' profits (ie, there would be relatively limited scope for out- as well as underperformance if the company's outturn expenditure differs from the regulator's view). On the other, with a nearly constant incentive rate, the regulator may replicate the RPI – X system.

– The menu approach would be unlikely to add a significant regulatory burden to companies or to the regulator, since, once designed, the approach is likely to require only minor modifications.

– The menu approach need not have important implications for various other aspects of the regulatory framework. A common base cost of capital can continue to be applied. Some expected variation in the returns to firms might arise from the application of the menu rewards and penalties for low- and high-cost firms, respectively.

– The current approach to the regulatory capital value (RCV) will continue to be appropriate. The impact of under- and outperformance can be dealt with through a revenue adjustment in the subsequent price control period.

– Financeability tests and interim determinations can continue to be used broadly in their existing form. With regard to how Ofwat deals with these issues under a menu approach, there are a number of options available for the regulator to consider, including the assumption of the level of expenditure to model in applying these tests.

– Investment incentives under the menu approach are likely to be at least as strong as under the existing framework.

– In certain circumstances, the menu approach could be consistent with the regulators' objective of protecting consumers' interests, by ensuring that bills are ultimately lower than they would have been without the menu approach. In particular, this will be the case where there is significant uncertainty about the appropriate level of costs, which is most likely to be the case for CAPEX.

Weaknesses

– The determination of the regulator's view of expenditure (ie, the baseline) remains a crucial aspect of the framework. Because customers' bills and firms' profits are sensitive to errors in setting the baseline, the regulator is unlikely to be able to significantly reduce existing aspects of its efficiency analysis approach.

– If the regulator relies on a first round of business plan submissions to inform the baseline determinations for expenditure categories that are difficult to forecast econometrically, such as capital enhancement, the menu system will not induce companies to provide accurate first-round submissions. If the menu is to be adopted for enhancement expenditure, it will therefore be important to employ approaches to challenge companies' business plans (such as a bottom-up challenge, or the use of cost base comparisons).

– There is a risk that the menu approach could reduce the efficiency incentives that firms face, whether applied to CAPEX or OPEX. This may arise if the configuration of the menu and efficiency incentive rate are chosen such that the cost pass-through is greater under the menu approach than under the RPI – X framework.

– The menu does not provide independent incentives for quality, so traditional means of defining outputs and assuring their provision are required. However, a menu approach supplemented with a quality framework of the type already in existence would deliver quality outcomes similar to those under the standard RPI – X framework.

– There is a risk that adopting the menu approach could lead to a less beneficial outcome for customers in the short term, if companies end up choosing higher levels of expenditure than the regulator would have allowed for in the absence of this approach. However, this would not be a disadvantage in the longer term if the company's estimate proves to be consistent with the level required to meet output requirements.

– The modelling suggests that, unless the menu approach encourages companies to reveal levels of expenditure significantly below those that the regulator might otherwise adopt, the extent of benefits to consumers may prove to be fairly limited.

Recommendations

Ofwat could take forward the analysis of the menu approach in the following areas and ways.

– **Expenditure categories**—Ofwat might wish to assess further the case for and against applying the menu to different expenditure categories, taking account of the advantages and disadvantages identified in this report. There appears to be a stronger case for its adoption for capital maintenance expenditure, and possibly for capital enhancement.

While, in principle, it could be adopted for operating costs, further modelling would need to be undertaken to determine whether this would offer sufficient 'value for money' to consumers in the long run.

– **Requirements for baseline**—as the baseline continues to play an important role under menu regulation, Ofwat might wish to assess the requirements for establishing a baseline for each category of expenditure for which a menu approach is to be introduced. To ensure that companies are treated fairly, it is not recommended that Ofwat significantly reduce the analysis required to establish baseline costs, unless a reasonable alternative to this can be developed.

– **Balance between rewards and penalties**—if Ofwat wishes to adopt a menu approach, it should ensure that the specification of the menu does not lead to excessive rewards or penalties for the range of plausible expenditure ratios that would be expected to emerge from the process, in order to avoid creating excessive risks to returns across companies in the sector.

– **Timetable**—if the menu approach is to be introduced, a clear timetable will need to be developed for its application. This will help to ensure that companies and the market can familiarise themselves with the approach.

Incentive-based business planning

The incentive-based approach to business planning (IBP) introduces penalties and rewards according to comparisons of business planning. This approach has some desirable properties that represent an improvement over the PR04 RPI – X approach, including a reduction in the reliance on historical capital maintenance expenditure estimates. However, under the strong assumption that companies are driven purely by financial incentives and put little weight on other important considerations (including stakeholder perception and reputation), if the IBP approach were to be implemented without a system that rewards companies for submitting low business plans, this is unlikely to induce them to submit accurate business plans. Such a reward system might incentivise companies to submit accurate bids, but the reward offered might need to be significant in order to offset the benefit that companies might receive from inflating their business plans. This suggests that further development of the IBP approach would be required to overcome these issues and to offer an improvement compared with the alternative approaches considered in this report (ie, the evolution and menu approaches).

Evolution of the PR04 approach to expenditure and incentives

This report also examines the evolution approach to capital maintenance expenditure. The proposed approach overcomes one of the major criticisms of the PR04 approach. Were this approach to be employed again, this might incentivise companies to inflate their bids in order to boost their expenditure allowance. The evolution approach reduces the reliance on purely historical expenditure levels; rather, econometric and unit cost modelling is used to estimate a lower bound of an allowed expenditure range. The upper bound is determined by companies' business plans (with a cost base efficiency challenge applied). Allowed expenditure is based on the quality of the asset management case and an uplift method. While companies might still have an incentive to inflate their bids, this would be successful only to the extent that Ofwat's asset management assessment would not be able to detect the inflating of expenditure plans. As with the other approaches discussed in this report, Ofwat's view of companies' expenditure requirements is important. Here, these requirements are estimated using econometric and unit cost techniques, and the modelling therefore needs to be sufficiently robust to be used for this purpose. Assuming that this is the case, this method would be a useful development of the RPI – X approach taken at PR04.

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The paper was discussed at a workshop on June 20th 2007, organised by Ofwat and attended by all the water and sewerage companies (WASCs) and water-only companies (WOCS). The views reflected in the responses to the discussion paper were influenced by the discussion during the workshop and are summarised by Ofwat in its report ‘Expenditure and Incentives Consultation: Summary of Responses’ (June 2007).

The four options considered in Ofwat’s discussion paper are:

– menu regulation;
– incentive-based business planning;
– an evolution of Ofwat’s PR04 approach;
– an enhanced bottom-up challenge.

Overall, the key messages from the responses to the consultation are the following.

– The most important criteria for any approach to setting expenditure are: best value, sustainability, incentives, regulatory burden, simplicity and company ownership of plans.

– There is strong support for menu regulation (albeit with caveats), support for the evolution approach, mixed views about incentive-based planning, and strong opposition to the enhanced bottom-up approach.

– The setting of benchmarks is crucial. However, many companies oppose the use of econometric modelling for setting the benchmark.

– The approach to expenditure needs to be part of a wider package, including outputs.

1.1 Purpose of the report

This report is designed to assist Ofwat in making decisions about which areas to take forward in its work programme for PR09 in developing its approach to expenditure and incentives. Ofwat’s views will be presented in its proposals for the formal methodology consultation in October.

Following Ofwat’s instruction, this report places particular emphasis on examining the menu approach, including the development of a prototype menu model.

The key objectives of the report are to:

– assess the financial incentives and practical implications of menu regulation, incentive-based business planning, and the evolution approach, with a main focus on menu regulation;

- develop a prototype menu model for capital maintenance expenditure and produce outputs that allow an assessment of the menu model's properties, both on a stand-alone basis and relative to Ofwat's PR04 approach;
- review existing models developed by Ofwat to underpin the analysis presented in the discussion paper for incentive-based business planning (for operating expenditure, OPEX, and capital maintenance expenditure) and the evolution approach (for capital maintenance expenditure),

1.2 Structure of the report

- Section 2 examines the menu approach.
- Section 3 examines the incentive-based business planning approach.
- Section 4 examines the evolution approach for capital maintenance expenditure.
- Section 5 discusses bottom-up modelling and the case for and against modelling capital expenditure (CAPEX) and OPEX jointly and separately.
- Section 6 summarises and provides recommendations.
- Appendix 1 contains a case study of Ofgem's sliding scale mechanism.
- Appendices 2 to 5 contain supporting analysis for the menu approach.
- Finally, Appendix 6 contains technical details in support of the conclusions for the incentive-based business planning approach.

2 The menu regulation approach

One of the approaches set out by Ofwat in its May discussion paper is menu regulation. Under this approach, companies are no longer presented with a 'take it or leave it' regulatory offer regarding the allowed level of expenditure, but are given a range of options from which to choose. A similar approach was developed in the electricity sector by Ofgem in the 2004 distribution price control review (DPCR4), and Ofgem has developed the approach further during the initial phases of the 2008 gas distribution price control review (GDPCR).

The menu approach has a number of important objectives:

- to minimise the scope for gaming in business plans by companies;
- to place more emphasis and accountability for business planning in the hands of companies, and to reward them for putting forward realistic business plans;
- to offer some protection to companies that need to spend more than the allowed expenditure for legitimate reasons, while not encouraging overspend;
- to provide ongoing incentives to reduce costs throughout the periodic review.

While there are many specific ways in which the menu may be constructed, the various options have several elements in common, including the following.

- A level of allowed cost (similar to any regulatory model), which depends on a baseline estimate of expenditure and a range of alternative options around this.

- An efficiency incentive rate to address variations in outturn levels of expenditure—ie, a certain proportion of the net present value (NPV) of outperformance of allowed costs is passed through to shareholders, driving efficiency and managerial effort. This incentive rate changes according to how far a company's view of its expenditure requirement differs from the regulator's view (the baseline).

- The ability of the company to choose an option from the menu. This choice will be determined by the contract that offers the best pay-off (ie, total financial reward), taking into account the company's expected level of outturn costs.

The regulator may need to offer 'inducements' to encourage companies to accept contracts with lower allowed revenues. It can do this through a series of adjustments to the allowed levels of costs, which in general will be higher for low-cost contracts.

The structure of this section is as follows.

- Section 2.1 sets out the principles of the menu approach, based on a review of the literature, with reference to the menu used by Ofgem for electricity distribution companies at DPCR4.

- Section 2.2 sets out the key elements of the menu approach to regulation. In order to illustrate the working of the approach in practice, this section then presents scenarios of the impact of the menu on allowed expenditure and compares outcomes under the menu approach with those from the RPI – X approach taken at PR04. The key characteristics of the menu approach are illustrated with a menu regulation model developed by Oxera.

- Section 2.3 discusses the implications of the menu approach for the incentives that companies face.

– Section 2.4 provides an overview of practical issues encountered in the construction and implementation of menu regulation.

– Section 2.5 examines other aspects of Ofwat's regulatory framework, and examines how these may be affected by the introduction of menu regulation.

– Section 2.6 summarises the key findings.

The appendices to this section set out a case study of the Ofgem work in establishing a menu for the electricity and gas distribution price controls (Appendix 1); further scenarios illustrating relevant aspects of the menu approach using the Oxera Menu model (Appendix 2); a user guide to the Oxera Menu model (Appendix 3); and further technical details of the Menu model components, its features and theoretical outcomes of the Menu model (Appendices 4 and 5).

2.1 Description of the menu regulation approach

2.1.1 Lessons from the literature on the menu approach

Theories of optimal regulation often assume that regulators are completely informed about the technology, costs and demand faced by the regulated firm. However, in practice, this is often not the case. More recent models of economic regulation recognise, and address, two sources of informational problems.[1]

– **Uncertainties about the firm's inherent cost opportunities**. The inability of regulators to discern whether a firm has cost-reduction opportunities gives firms a strategic advantage. Firms with 'low-cost' opportunities might attempt to convince the regulator that they are 'higher-cost' firms in order to obtain a higher tariff.

– **Uncertainties about the managerial effort**. Managerial effort reduces the firm's costs, all other things being equal. It is also necessary for the full realisation of the firm's cost opportunities. However, managerial effort represents a cost for managers (and for society) and it is not directly observable for the regulator.

While the first problem could, in principle, be solved by setting the regulated price equal to the firm's realised costs ex post (increasing, perhaps, the frequency with which the firm's realised costs are audited), this regulatory mechanism will not help in solving the information asymmetry regarding the firm's managerial effort. In particular, a regulatory scheme where the price is set equal to the firm's realised costs would be likely to lead to very low managerial efforts or X-inefficiency.

If, instead, the regulator opts for setting a fixed price for a period of time (eg, a price cap that varies with exogenous indices), managers become the residual claimants of any cost reductions, and are therefore induced to exert varying levels of effort to exploit the firm's cost opportunities. While this regulatory mechanism performs well in addressing issues concerning managerial effort, it will not eliminate the strategic advantage of the firm regarding its cost opportunities. Firms will still have an economic incentive to convince the regulator that they are 'higher-cost' firms in order to obtain a higher tariff.

To the extent that this is a problem facing regulators such as Ofwat, there may be gains to society from reducing the informational gap about the true nature of the firm's cost opportunities. Price cap regulation, while creating managerial incentives to reduce costs, is not necessarily sufficient to induce firms to reveal their true cost opportunities. Since the

[1] See Joskow, P.L. (2007), 'Regulation of Natural Monopolies', M. Polinsky and S. Shavell (2007), *Handbook of Law and Economics*, North Holland.

regulator needs to consider the financial viability of the firms, it might end up setting a tariff that is too high relative to the firms' true cost opportunities.

Laffont and Tirole (1993) developed economic models to deal simultaneously with the informational asymmetry problems surrounding firms' cost opportunities and managerial effort.[2] The solution involves a regulatory mechanism that takes the form of a *profit-sharing* or a *sliding scale* contract, where the regulated price is partly responsive to changes in *realised* cost and partly fixed ex ante. By offering the firm a menu of regulatory contracts with different cost-sharing provisions, the regulator can make it profitable for firms with low-cost opportunities to choose a relatively high-powered incentive scheme (ie, those with significant potential to outperform the regulatory targets, but equally significant downsides if these targets are missed), and those with high-cost opportunities to opt for a low-powered incentive scheme (ie, those with limited scope to outperform or potential to underperform).

One version of Laffont and Tirole (1993) assumes two types of firm (high- and low-cost). Ex ante, the regulator knows only the probability of a firm being high- or low-cost, but it cannot observe the firm's type or level of managerial effort. Ex post, however, the regulator can observe the actual production costs. The regulator offers the regulated firm a choice between two regulatory contracts. One is a fixed-price option that leaves some rent if the firm is a low-cost type, but negative rent if it is a high-cost type (ie, overall, it is a high-powered scheme). The second is a cost-contingent contract that allows the firm to make less effort than optimal, but leaves no rent (ie, overall, it is a low-powered scheme). In this model, the following conclusions are shown.

– The level of managerial effort exerted by the high-cost type will be less than the optimal (the 'optimal' being the case where the regulator has full information).

– The firm participation constraint is binding for the high-cost type but not for the low-cost type. This means that the high-cost firms end up with no rent (ie, their revenues are equal to their costs).

– The low-cost firm chooses the optimal level of effort and gains an information rent, such that its revenues are above the level of its costs, although customers pay less than if the company had selected and delivered a high-cost contract.

For a menu of contracts to work, the range of options to choose from should be incentive-compatible so that the greatest gain accrues to a company when choosing a contract that is associated with a given firm's cost structure and effort level. Low-cost firms are then better off opting for the high-powered scheme (and providing the optimal level of effort), while high-cost firms are attracted by the low-powered scheme (and providing less effort).

2.1.2 Menu regulation in practice

The way in which the menu approach works is best explained using a practical example. Ofgem developed a menu approach to assess CAPEX, also known as the sliding scale approach, for DPCR4.[3] Using this as an example, this section introduces the key components of the menu approach (these are explained in more detail in section 2.2). Appendix 1 presents a case study of Ofgem's approach, including how the mechanism works, the timetable for the process, and some of the associated conceptual and practical issues.

[2] Baron and Myerson (1982) focus only on the adverse selection problem, and Laffont and Tirole (1986) on managerial efforts (the moral hazard problem); Laffont and Tirole (1993) cover adverse selection and managerial effort at the same time. Baron, D. and Myerson, R. (1982). 'Regulating a Monopolist with Unknown Cost', *Econometrica*, **50**:4, 911–30; Laffont, J. and Tirole, J. (1986), 'Using Cost Observations to Regulate Firms, *Journal of Political Economy*, **94**:3, 614–41; and Laffont, J. and Tirole, J. (1993), *A Theory of Incentives in Procurement and Regulation*, Cambridge, MA: MIT Press.
[3] Ofgem (2004), 'Electricity Distribution Price Control Review: Initial Proposals', June.

Table 2.1 shows the key components of Ofgem's menu of options used at DPCR4. The menu components interact to give shape to the menu approach. They are as follows.

– The **baseline** represents the projected benchmark level of expenditure from the point of view of the regulator. The baseline and the companies' business plans, which combined create the business plan:baseline ratio (row 1 of Table 2.1), are the starting point of the menu.

– The **business plan** contains the projected expenditure from the point of view of the company. One of the key characteristics of the menu approach is that companies are incentivised to submit business plans that represent their true expenditure requirements (or what the regulator expects them to be).

– The **efficiency incentive rate** is the rate at which companies' outperformance (underperformance) in terms of their allowed expenditure is rewarded (penalised) and is set by the regulator. Companies are rewarded (penalised) for outperformance (underperformance) at the specified efficiency incentive rate, and are given an additional income payment which is payable after the outturn expenditure is known (ie, at the end of the price review period). A key characteristic of the menu system is that the efficiency incentive rate (row 2) decreases as the business plan:baseline ratio increases. This means that the higher the bid relative to the baseline set by the regulator, the smaller the reward from outperforming the expenditure allowance. At the same time, the company's exposure to underperformance is reduced.

– The regulator compares **allowed expenditure** with outturn expenditure in order to calculate companies' rewards. The allowed expenditure, expressed as a ratio to the baseline, for different levels of business plan:baseline ratios is shown in row 3 of Table 2.1.

– The **additional income** is a bonus payment to companies that is used to ensure that the overall menu is incentive-compatible—in other words, that companies achieve the greatest total reward by 'choosing' a business plan:baseline ratio that is equal to expected actual expenditure. The allowed expenditure, expressed as a ratio to the baseline for different levels of business plan:baseline ratios, is shown in row 4 of Table 2.1.

– **Actual expenditure** is the outturn expenditure incurred by firms. The actual expenditure is necessary for assessing the level of outperformance (ie, allowed expenditure – actual expenditure), which in turn is used to calculate companies' rewards.

– The **total reward** is the total value paid to companies for outperformance plus the additional income payments. The figures below row 4 in Table 2.1—the payoff matrix—show the total reward:baseline ratios for different actual expenditure:baseline ratios (in this example 70 to 140) and business plan:baseline ratios (row 1). The total reward is the amount of money that the company would earn beyond the allowed cost of capital. A positive 'reward' indicates that the firm would earn more than the allowed cost of capital (once adjustments for outperformance/underperformance are taken into account), while a negative reward indicates that the firm would earn less than the allowed cost of capital.

Table 2.1 Ofgem's sliding scale mechanism for electricity (DPCR4)[1]

1. Business plan:baseline	100	105	110	115	120	125	130	135	140
2. Efficiency incentive rate (%)	40	38	35	33	30	28	25	23	20
3. Allowed expenditure:baseline	105	106.25	107.5	108.75	110	111.25	112.5	113.75	115
4. Additional income:baseline	2.5	2.1	1.6	1.1	0.6	–0.1	–0.8	–1.6	–2.4
Total reward:baseline									
Actual expenditure:baseline									
70	16.5	15.7	14.8	13.7	12.6	11.3	9.9	8.3	6.6
80	12.5	11.9	11.3	10.5	9.6	8.5	7.4	6.0	4.6
90	8.5	8.2	7.8	7.2	6.6	5.8	4.9	3.8	2.6
100	4.5	4.4	4.3	4.0	3.6	3.0	2.4	1.5	0.6
105	2.5	2.6	2.5	2.3	2.1	1.7	1.1	0.4	–0.4
110	0.5	0.7	0.8	0.7	0.6	0.3	–0.1	–0.7	–1.4
115	–1.5	–1.2	–1.0	–0.9	–0.9	–1.1	–1.4	–1.8	–2.4
120	–3.5	–3.1	–2.7	–2.5	–2.4	–2.5	–2.6	–3.0	–3.4
125	–5.5	–4.9	–4.5	–4.2	–3.9	–3.8	–3.9	–4.1	–4.4
130	–7.5	–6.8	–6.2	–5.8	–5.4	–5.2	–5.1	–5.2	–5.4
135	–9.5	–8.7	–8.0	–7.4	–6.9	–6.6	–6.4	–6.3	–6.4
140	–11.5	–10.6	–9.7	–9.0	–8.4	–8.0	–7.6	–7.5	–7.4

Note: [1] Table 2.1 is a modified version of Ofgem's DPCR4 menu. The original Ofgem menu table is provided in Appendix 1 (Table A1.1).
Source: Ofgem (2004), 'Electricity Distribution Price Control Review: Final Proposals', November.

The shaded cells in Table 2.1 indicate the highest reward:baseline available in each row of the payoff matrix (ie, for each level of the actual expenditure:baseline ratio). The payoff matrix is incentive-compatible, which means that a company earns the greatest reward given its expected expenditure by submitting a business plan equal to its required expenditure. For example, in the row where actual outturn expenditure:baseline is 110, the greatest reward available is 0.8, which is obtained by submitting a business plan with a forecast expenditure of 110.

For a given forecast (the columns in the menu table), both customers and firms are better off when the actual outturn (rows) is lower than that allowed. When less expenditure is incurred in providing a given service provision, companies earn greater rewards and customers enjoy lower tariffs due to pass-through. For example, if a firm forecasts expenditure of 110 but spends only 100, it earns a reward of 4.3, which is greater than 0.8, and customers pay 104.3 (100 + 4.3), which is less than 110.8 (110 + 0.8).

The concept of 'total reward' referred to above (and in this report in general) abstracts from timing issues (ie, part of the reward arises as an adjustment at the end of the regulatory period).

2.2 Modelling the menu approach

This section sets out the key elements of the menu approach. The following aspects are examined to illustrate the working of the menu approach in practice:

- the different elements of the menu, the choices that need to be made when constructing it, and how the menu is constructed;
- the impact of the menu on allowed expenditure and other outcomes of interest;
- how the outcomes under the menu compare with the RPI – X approach taken at PR04.

Throughout this section the different aspects are illustrated with examples from the Oxera Menu model. The examples presented use capital maintenance expenditure; however, similar insights could be derived for OPEX and capital enhancement.[4] Section 2.4.6 discusses issues regarding the application of the menu to different types of expenditure. Most of the examples provided are derived using the model parameters as per Ofgem's gas distribution networks (DNs) (shown in Table A1.2 in Appendix 1).[5]

A more detailed user guide to the Oxera Menu model is provided in Appendix 3.

2.2.1 Menu construction

The baseline and company expenditure forecasts

The starting point for constructing a menu is the setting of a baseline estimate of expenditure—ie, the regulator's view of what the economic costs will be over the next price review period. The baseline is developed independently of the menu model—for example, these were provided by PB Power in the case of Ofgem's DNO menu. Estimates of the baseline are then incorporated into the model as an input.[6] An explanation of the different methods to set the baseline is provided in section 2.4.2.

The other input required for the construction of the menu is company expenditure forecasts, as submitted in the company business plans.

Components to be set by Ofwat

The three main components that need to be set by the regulator and which give shape to the menu are the following:

- the efficiency incentive rate;
- the allowed expenditure:baseline ratio;
- the additional income:baseline ratio.

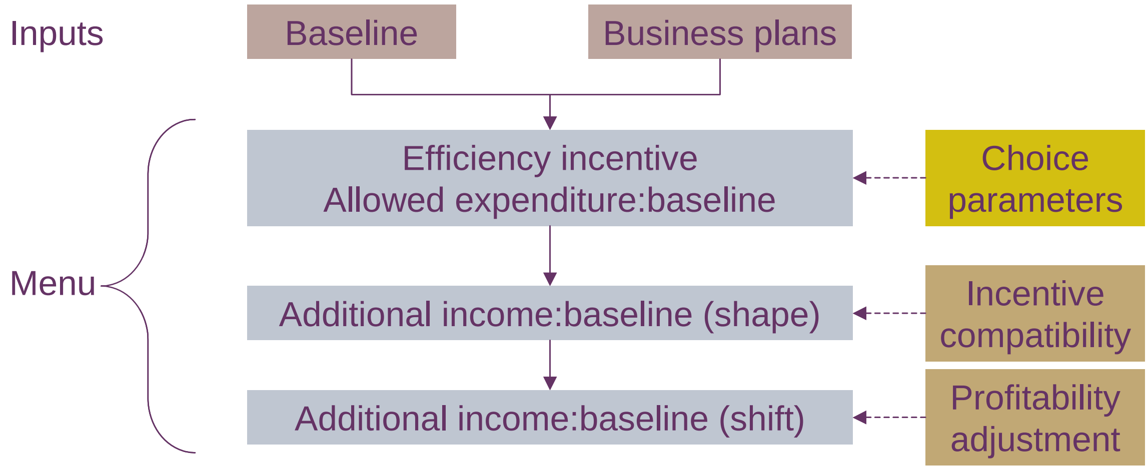
Figure 2.1 illustrates the process of setting menu components using inputs such as the regulator's baseline estimate. Each step of the process is described below.

[4] Oxera also developed prototype models for OPEX and capital enhancement. However, some of the data required for carrying out simulations was not available for these categories of expenditure. Results from these models are therefore not presented in this report.

[5] The Oxera Menu model also has the option of using the electricity distribution network operator configuration, and allows for users to specify alternative configurations.

[6] In order to assess the sensitivity of changes in the baseline assumption, the Oxera Menu model includes the option of simulating changes to the baseline.

Figure 2.1 Menu construction process



Source: Oxera.

The menu components, in conjunction with companies' actual outturn expenditure, determine the reward obtained by the firms under the menu system. The firms are rewarded (penalised) for outperformance (underperformance) of their allowed expenditure at the specified efficiency incentive rate, and are guaranteed the additional income payment. This is demonstrated in the equation below:[7]

Reward = (allowed expenditure – actual expenditure) * incentive rate+ additional income

One of the key characteristics of the menu approach is that the components are not determined freely. Instead, each is a function of the business plan:baseline ratio within the bounds of the menu.[8] Table 2.2 shows the functional forms for the three components of the menu.

Table 2.2 Functional forms of the menu components

Component	Type of function	Functional form
Efficiency incentive rate	Linear	$\sigma_1 + \sigma_2 f$
Allowed expenditure:baseline ratio	Linear	$\gamma_1 + \gamma_2 f$
Additional income:baseline ratio	Quadratic	$\alpha_1 + \alpha_2 f + \alpha_3 f^2$

Note: f denotes the business plan:baseline ratio, and the Greek symbols denote key parameters defining each component.
Source: Oxera Menu model.

The functional forms shown above are the simplest functional forms required to construct a menu. The standard RPI – X is a special case of these functional forms—ie, the efficiency incentive rate and allowed expenditure components are set as constants rather than depending on the business plan:baseline ratio (f). More elaborate functional forms could be chosen but would be technically more cumbersome. For example, if the regulator wished to reward outperformance and penalise underperformance at different incentive rates to

[7] Both sides of the equation are expressed as a ratio relative to the baseline.

[8] Forecasts that are above the upper bound or below the lower bound are assigned the incentive rate, allowed expenditure, and additional income that apply at the bound. Incentive compatibility does not apply outside the bounds, but firms expecting expenditure below the lower bound, for example, will not submit a business plan above the lower bound.

encourage companies to submit more challenging business plans, it would make the efficiency incentive rate a function of realised expenditure as well as the forecast. This would then require the regulator to make assumptions about the distributional properties of the firm's uncertainty regarding future expenditure in order to design an incentive-compatible menu.[9]

The regulator constructing a model determines these components by choosing the parameters (ie, the Greek symbols). For example, in the Ofgem gas DN menu, σ_1 equals 0.9 and σ_2 equals –0.005.

This implies that by choosing the parameters, the regulator will determine the components and subsequently the reward that the companies will receive under the menu approach. However, for some of the parameters the choice is restricted by the incentive-compatibility requirements.

Incentive compatibility

In order to construct a menu, the regulator has to ensure that it is incentive-compatible. An incentive-compatible menu guarantees that a profit-maximising company will have the incentive to submit an accurate business plan to the regulator. For example, as can be seen in the Ofgem electricity distribution network operator (DNO) menu in Table 2.1, a firm that expects to spend 105 (in terms of the business plan:baseline ratio) will receive the maximum reward:baseline ratio (2.56) by submitting its true expectation to the regulator. From a purely profit-maximising perspective, it would not be rational for companies to submit a higher or lower bid than 105 to the regulator.

The Oxera Menu model guarantees that the incentive compatibility of the menus constructed is achieved.[10] It does so by automatically adjusting α_2 and α_3 (ie, the first- and second-order parameters of the additional income:baseline ratio).[11]

Profitability adjustment

Restrictions on the constant of the additional income:baseline ratio (α_1) are not required to achieve an incentive-compatible menu, since this constant represents an equal payment given to every firm, regardless of its forecast. Therefore, the regulator is free to shift (ie, change the constant) the additional income:baseline ratio. This parameter can be used by the regulator to determine the overall profitability or generosity of the menu system after having selected the efficiency incentive rate and the allowed expenditure:baseline ratio (ie, parameters σ_1, σ_2, γ_1 and γ_2).

Adjusting the profitability of companies under the menu may be interpreted as choosing a break-even point, which is the business plan:baseline ratio that yields zero reward to a company (ie, companies only earn their cost of capital). For example, in Table 2.1 companies earn their cost of capital (ie, a reward of zero) somewhere between 110 (reward of 0.8) and 115 (reward of –0.9).[12] The profitability adjustment might be made in one of two ways:

– prior to receiving any business plan submissions;
– using a first round of business plan submissions.

Adjusting profitability prior to any business plan submission would involve setting the menu parameters such that a chosen cell in the matrix of payoffs is the break-even point (ie, has a

[9] For further details see Appendix 4.4. The most easily introduced complication in functional form is to make the linear functions alternately kinked and linear in segments. See Appendix 4.5 for details of this approach.

[10] The possibility of constructing a menu that is not incentive-compatible is also considered in the model.

[11] A detailed mathematical explanation about how the automatic incentive compatibility is achieved is included in Appendix 4.

[12] The specific value is 112.2. The choice of category shown is for illustrative purposes only: the model itself is continuous and provides a payoff for any given business plan:baseline ratio.

value of zero, where a company earns enough only to cover its cost of capital). The regulator might do so if it is confident in its prior expectations about expenditure requirements.[13]

Alternatively, the regulator might request a first round of business plan submissions to inform its baseline estimate or expectation of firms' business plan:baseline ratios. Based on this information, the regulator could construct a menu that is break-even for the average company (weighted by its share in total expenditure). To construct such a menu, the regulator would assume a percentage by which it expects the first-round submissions to be reduced in the second round, as the menu incentives to provide accurate business plans do not apply to the first round of submissions.[14]

Table 2.3 depicts a payoff matrix from the Oxera Menu model of a break-even menu, designed with the assumption that the (weighted) average firm will submit a business plan that is 121% of the baseline estimate.

Table 2.3 Example of a break-even menu

Business plan:baseline	100	105	110	115	120	125	130	135	140
Efficiency incentive rate (%)	40	38	35	33	30	28	25	23	20
Allowed expenditure:baseline	100.00	101.25	102.50	103.75	105.00	106.25	107.50	108.75	110.00
Additional income:baseline	7.32	6.78	6.19	5.53	4.82	4.03	3.19	2.28	1.32
Total reward:baseline									
Actual expenditure:baseline									
70	19.32	18.50	17.57	16.50	15.32	14.00	12.57	11.00	9.32
80	15.32	14.75	14.07	13.25	12.32	11.25	10.07	8.75	7.32
90	11.32	11.00	10.57	10.00	9.32	8.50	7.57	6.50	5.32
100	7.32	7.25	7.07	6.75	6.32	5.75	5.07	4.25	3.32
105	5.32	5.38	5.32	5.13	4.82	4.38	3.82	3.13	2.32
110	3.32	3.50	3.57	3.50	3.32	3.00	2.57	2.00	1.32
115	1.32	1.63	1.82	1.88	1.82	1.63	1.32	0.88	0.32
120	-0.68	-0.25	0.07	0.25	0.32	0.25	0.07	-0.25	-0.68
125	-2.68	-2.12	-1.68	-1.37	-1.18	-1.12	-1.18	-1.37	-1.68
130	-4.68	-4.00	-3.43	-3.00	-2.68	-2.50	-2.43	-2.50	-2.68
135	-6.68	-5.87	-5.18	-4.62	-4.18	-3.87	-3.68	-3.62	-3.68
140	-8.68	-7.75	-6.93	-6.25	-5.68	-5.25	-4.93	-4.75	-4.68

Note: This menu is based on the Ofgem gas DN menu. The only different parameter is the additional income:baseline constant, which was changed to 4.8 to provide a zero reward to the (weighted) average company. This reflects an assumption that PR04 business plan submissions will be reduced by 11% by introducing the menu.
Source: Oxera Menu model applied to PR04 capital maintenance data.

[13] Results obtained from the Oxera Menu model of this type of profitability adjustment are provided in Appendix 2.2.

[14] This approach is employed in section 2.2.5 to simulate applying a menu to PR04 data. PR04 submissions are interpreted as first-round submissions informing the regulator's choice of the break-even point; a second round of submissions under the menu would then occur.

2.2.2 Description of key model outputs

The Oxera Menu model uses expenditure allowances and rewards as an approximation to measure the effect of the menu on customers.[15] The model provides several outputs (for a given set of baseline assumptions of company expenditure, menu parameters, and assumptions about the accuracy of the first business plan submissions) that can be used to draw conclusions about the menu's impact and make comparisons between different scenarios (eg, with outcomes under the RPI – X approach taken by Ofwat at PR04).

The outputs are summarised in Box 2.1. The aim of this report is to examine the impact on the water industry as a whole—however, the model could also be used to examine the impact on individual companies.

[15] The actual impact could be simulated by building a financial model that calculates the allowed revenue resulting from assuming a certain depreciation of the assets and cost of capital.

Box 2.1 Outputs from the Oxera Menu model

Given a menu and set of assumptions about PR04 data, the Oxera Menu model simulates the outcome of applying the menu, and produces the following outputs.

The **total allowed expenditure** is the aggregate industry allowed expenditure, and is determined by the companies' expenditure forecasts and the menu parameters.

The **total actual expenditure** is the amount companies spend after submitting their business plans. In simulations, business plans are assumed to be accurate forecasts of actual expenditure.

The **total allowance**—ie, the total cost allowance that is passed on to customers—is the sum of companies' expenditure and rewards:

total allowance = total actual expenditure + total reward

While the total allowance captures the NPV impact of the menu on customers, it should be noted that it abstracts from timing issues, such as the fact that outperformance is rewarded in the next review period.

The **incentive income** is the aggregate value of industry-wide rewards (penalties) for outperformance (underperformance) relative to allowed expenditure at the efficiency incentive rate over the price control period. It is derived as follows:

incentive income = (allowed expenditure – actual expenditure)*efficiency incentive rate

The **additional income** is the aggregate value of industry-wide additional income payments made to companies based on their simulated business plan forecast submissions.

The **total reward** is the aggregate value paid to companies for outperformance plus their additional income payments. This amount represents a net transfer from the customers to the companies, and is necessary to provide incentives both to submit accurate business plans and to improve efficiency and managerial effort. The total reward is calculated as follows.

total reward = incentive income + additional income

The **total reward** per annum expressed **as a percentage of regulatory capital value (RCV)** is the total reward annualised and reported as a share of the total RCV of the water companies' water assets.

Source: Oxera.

2.2.3 Impact of using different menus

Table 2.4 shows sample results from the Oxera Menu model for three different menus, and compares these with outcomes from PR04. The menus differ in the following respects.

- **Menu 1** is the Ofgem menu for gas DNs (this menu is shown in the Appendix 1, Table A1.2).
- **Menu 2** is the Ofgem menu for gas DNs with the additional income function's constant increased (ie, α_1 in Table 2.2) relative to Menu 1 (this menu is shown in Table 2.3).
- **Menu 3** is the Ofgem menu for electricity DNOs, which has greater allowed expenditure and additional income levels than Menu 1 (this menu is shown in Appendix 1, Table A.1.1).

Table 2.4 Comparison of outcomes for example menus[1]

	Menu 1	Menu 2	Menu 3
Total allowance (£m)	**4,065**	**4,230**	**4,134**
Incentive income (£m)	–145	–145	–96
Additional income (£m)	–19	145	0
Total reward (£m)	**–165**	**0**	**–96**
Total reward per annum (% of water RCV)	–0.18	0.00	–0.11
Allowed expenditure (£m)	3,604	3,604	3,775
Actual expenditure (£m)	4,230	4,230	4,230

Note: [1] The Oxera Menu model simulations assume that companies' actual expenditure is equal to that forecast in their business plan submissions. All simulations also assume that the baseline is set using econometric/unit cost approaches (methods to set the baseline are discussed in section 2.4.2). The business plan submissions are assumed to be the PR04 submissions minus 11%.
Source: Oxera Menu model applied to capital maintenance data.

The point at which companies earn their regulatory cost of capital in Menu 1 is 106.5. At PR04, where companies' submitted business plans in the absence of the menu approach, their bids tended to exceed 106.5. Therefore, using Menu 1 reduces the allowance by £165m compared with the PR04 outcome, and firms incur a penalty equal to this difference—ie, they earn less than their allowed cost of capital. For Menu 2, the additional income constant (α_1) is greater than in Menu 1. As a result, companies under Menu 1 start earning less than their allowed cost of capital at a higher business plan:baseline ratio than under Menu 1. The constant is set such that the total allowance is equal to the PR04 outcome with the weighted average firm earning a reward of zero (ie, companies are earning their allowed cost of capital). Using Menu 3's menu specification, as used by Ofgem for the DNOs, results in a total allowance that lies between Menu 1 and Menu 2.

The Oxera Menu model provides a range of other simulations to assess menus. These simulations (explained in further detail in Appendix 2) provide the following insights into some key aspects of the menu approach.[16]

– **The impact on total allowance and rewards of setting the baseline at a different level**. Raising the baseline by 25% increases the total allowance by almost 8%, which, in terms of the total reward received by the firms, represents nearly £300m, or an increase of 0.3% of the annual reward as a percentage of the RCV (see section A2.1).

– **The impact of adjusting the parameters of the Oxera Menu model to reflect the regulator's confidence in the baseline**. This involves a regulatory decision regarding the menu break-even point (ie, where a business plan:baseline ratio yields a total reward of zero). Increasing the break-even business plan:baseline ratio from 100 to 140 increases the total allowance by more than 10%. In terms of total reward, this implies more than £400m, or an increase of almost 0.45% of the annual reward as a percentage of the RCV (see section A2.2).

– **The impact of the regulator's view about the accuracy of business plans** (if the regulator decides to analyse the first business plan submissions before setting the menu). Assuming 5% inaccuracy instead of 20%, for example, could lead to a transfer of more than £200m from customers to companies (see section A2.3 for an explanation).

[16] The simulations use the Ofgem gas DN menu. Sensitivity tests around this menu specification, including the DNO menu, show that the results do not vary substantially when different specifications are used.

2.2.4 Comparisons with RPI – X without using PR04 data

Measuring the differences in outcomes under the RPI – X approach taken at PR04 and the menu model approach is essential for Ofwat to be able to determine whether it is worthwhile implementing the menu approach to assess expenditure. A comparison can be made on the basis of the outcomes described in the previous section. However, quantitative measures of the outcomes are not the only factor to be considered by Ofwat. There are other factors, such as the benefit of the companies owning their business plans, which are not quantified by the model but which should be considered by Ofwat.

In order to compare the menu approach with RPI – X, the key assumptions must be similar for both systems so that the scenarios are comparable. This suggests that there should be:

– **comparable efficiency incentives**—the incentive rate of the RPI – X system and the menu should be similar for the expected range of outcomes;

– **comparable profitability levels**—the allowed expenditure set for RPI – X should be the break-even ratio of the menu, such that firms with this outturn level earn zero reward under either system.

The following sections make comparisons based on various possible parameter choices for both the menu and RPI – X approaches, without using data from PR04 to simulate the actual outcome.

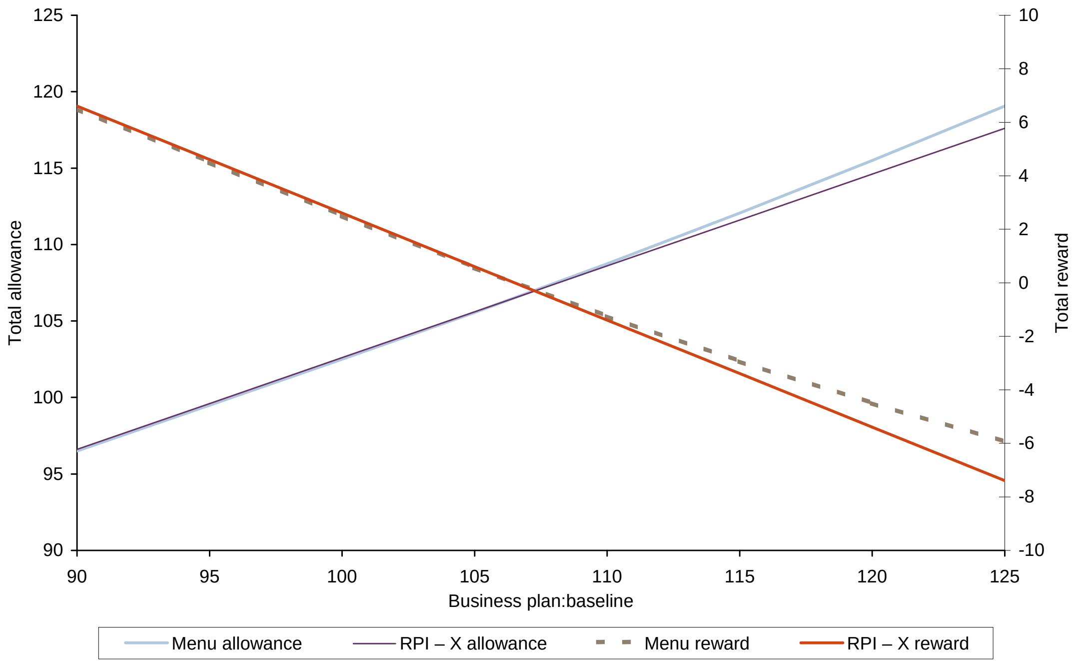
Comparison of outcomes with low and high break-even ratios

The regulator may wish to set a low business plan:baseline break-even ratio if it has high-quality information with which to form its view regarding expected expenditure requirements and therefore can be confident in its baseline estimate. The difference between the menu and RPI – X approaches can be highlighted by contrasting a range of possible outcomes under the two approaches, both with the same break-even point.

An example of a menu with a low break-even ratio is the Ofgem gas DN menu, in which firms with a business plan:baseline ratio exceeding 106.5 earn negative rewards (ie, less than their allowed cost of capital).

Figure 2.2 compares the outcomes of various business plan submissions under the Ofgem gas DN menu with those of an RPI – X approach set at the same break-even ratio (106.5) with a symmetric 40% incentive rate. The figure assumes that the outturn expenditure is equal to companies' business plan submissions—ie, companies earn the highest possible reward given their expenditure outturn.

Figure 2.2 Total allowance and reward under the menu and RPI – X approaches with a low break-even ratio (£m)



Source: Oxera Menu model.

For both menu and RPI – X approaches, the figure shows that at a business plan:baseline ratio of 106.5, the total reward (the right-hand axis) is zero, and the total allowance (the left-hand axis) is 106.5.

As the figure also shows, the menu and RPI – X approaches are very similar in total allowance and reward when the company forecast and outturn are below the assumed break-even ratio of 106.5.[17] This is due in part to the Ofgem menu's lower bound of 100 having an allowed expenditure of 100 and an incentive rate of 40%, so business plans below 100 mirror the RPI – X structure.

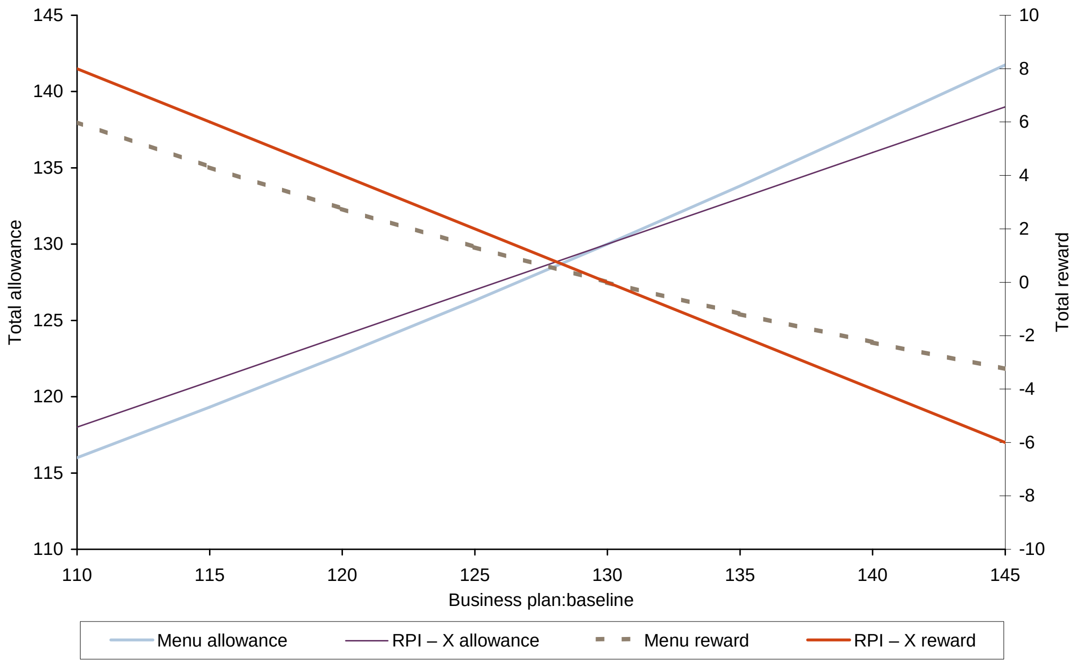
When expenditure is above the assumed break-even ratio (ie, to the right of 106.5), the menu outcomes lie above those under RPI – X. This differential implies that when expenditure is above the assumed break-even ratio, the menu approach is more expensive to customers. This is due to the fact that the menu's incentive rate decreases as the forecast increases, resulting in a smaller penalty (actual costs are greater than allowed costs) and thus a higher pass-through rate. If this figure depicts the range of expected outcomes, there is not a significant difference between the two regulatory approaches.

The above outcome does not always hold. For example, if the regulator has less confidence in the accuracy of its baseline expenditure estimate, it may choose a more conservative menu with a higher break-even ratio, such as 130 (ie, it has a high uncertainty baseline).

Figure 2.3 compares the outcomes under RPI – X and the Ofgem gas DN menu (which is modified to break even at 130). Realised outturn is assumed to be equal to the business plan.

[17] For example, for a business plan:baseline of 100, the menu total allowance is 102.5 and RPI – X total allowance is 102.6.

Figure 2.3 Total allowance and reward under the menu and RPI – X approaches with a high break-even ratio (£m)



Note: RPI – X is made consistent with the menu approach by setting a 130 break-even level with symmetric 40% incentive rates. Menu parameters are Ofgem gas DNs' with an additional income constant (α_1) equal to 7.25.
Source: Oxera Menu model.

Since the assumed break-even business:plan to baseline is 130, the total reward lines under both menu and RPI – X take a value of zero at this ratio. Similarly, by design, the total allowance is equal at this ratio, and takes a value of 130.

As the figure shows, there are greater differences between the menu and RPI – X outcomes both above and below the chosen break-even ratio. When companies spend less than 130, there are greater savings to customers under the menu approach than under RPI – X. When companies exceed the assumed break-even expenditure level, more of the underperformance burden is borne by customers in the form of a greater total allowance and therefore larger bills.

However, these results are driven by the parameter choices and do not indicate intrinsic differences between the menu and RPI – X approaches. In the comparison made in Figure 2.3, lowering the RPI – X incentive rates such that they are closer to the menu's ex ante incentive rates, such as 33% for outperformance and 20% for underperformance, would yield very similar outcomes to the menu approach.[18]

Using the slope of incentive rate to allow for uncertainty in the baseline estimate

An important feature of the more complex menu approach is its non-linear total allowance function. This grants the regulator more flexibility than it has under the RPI – X system.

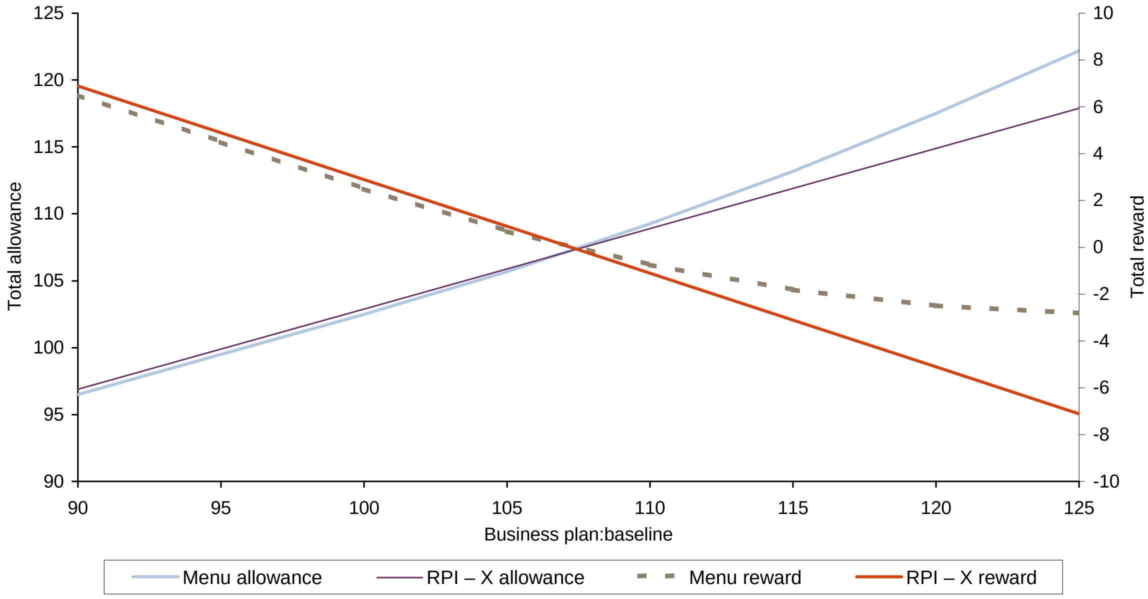
For example, if the regulator is not confident in its baseline, it might set a more steeply declining incentive rate in order to reduce firms' profit sensitivity to the baseline estimate (since actual costs increase compared with allowed costs, the penalty will be reduced). With a steeply declining incentive rate, low-cost firms may choose a high-powered incentive scheme, while high-cost firms might opt for a high pass-through rate and thus would not incur

[18] The Oxera Menu model provides the tools required to perform such analysis (see Appendix 3).

significant losses. Therefore, more differentiation between menu choices reduces the financial risk of the menu to companies. When forecasts significantly exceed the regulator's estimate, customers bear the costs; when forecasts are below the baseline estimate, customers pay less than they would under an RPI – X scheme with a similarly powered incentive rate near the baseline.

Figure 2.4 illustrates these outcomes for a menu that has a 40% incentive rate at 100, which falls to 2.5% at 125. (The break-even ratio resulting from these assumptions is 107.2.) Realised outturn is assumed to be equal to the business plan.

Figure 2.4 Total allowance and reward under the RPI – X and a menu approaches with a steeply declining incentive rate (£m)



Note: Menu parameters are σ_1 = 1.9, σ_2 = -0.015, and α_1 = -25. The break-even ratio that results from these assumptions is 107.2. RPI – X has a symmetric 40% incentive rate.
Source: Oxera Menu model.

This example produces similar results to those depicted in Figure 2.3. To the left of the break-even ratio both systems present very similar results, whereas to the right they diverge. However, the more steeply declining incentive rate in Figure 2.4 leads to a more pronounced divergence between the two systems.

2.2.5 Comparisons with RPI – X using PR04 data

The above comparisons consider the impact of possible parameter choices on the outcome when only a single company submits its business plan. This section compares the RPI – X and menu approaches for the water industry using simulations driven by PR04 data on company business plan submissions.

To compare regulatory systems with similar efficiency incentive rates and break-even outturn levels, the RPI – X rate is compared with Menu 2 from Table 2.4. The following assumptions are made for the first example, shown in Table 2.5.

– The RPI – X incentive rate is 40%. (The actual incentive rate for capital maintenance at PR04 is a function of the discount rate and asset life and is between 30 and 40%.)[19]

[19] Alternative RPI – X incentive rates can be simulated using the Oxera Menu model.

– The RPI – X and menu systems have a 40% incentive rate when the business plan:baseline ratio is 100, and they break even at a business plan:baseline ratio of 121.[20] This break-even business plan:baseline ratio is used as an example because, on average, Ofwat's PR04 final determinations were 121% of its baseline estimate. Put differently, if the menu system had been in place at PR04 (and companies would not have changed their behaviour) the (weighted) average company would have submitted a business plan that was 121% of Ofwat's baseline estimate by reducing its PR04 submission slightly more than 11%.

A business plan submission (of the weighted average company) of around 11% below the PR04 submission is used as the base case scenario for which the total allowances are equal under both the menu and RPI – X approaches (Table 2.5).

Table 2.5 Outcome if business plan submissions are 11% below PR04 submissions

	RPI – X	Menu
Total allowance (£m)	4,230	4,230
Total reward (£m)	0	0
Average incentive rate (%)	40	29

Source: Oxera.

For the 11% reduction outcome, both systems would yield a total allowance of £4.230m, the total industry expenditure allowed by Ofwat at PR04, and a total reward of zero. Clearly, actual outturn is uncertain and the regulator is concerned with scenarios that differ from this base case. The Oxera Menu model provides simulations describing the outcomes when the regulator sets the menu parameters and RPI – X level assuming an 11% reduction from the PR04 submissions and the realised reduction differs.

If the business plan submissions turned out to be more than 11% below the PR04 submission, expenditures would be lower than the regulator assumed, and both customers and companies would be better off than anticipated. Comparison of the simulation outcomes reveals that the example menu and RPI – X approaches described above differ in their distribution of these gains. For example, if the business plan submissions were 20% below the PR04 submissions, the specified menu would save customers approximately £41m compared with the chosen RPI – X system, as shown in Table 2.6.

Table 2.6 Outcome if business plan submissions are 20% below PR04 submissions

	RPI – X	Menu
Total allowance (£m)	3,973	3,932
Total reward (£m)	171	130
Average incentive rate (%)	40	33

Source: Oxera.

The converse also holds for this example. If companies submitted higher expenditure plans than assumed by the regulator (ie, less than an 11% reduction from PR04 submissions), customers would end up paying more under the menu than under RPI – X due to a greater

[20] The fact that, under the menu approach, the efficiency rate decreases as the level of costs increases means the incentive rates are exactly equal only at a single point.

share of underperformance being passed through to them.[21] These outcomes are summarised in Table 2.7.

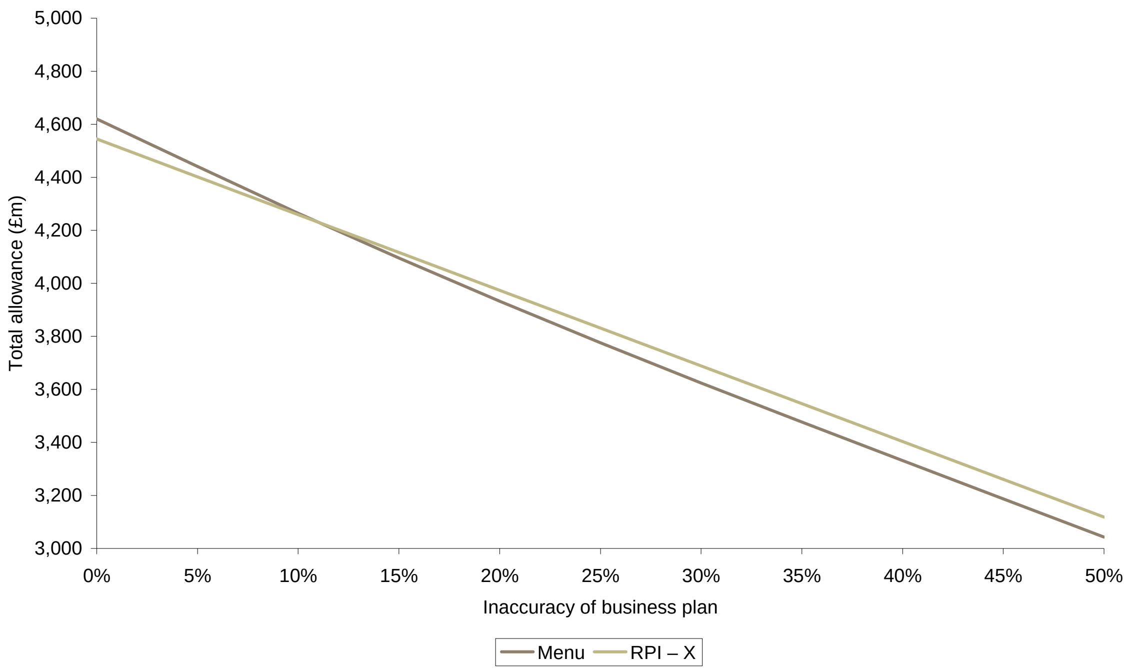
Table 2.7 Outcome if business plan submissions are 5% below PR04 submissions

	RPI – X	Menu
Total allowance (£m)	4,401	4,440
Total reward (£m)	–114	–76
Average incentive rate (%)	40	26

Source: Oxera.

Figure 2.5 shows the menu and the RPI – X total allowance outcomes for a range of levels in business plan inaccuracy (the amount by which PR04 submissions are reduced) from 0% to 50%. For PR04 business plans with inaccuracy of less than 11%, the menu delivers a higher total allowance (almost £80m higher at zero business plan inaccuracy). For business plans more than 11% below PR04 submissions (ie, a greater reduction relative to PR04 submissions than anticipated), the menu delivers a lower total allowance than RPI – X. See section A2.4 for further examples.

Figure 2.5 Total allowance under the menu approach versus the RPI – X approach



Note: Menu 2 from Table 2.3 was used and a symmetric 40% efficiency incentive was assumed for RPI – X.
Source: Oxera Menu model applied to capital maintenance data.

2.3 Evaluation of incentive properties

Given that the menu approach has been developed with the objective of improving firms' incentives within the regulatory process, it is important to examine how it may be expected to affect incentives. Incentives that may be affected are the following:

[21] Under the menu approach, higher business plan submissions (and therefore, by assumption, a higher outturn) result in lower penalties due to the lower incentive rates under the menu, which means that customers pay for more of the underperformance.

– incentives to bid for expenditure for the price control review period;
– investment incentives during the price control period;
– efficiency incentives during the price control period;
– incentives to encourage the regulator to adopt a conservative baseline.

2.3.1 Bidding for allowed expenditure for the review period

The incentive-compatible nature of the menu system should in principle lead to a business plan that best reflects the company's expectations at the time when the regulator requires it to 'select' its price control contract. However, it is possible to envisage exceptions to this rule.

Asymmetry in the uncertainty of the required expenditure level

If the company considers that the risk of significant overspend relative to a central scenario is high, it may consider a higher bid than the central expectation in order to mitigate the risk of very low returns. To the extent that the rewards to the firm for selecting a lower expenditure base are relatively small, this type of behaviour is likely to be more significant since the perceived 'penalty' for engaging in this behaviour is low.

Significant risk aversion

Even if the profile of uncertainty is symmetric, if firms are highly risk-averse they may choose a somewhat higher cost (with a higher cost pass-through allowance) such that they are less exposed to overruns.

Rate of time preference

If the rewards for outperformance (or penalties for underperformance) are factored into a revenue adjustment at the next price control, companies may place different values on the rewards or penalties offered than assumed by the regulator. A significant difference in the rate of time preference could undermine the design of the menu. For example, if firms were awarded tariff revenues equal only to their allowed expenditure figures, and the pass-through of out- or underperformance were calculated at the end of the price control period, they would be substituting between an income stream of tariff earnings and future end-of-period rewards/penalties.[22] If firms discounted future income to a greater extent than assumed by the regulator, they would place more value on the allowed expenditure component's contribution to firm profit than assumed in the menu design, and hence would increase their forecast ratio above their expected expenditure. The menu would not be incentive-compatible.

Menu payments may be structured such that they are not sensitive to intertemporal substitution. If expected ex post payments (end-of-period adjustments) are zero, the firm will not substitute between its income stream and these payments. Therefore, even if the firm's discount rate substantially differs from that assumed by the regulator, it will discount all pay-offs in the menu matrix equally and incentive compatibility will be preserved. This would require the inclusion of anticipated out- or underperformance in the initial tariff structure or a menu in which allowed expenditure equals forecast expenditure.

In practice, the magnitude of any error resulting from different discount rate assumptions may be relatively small. For example, under the Ofgem gas DN menu, a company with a high discount rate valuing the NPV of the ex post adjustment at only 90% of the NPV assumed by the regulator, and expecting to spend 125, would maximise its profits by announcing a forecast of 126.6—an error of less than 1.3%.[23] However, firms that are closer to the

[22] Whether the additional income payment would be awarded as part of the tariff structure or as an adjustment at the end of the price control period is not important in this example, although this would affect substitution.
[23] This example is derived using the procedures described in Appendix 5.3. The tariff is assumed to include the additional income payment. A 90% valuation after five years is approximately an annual valuation of 98%.

regulator's baseline have a greater incentive to trade higher allowed expenditure at the beginning of the price review for larger underperformance penalties at the end of the price review: a firm with a high discount rate valuing NPV at 90% of the assumption and expecting expenditure of 100 would announce a forecast of 102.9. Nonetheless, these figures are the upper bound of the possible distortion, as firms with greater discount factors would also discount the NPV of the income stream from tariff revenue and therefore not enjoy as large a marginal benefit from inflating their forecast as assumed here.

Incentives for business planning

If companies do not have a single preferred business plan that minimises costs, but rather consider choosing from business plans of varying aggressiveness in cost savings, the regulator may be concerned with the incentives for companies to submit 'challenging' business plans. Under the menu system, the incentive to reduce expenditure from a given level to a lower-cost level is the average of the incentive rates at those two levels.[24] For example, using the Ofgem gas DN menu, a firm that announces a forecast of 100 will then face an incentive rate of 40% during the price control period, and a firm that announces a forecast of 120 will face an incentive rate of 30%. At the planning stage, in choosing to reduce its forecast expenditure from 120 to 100 and submit a more aggressive business plan, a company will expect to earn only 35% of the cost savings produced by successfully implementing this plan. Since under the menu system the incentive rate is a declining function of the company's business plan submission, the ex ante incentive to plan more aggressively (for a lower expenditure) is weaker than the ex post incentive rate that applies during the price control period at the more challenging business plan level.

2.3.2 Investment incentives during the price control period

Once the system is operating, the incentive to invest will largely depend on:

– the way in which expenditure will be treated in the regulatory asset base (RAB);
– the allowed rate of return which the firm expects to be permitted on assets in the future;
– the benefits that the firm could obtain in the shorter term by reducing investment (whether due to efficiency or other reasons).

These issues are also relevant in the standard price control approach where the treatment of investment in the RAB is also critical; the only change that the menu system would be likely to create is that the proportion of savings from reduced expenditure may differ. For example, in the Ofgem approach, the incentives for outperformance begin at 40% of the present value of the savings achieved relative to the allowed investment for companies bidding at 100% or less of the benchmark. However, the incentive rate falls to 20% for companies choosing a menu contract at 140% of the benchmark. In principle, this could lead to an increase in incentives to invest for some firms in the sense that a higher proportion of investment at the margin will be captured as value to the firm through the RAB. There is a risk that it will be the highest-cost firms that also face the highest incentives to invest.

2.3.3 Efficiency incentives during the price control period

After allowed expenditure has been determined by companies' business plan submissions, the incentives to reduce expenditure during the price control period under the menu approach are similar to those of RPI – X. Each company has financial incentives to outperform the price control determination so as to retain a percentage share of the savings. Unlike under RPI – X, that share is not common to all companies, but varies according to the business plan:baseline ratio for each firm. The regulator's parameter choice of how sharply the efficiency incentive rate declines determines the degree of variation in these incentives between high business plan:baseline ratio and low business plan:baseline ratio companies.

[24] See Appendix 5.1.

2.3.4 Benchmarking and the process of interaction with the regulator

Under a menu approach, companies are likely to continue to be incentivised to encourage the regulator to adopt a conservative baseline (or benchmark) estimate for required costs against which the menu of alternatives is developed. This is because the menu system is designed to elicit information about the company's expectations about costs, but companies' overall financial performance will still be subject to the way in which the menu is constructed. The higher the baseline, and the greater the allowance for 'additional income' as part of the process for ensuring incentive compatibility, the better a firm's financial performance will tend to be. This suggests that a regulator needs to consider two important issues when implementing a menu system:

– the approach to developing a reasonable benchmark;
– the level of expenditure at which a company can be expected to break even (ie, earn a rate of return equal to the allowed cost of capital).

2.4 Practical challenges

One key criterion identified by Ofwat regarding the assessment of the options is their practical feasibility. The following practical aspects need to be considered for the adoption of a menu approach:

– alternative ways to implement the menu;
– the approach to establishing a baseline;
– the appropriate timetable for developing the menu of options, and how this should relate to the companies' business planning timetable;
– how to deal with out- and underperformance;
– how to define outputs;
– identifying the types of expenditure, if any (eg, OPEX, capital maintenance, enhancement expenditure) for which a menu approach could be a practical option.

2.4.1 Alternative ways of implementing the menu

There are several ways in which Ofwat could incorporate a menu approach within its process for setting price control limits. It could refine the existing approach, making use of available cost data and existing models, but introducing a further step that allows flexibility for the company in choosing the precise contract. The alternative approach would be to significantly reduce the burden of the existing framework by eliminating key steps from the analysis (such as econometric modelling, the common framework, or bottom-up challenge to costs, depending on the cost category).

The choice between these two approaches will come down to two critical questions:

– what is the importance of establishing the baseline, and how might this be done if a menu system is used?

– what is the extent of the burden that the menu approach will impose?

Detailed options for measuring the baseline are set out in section 2.4.2. However, the general point to note is that the baseline is likely to be the most significant area of dispute within the menu approach. If a baseline is set too low, companies will face difficulties in earning a normal return, even if they are efficient and choose the 'appropriate' level of costs. If the baseline is too high, the regulator may overcompensate companies for revealing information. A quantification of these possible scenarios is included in section A2.1 of Appendix 2. This is an important issue, although it is arguably less critical (given the flexibility within the model) than the choice of the cost allowance in the standard price control framework. In the theoretical model developed by Laffont and Tirole (see section 2.1.1), the problem is avoided in that the regulator typically has information about the possible upper level of costs, and can set an option that enables a high-cost firm to cover its costs. In reality, such information is not available, and the menu approach may therefore not ensure full coverage of the firm's costs at the selected cost level. This risk of losses may further increase the importance of ensuring that the baseline is set appropriately.

Ofwat may be concerned about adding a menu to an already detailed regulatory process. While the above discussion highlights the importance of using reasonable information to set the baseline, overlaying complex new regulatory structures on top of an already intensive process may not be attractive. However, Ofwat may wish to consider the following.

– Compared with the detailed work required to set a baseline level of costs, the additional regulatory burden of using a menu would not be particularly significant.

– The main burden introduced would be the design of the menu contract. However, this can be done upfront; moreover, it is common (in form) across the industry, and should not require major revisions across time, even if some parameters need to be adjusted.

Overall, introducing a menu could lead to some reduction in the burden of the existing framework by allowing flexibility for companies to choose the most appropriate regulatory contract. For setting expenditure, in order to determine the scope for catch-up efficiencies, Ofwat would need to continue to undertake some form of efficiency analysis (eg, econometric, unit cost or cost base). This would not only play a role in setting targets for price reviews but also in continuing to monitor companies' performance—eg, to check their progress over time. To set the baseline, Ofwat's discussion paper proposes the use of econometric modelling. This would provide some confidence that companies' baselines would be set on the same basis and would be similarly challenging. For capital maintenance the justification of some of the expenditure would still need to be undertaken on the basis of an assessment of quality of the asset management case. On balance, it is not clear whether it would be realistic to drop significant aspects of the existing approach to efficiency and expenditure analysis unless the process can be refined to deliver similar levels of confidence to the baseline estimates. This warrants further investigation.

2.4.2 Establishing the baseline

As previously highlighted, it is important to recognise that the baseline estimate for costs plays an important role in the menu framework. This is because the actual allowance depends on the relationship between the baseline and the company's bid. Consequently, the level of the baseline selected for each company will have an important impact on its rates of return, as well as on the efficiency incentives it chooses, even if it does not directly influence the company's expectation of its costs (and therefore the level of costs it bids under the menu system).[25]

The following options may be useful to consider in determining how the baseline should be established.

– **Historical cost levels**. This approach would set a baseline equal to observed costs from a given base year. At PR04, historical levels of cost were important in setting allowed expenditure. A potential advantage of this approach would be its transparency and the limited regulatory burden involved. It is most likely to be relevant if costs are expected to be stable over time; however, if costs are variable over time or performance across companies is variable, it may not be appropriate to use a base year as the baseline. Importantly, if historical costs are inflated, allowances, and therefore prices, will be higher than they would be if costs were subject to challenge.

[25] This concurs with UKWIR's argument that the menu approach does not reduce the importance of the regulator's view of expenditure requirements. UKWIR (2007), 'Review of the Approach to Efficiency Assessment in the Regulation of the UK Water Industry', May.

– **Econometric baselines**. An alternative approach would be to employ econometric and unit cost approaches to estimate required expenditure. This would enable Ofwat to use existing approaches to provide a more precise view on achievable costs for each company based on a number of cost drivers. It has the possible downside of requiring the existing methodology to be preserved (including the data requirements) with a new 'overlay' of complexity in the form of the menu. However, it could be argued that the menu, while in some areas quite complex, may not add a significant amount to the regulatory burden since, once designed, it would be relatively easy to maintain.

– **Bottom-up challenge or unit costs**. Given the importance of setting an appropriate baseline, there may be a case for enhancing the bottom-up challenge to costs put forward by companies before the baseline expenditure requirements are established. These issues are examined in more detail in section 5.

2.4.3 Timetable for the process

For the incentives to operate, companies need an opportunity to respond to the menu. Ideally, the regulator would develop the structure at an early stage to inform the industry of the methodological approach, and it should ensure that the data for setting out baselines is collected at a sufficiently early stage. Companies should have the opportunity to review the menu selection in light of wider aspects of the review.

The timetable suggested by Ofwat is illustrated in Figure 2.6.

Figure 2.6 Possible menu timetable

Note: [1] The underlying structure of the menu could be developed beforehand.
Source: Oxera based on discussions with Ofwat.

Two alternatives to this process could be considered.

– First, there could be a second iteration—for example, once companies reveal their expected expenditure (ie, the last stage in Figure 2.6), the regulator might set new benchmarks. This would potentially allow Ofwat to make direct use of companies' forecasts in forming baselines. However, the obvious disadvantage to this approach is that companies would not have an incentive to reveal their true expectations in the first round.

– The second alternative could be to set the baseline *prior* to the submission of business plans, on the basis that initial business plans would otherwise risk being subject to the same pressures that Ofwat was concerned about in the PR04 approach (companies not having an incentive to reveal their true expectations regarding expenditure requirements), and companies may therefore wish to provide a higher-expenditure initial business plan. The risk of this approach is that the baseline would not be sufficiently robust to form a reasonable starting point for the menu, undermining the fairness of the approach. However, for OPEX, an expenditure category that is likely to be more readily 'predictable', this may provide an alternative.

For CAPEX, it would appear that the option outlined in Figure 2.6 offers the best balance between setting a reasonable baseline within the menu, and ensuring that the regulatory burden is not excessive. For OPEX, both the option in Figure 2.6 and the second alternative may be considered.

2.4.4 Dealing with under- or outperformance

As noted in the discussion on the incentive properties of the menu approach, the construction of the menu of options available to companies implies that different firms will have different incentives to outperform the regulatory contract, in that they will be permitted to retain varying proportions of the value of any outperformance.

In addition to the proportion of outperformance that the company is permitted to retain, the amount retained *within* the price control period will need to be assessed. For example, if a company has an allowed expenditure of 100 and spends 90, an adjustment at the end of the price control period is needed to pass through the share of the outperformance (10) to which customers are entitled. This can be done using the following formula:

PV (adjustment) = PV (allowed outperformance) – PV (within-period gains)

where PV (allowed outperformance) is equal to the present value of the difference between the allowed expenditure and the actual expenditure multiplied by the efficiency incentive rate for the firm in question, and where PV (within-period gains) is equal to the present value of the difference between allowed and actual expenditure.

Even if a firm outperforms, the required adjustment could, in principle, be either positive or negative. The same holds if the firm underperforms. This is because the firm will already have achieved some of the benefits of the outperformance within the price control period. If the menu selection leads to a low incentive rate, a negative adjustment might be required in order to extract some of the surplus. Conversely, if the incentive rate is high (eg, if the firm selected a lower-cost contract), the adjustment may need to be positive. The sign and magnitude of the required adjustment will also depend on the type of expenditure to which the menu is applied, as different proportions of outperformance may be maintained by firms within a price control period for CAPEX relative to OPEX, depending on the treatment of depreciation and the way in which the share of the present value of outperformance is measured for permanent or temporary savings, for example).

Having determined the magnitude of the required adjustment, any out- or underperformance, could be dealt with in a number of ways, such as the following.

– **Adjustments to the RCV**. The adjustment could be added to the RCV at the end of the period and would then be remunerated over time, as a return on capital. However, this has a disadvantage in that it could lead to confusion in the comparison of firms' RCVs, since the adjustment would not be related to actual investment or depreciation policy. Furthermore, the reward would be profiled out indefinitely, rather than being awarded after the five-year regulatory period.

– **One-off revenue uplifts at the beginning of the next price control period**. This approach would simply increase (or decrease) the revenue entitlement in the first year of the control. However, it could lead to volatility in bills if the size of the adjustment is significant for some firms.

– **Profiled revenue uplifts at the subsequent price control period**. This approach would adjust the P_0 factor to rebase prices for the following period. The impact of the adjustment would be profiled across the whole period.

On the basis that the profiled revenue uplift avoids both complicating the RCV calculation and introducing unnecessary volatility to bills, it would appear to be the preferred option for adjusting for outperformance.

2.4.5 Defining outputs

It is important to ensure that the nature of the regulatory 'contract' is specified as clearly as possible. In a standard price control, a lack of clarity in the outputs to be produced by the firm may lead to underinvestment (as the firm seeks to increase profits) and/or reductions in quality of service (since rewards for improving service are not clear).

In principle, the importance of establishing clear outputs would also hold under a menu approach. In addition to the risks of investment or quality cuts, the following issues specific to the menu approach may need to be considered.

– It may be more difficult to define an appropriate baseline if the outputs are not clear. This is because a wide range of 'baseline' levels of expenditure could be conceived of, each of which might be consistent with different outputs.

– The incentive-compatibility property of the menu approach may be undermined by the absence of clarity about the outputs to be delivered. If these are not clear, the firm may find it difficult to form a clear view on its own expenditure forecasts.

– A further feature of the menu is that failure to define outputs could lead to companies selecting low expenditure contracts, since such low expenditures will provide the companies with the highest reward. They will also then face strong incentives to spend below the (already low) allowance, which, in the absence of well-defined outputs could lead to a reduced quality of service.

The above suggests that the menu approach is likely to be most effective in providing an appropriate outcome when both the regulator and the firm can link their baseline or business plan forecast to a precise set of outputs.

An alternative argument is that if the menu approach allows companies to make choices about their expenditure levels, it may also be configured such that it allows companies some control over the specific nature of outputs (or 'scope of work') required to deliver their regulatory/legal obligations and meet customers' preferences. For a given menu, companies may therefore not only disagree with the regulator on the baseline, but also on the scope of the output. This might involve higher-level output definitions, rather than very precise project lists. The Water Industry Commission for Scotland is considering whether to allow Scottish Water additional annual operating costs dependent on a defined improvement in the Overall Performance Assessment (OPA).[26]

2.4.6 Application to categories of expenditure

One feature of the Ofgem sliding scale mechanism is that it is applied to capital investment only, rather than to operating costs.

Ofwat could in principle apply a menu approach to any of the three categories of expenditure reported within the water regulatory framework: OPEX, capital maintenance or enhancement. The question is whether there are strong justifications to apply it to any one of these categories but not others.

To consider this issue, it is useful to recall that the principal objective of the menu is to encourage business plans that best reflect companies' expectations. This suggests that the greater the amount of uncertainty on the part of the regulator regarding the appropriate level of costs, the more useful the menu approach is likely to be.

However, if the range of outcomes for costs is known with a reasonably high degree of confidence, the value associated with encouraging the company's underlying views to be

[26] Water Industry Commission for Scotland (2007), 'Strategic Review of Charges 2010–14: Methodology—Volume 3: Approach to Assessing Operating Cost Efficiency'.

fully reflected in the business plan is likely to be less important. Indeed, in such a situation, the regulator may risk being required to set up incentive allowances for information that does not add significantly to the process, with customers bearing the cost of this.

Based on this important issue—namely, the degree of underlying uncertainty about cost levels—the menu may, as suggested by Ofgem's approach, be most valuable for CAPEX (maintenance or enhancement).

At the same time, the menu approach is most likely to be sustainable where the approach to developing a baseline is agreed. For capital enhancement expenditure, setting the baseline is likely to be somewhat more challenging than for operating costs, for example, because the drivers of the overall size of the capital programme are likely to be more sensitive to company-specific factors or variations leading to differences in the required scale of expenditure. This is an issue that Ofwat currently faces within the price control approach, and which is currently addressed by using the cost base approach alongside the bottom-up challenge of companies' expenditure plans. Ofwat is also currently consulting on developing improved/new capital maintenance econometric models.[27] If the menu approach were to be adopted for capital enhancement, either approach would appear likely to be retained or an alternative developed to ensure that a reasonable baseline is established for each company.

A second relevant factor may be the burden associated with the development of the menu for different types of expenditure. For example, if it were more difficult to develop an appropriate baseline for one category of expenditure, this would make it more difficult to adopt a 'fair' menu approach. Therefore, if a baseline could be developed relatively easily—eg, for OPEX based on recent cost levels, reflecting stability in this variable—the burden associated with using a menu might be low.

A third factor that Ofwat may wish to take into account is the consistency of the menu approach with existing features of the regulatory framework. For example, for CAPEX, Ofwat currently maintains an asymmetric approach to dealing with under- or outperformance. While a certain proportion of savings are passed through to customers, in most circumstances, capital overspends are capped at the level of the allowance. A menu approach, if applied to this type of expenditure, would not easily permit such asymmetry in the treatment of under- or outperformance, since to do so would undermine the incentive-compatibility nature of the system. Ofwat will therefore need to consider whether a menu approach is consistent with its intended future approach to the treatment of company performance.

2.5 Implications for other aspects of the regulatory framework

The menu approach may have implications for other aspects of Ofwat's price-setting policy. This section discusses some of the key areas and impacts that may arise with the introduction of the menu approach.

2.5.1 What elements of the current regulatory burden might be reduced or removed?

The previous section examined several options for the way in which the menu could be implemented and the baseline established. This discussion identified that it may be possible to reduce the burden in some areas (eg, simplifying the efficiency analysis), but that this would involve a trade-off. If the removal of some forms of analysis were to reduce the credibility of the baseline estimates, this may undermine the benefits of the menu approach.

[27] Ofwat (2007), 'Capital Maintenance Relative Efficiency Modelling for the 2009 Periodic Review', May.

2.5.2 Cost of capital and risk implications

One issue for consideration is whether the menu approach has any implications for how Ofwat sets the allowed rate of return for firms, either in terms of the continued use of the industry-level weighted average cost of capital (WACC), or in terms of the level of risk facing companies in aggregate.

Common or company-specific cost of capital

In assessing whether a common cost of capital across the industry would be appropriate under a menu approach, the following factors would need to be taken into account.

– The use of a common cost of capital assumption significantly reduces Ofwat's regulatory burden. The cost of capital is already an area of contention at most price reviews, and to introduce company-specific WACC estimates could lead to incentives for companies to focus to a much larger extent on company-specific risk factors.

– On the other hand, it may offer more 'protection' against downsides for some higher-cost companies, which will be able to have a higher cost allowance than might otherwise have been the case. It could lead to differences in the marginal incentive rate across firms, which may lead to some differences in risk.

On these grounds, it could be argued that companies face a 'choice' between a high-risk/high-powered contract and a lower-risk/lower-powered contract, and that the cost of capital for firms choosing the former type of contract is likely to be higher since they may face a greater probability of cost overruns, and a more significant penalty if overruns occur.

To some extent, the features of the menu approach implicitly allow for differential rates of return across the different contracts. To the extent that companies ultimately spend the amounts they have chosen to bid for, the 'low-cost' companies will earn rewards, and hence will earn a higher return than the underlying cost of capital assumed by the regulator. Similarly, the 'high-cost' companies will face penalties, and earn a lower cost of capital. It could therefore be argued that the menu to some extent allows for differential costs of capital for firms facing different risks, without requiring the regulator to determine separate 'base' WACCs for individual companies.

While firms under different menu contracts will earn different rates of return, such differences in returns will not necessarily match any differences in the cost of capital. Indeed, within the menu approach, the purpose of the rewards and penalties is primarily to induce the selection of the appropriate level of expenditure, rather than an explicit recognition of cost of capital differences. However, measuring the nature of the cost of capital difference arising from various menu options is likely to be difficult. Even if this were possible, applying these in addition to the rewards/penalties already incorporated into the menu approach, would be likely to add significant complexity to the regime, the benefits of which are unclear without detailed investigation. Given this, Ofwat may wish to retain an industry-wide baseline WACC even if it adopts a menu approach. However, the regulator may wish to calibrate the menu so that the rewards and penalties are commensurate with its judgement about the variations in risk being taken. This could be done by examining the penalties and rewards in terms of the impact on returns, and sizing them accordingly, based on regulatory judgement and insight into investors' perceptions

Impact on the level of the cost of capital

Another important question is whether, on average across the industry, the adoption of a menu approach would be likely to change firms' risk profile, leading to a higher or lower WACC being required. Ofwat may wish to consider the following aspects in this regard.

Could a significant change in the regulatory framework such as the introduction of a menu approach lead to a change in the perception of risk by the market? A key issue in determining the cost of capital is the perceived stability of the regulatory regime. This relates both to the broad framework used and to the way in which assumptions are formed about key price control parameters, allowing for reasonable evolution over time. Introducing a menu may be perceived as a fairly significant change in the framework. To the extent that investors (and other regulatory observers) will have had the opportunity to review the Ofgem approach to menu regulation in practice, and the fact that it arguably puts somewhat less emphasis on regulatory views about costs relative to those of the company, the adoption of a menu approach in the water sector may be less likely to cause concern to the market.

The main impact on market perception is instead likely to be derived from market views about the achievability of the cost targets set as a result of the menu approach, as well as the volatility that may arise in financial performance. This might be largely determined by views of the process by which the baseline was formed, and the perceived generosity of the rewards/penalties structure within the menu. One factor that could lead to an impact on the average WACC would be a marked increase in the level of cost pass-through. As previously highlighted, the menu approach requires some variation in the incentive rates for different cost levels. If Ofwat were to develop a menu structure that featured low average incentive rates at the cost levels ultimately chosen by firms, the level of risks facing the firms could be expected to fall compared with the current framework. If cost pass-through rates were high on average, it may be the case that the forward-looking sensitivity to profits with respect to cost shocks would decline, and this may have an impact on the cost of capital. However, to the extent that Ofwat wishes to preserve incentives (and is therefore unlikely to design a menu which leads to very high rates of cost pass-through across the industry), this would appear to be less relevant in practice.

Looking at the risk implications of adopting a menu approach across different categories of expenditure, this may depend on the extent to which the adoption of the menu affords protection against cost uncertainties. Previous analysis has suggested that the level of uncertainty is likely to be less compared with operating costs, and so any risk reducing benefits associated with a structure that places more emphasis on company perspectives on costs is likely to be limited in this regard. There may, however, be greater benefits if a menu approach were to reduce uncertainties regarding the capital programme.

In summary, while a number of potential issues relating the adoption of a menu to an impact on the cost of capital may be highlighted, the overall impact is uncertain as a number of factors may offset each other. Taking account of the modelling results presented above, which suggest that the size of the impact is likely to be relatively modest in revenue terms, the significance of any overall effect of a menu approach on the cost of capital is likely to be limited. However, this ignores the potential impact on the cost of capital from increasing the level of cost pass-through for overspend compared with the existing regime.

2.5.3 Financeability implications: how does the menu affect companies’ ability to raise capital?

An important feature of previous periodic reviews has been the testing for financeability constraints, with revenue adjustments introduced in cases where the scale of expenditure was determined to be sufficiently high to jeopardise companies’ ability to raise finance.

Under a menu approach, the underlying importance of the financeability test would continue. Ofwat will wish to be assured that the overall price control package will enable firms to access the capital markets. Nevertheless, the menu approach could affect the application of the test in a number of ways.

– **The choice element of the menu**. One issue for consideration is whether the fact that companies would be able to choose levels of expenditure from a menu contract reduces the need for a financeability test, on the basis that no firm would voluntarily choose an expenditure level that was not financeable. While this approach may have some merit for classes of expenditure that are purely discretionary, this may not be the case for the majority of water companies' capital programmes. In the water sector, firms are required by their licence conditions or legislation to meet various standards of service, as well as environmental obligations. It would therefore be difficult to assume that there is no risk of a financeability problem.

– **Determining the level of CAPEX to assume in the financeability test**. Assuming that a financeability test is performed and that a menu approach is applied to CAPEX, Ofwat will need to decide how to determine the level of CAPEX within the modelling. Three options would appear to be reasonable: the underlying baseline against which the bid is compared; the allowance derived from the menu contract; or the level of expenditure revealed by the company. In previous years the allowance has been modelled assuming that companies spend the allowed level of CAPEX (ie, no out- or underperformance). This may continue to be appropriate within the menu approach, on the basis that customers should not be asked to contribute to financeability payments in order to fund companies' 'overspend', when the level of expenditure allowed for within the price limits is clearly defined within the contract. Companies could argue that the expenditure revealed by the company is the preferable option because the 'expected' level of CAPEX is best informed by the companies' selection. However, in the cases in which adjustments are not neutral in NPV terms, this might undermine the incentive compatibility of the menu, as companies may submit inflated business plans, creating unnecessary financeability payments. Using the baseline CAPEX would be an option to consider, particularly if Ofwat is confident that the baseline estimate is robust. However, given that the purpose of the menu is to reflect that there is real uncertainty in the appropriate level of CAPEX, which may be greater than the amount identified by the approach to deriving the baseline, Ofwat may wish to consider whether this would be sufficient to address its duty to enable companies to finance their functions.

– **Impact of under- and outperformance**. The construction of the menu may lead to some firms 'choosing' levels of expenditure that imply returns below the cost of capital, even if they spend no more than the regulatory allowance. To the extent that this reduces revenues, the 'penalties 'could in principle exacerbate the financeability problem. To the extent that Ofwat is confident that the baseline underpinning the menu is a reasonable expectation of the level of expenditure required by an efficient firm, it may wish to avoid consideration of the penalty when reaching a decision on financeability. If it were to allow for this, it would have a perverse incentive effect in encouraging companies to select higher expenditure levels—particularly in the cases where adjustments are not neutral in NPV terms. However, Ofwat will also wish to consider the case for symmetric treatment of rewards and penalties when conducting the financeability test for water companies. More generally, companies may under- or outperform the regulatory allowance. There would appear to be a limited case for treating the revenue impacts of such under- or outperformance in the financeability test, since this would affect incentives would address issues unrelated to the underlying financial position of the company, and would furthermore increase the complexity of the financeability test.

2.5.4 Regulatory capital value

The menu approach will only have an impact on the method of calculating the RCV if any of the adjustment factors that feature in the approach—such as the reward or penalty or the incentive payment—are dealt with by adjusting the RCV. While this is a possible approach, as section 2.4 above has highlighted, there does not appear to be a strong case for using the RCV as a means of adjusting for these factors. Rather, a revenue adjustment smoothed over the relevant regulatory period would appear to be simpler, offer a more direct incentive to the firm, and avoid amendments to the well-established approach to measuring the RCV.

2.5.5 Implications for quality of service

One of the criticisms of the price control form of regulation, at least in principle, is that it undermines incentives for delivering appropriate levels of quality for consumers. Within the price control framework, measures such as the OPA have been introduced to address this issue.

How might the introduction of a menu approach affect companies' incentives for quality? One risk may be that the level of menu incentive rewards and penalties could encourage firms to choose lower levels of expenditure than would be necessary to maintain quality. This reflects the fact that companies will be better off by choosing a low level of expenditure than a higher one, assuming that they would be in a position to vary expenditure in line with the contract selected.

However, it is important not to overstate this risk. As indicated previously, the menu approach provides incentives to identify the true expectation of costs. Furthermore, so long as the required outputs, including levels of service, are clear within the 'contract', and appropriate incentives are in place for their delivery, it is unlikely that the menu approach would have a significant impact on quality.

2.5.6 Interim determinations and the menu approach

Ofwat currently has a number of mechanisms within the regulatory framework to deal with changes in circumstances facing companies, including a relevant change in circumstances (RCC) clause to deal with material cost or revenue shocks, and interim determinations of price limits, which may be identified for particular aspects of the control and which may remain unknown at the time the price limits are established. The use of a menu system would not be likely to change the importance of this part of the framework, since even if companies are selecting reasonable contracts given their knowledge of the key drivers of costs, it is still possible that significant and uncontrollable events will materialise from time to time.

The issue is therefore how the materiality test would be performed. In relation to factors leading to costs above those expected, in the current system the approach relies on a comparison of the allowance against the outturn expenditure. It would appear to be reasonable to continue to use the allowed level of expenditure as the basis for interim determinations, rather than any alternative, such as the baseline, or the company's predicted level of costs.

2.6 Summary of findings and recommendations

The menu system has strengths and weaknesses when compared with the standard RPI – X approach taken at PR04.

Strengths

– Firms are induced to provide accurate forecasts of their expected expenditure, and their optimal choice does not depend on other firms' decisions. This reduces the scope for gaming and promotes ownership of business plans.

– The regulator has flexibility in setting the menu parameters. For example, on the one hand, with a sharply declining efficiency incentive rate, the regulator may reduce the variability in firms' profits (ie, there would be relatively limited scope for out- as well as underperformance if the company's outturn expenditure differs from the regulator's view). On the other, with a nearly constant incentive rate, the regulator may replicate the RPI – X system.

– The menu approach would be unlikely to add a significant regulatory burden to companies or to the regulator, since, once designed, the approach is likely to require only relatively minor modifications. It could also be based on company expenditure: benchmark ratios, so that a common menu structure may be adopted for the whole industry.

– The menu approach need not have important implications for various other aspects of the regulatory framework. A common base cost of capital can continue to be applied. Some expected variation in the returns to firms will arise from the application of the menu rewards and penalties for low- and high-cost firms, respectively

– The current approach to the RCV will still be appropriate. The impact of under- and outperformance can be dealt with through a revenue adjustment in the subsequent price control period.

– Financeability tests and interim determinations can continue to be used broadly in their existing form. There are a number of options for Ofwat to consider in relation to the precise way in which it deals with these issues under a menu approach, including the assumption of the level of expenditure to model in applying these tests.

– Investment incentives under the menu approach are likely to be at least as strong as under the existing framework.

– In certain circumstances, the menu approach could be consistent with the regulators' objective of protecting consumers' interests, by ensuring that customers' bills are ultimately lower than they may have been in the absence of the menu approach. This will be the case particularly where there is significant uncertainty over the appropriate level of costs, which is most likely to be the case for CAPEX.

Weaknesses

– The determination of the baseline remains a crucial aspect of the framework. Because customers' bills and firms' profits are sensitive to errors in setting the baseline, the regulator is unlikely to be able to significantly reduce existing aspects of its efficiency analysis approach.

– If the regulator relies on a first round of business plan submissions to inform the baseline determinations for expenditure categories that are difficult to forecast econometrically, such as capital enhancement, the menu system will not induce companies to provide accurate first-round submissions. Instead, companies may have an incentive to inflate their business plans. It will therefore be important to employ approaches to challenge companies' business plans (such as a bottom-up challenge, or the use of the cost base comparisons) if the menu is to be adopted for enhancement expenditure.

– There is a risk that the menu approach could reduce the efficiency incentives that firms face, whether applied to CAPEX or OPEX. This may arise if the configuration of the menu and efficiency incentive rate are chosen such that the cost pass-through is greater under the menu approach than under the RPI – X framework.

– The menu does not provide independent incentives for quality, so traditional means of defining outputs and assuring their provision are required. However, a menu approach supplemented with a quality framework of the type already in existence would deliver similar quality outcomes to those under the standard RPI – X framework.

– There is a risk that adopting the menu approach could lead to a less beneficial outcome for customers in the short term, if companies end up choosing higher levels of expenditure than the regulator would have allowed for in the absence of the menu approach. However, this would not be a disadvantage in the longer term if the company’s estimate proves to be consistent with the level required to meet output requirements.

– The modelling of the menu suggests that, unless it encourages companies to reveal levels of expenditure significantly below those that the regulator might otherwise adopt, the extent of benefits to consumers may prove to be fairly limited.

It is recommended that Ofwat take forward the analysis of the menu approach in the following ways.

– Consider the application of the menu across different categories of expenditure, taking account of the advantages and disadvantages identified in this report. There appears to be a stronger case for its adoption for capital maintenance expenditure, and possibly for capital enhancement. While, in principle, it could be adopted for operating costs, further modelling would need to be undertaken to consider whether this would offer sufficient 'value for money' to consumers in the long run.

– Assess the requirements for establishing a baseline for each category of expenditure for which a menu approach is to be introduced. As noted above, to ensure that companies are treated fairly, it is not recommended that Ofwat significantly reduce the analysis required to establish baseline costs unless a reasonable alternative to this can be developed.

– If it wishes to adopt a menu approach, Ofwat should ensure that the construction of the menu does not lead to excessive rewards or penalties for the range of plausible expenditure ratios that would be expected to emerge from the process in order to avoid creating excessive risks to returns across companies in the sector.

– Ofwat should develop a clear timetable for the application of a menu approach if it is to be introduced. This will help to ensure that companies and the market can familiarise themselves with the approach.

3 Incentive-based business planning

The previous section describes how a menu approach can be designed to encourage companies to bid for their true expected expenditure requirements in their business plans. An alternative approach would to use comparisons of companies' business plans as a way of incentivising companies to moderate their business plan bids. Ofwat's option to make greater use of companies' business plans is 'incentive-based business planning' (IBP).[28] This approach has the following objectives:

– to induce 'competition' between firms in presenting their planned expenditures;
– to minimise the scope for gaming in business plans by companies;
– to reduce trade-offs between CAPEX and OPEX.

Key elements of the IBP approach include the following.

– Ofwat and companies independently form initial forecasts of expenditure.

– A level of allowed expenditure is determined as a weighted average of the firm's expenditure forecast and Ofwat's forecast.

– The weights are determined by the degree of discrepancy between the forecasts and a qualitative assessment of the firm's application of the common framework to asset management.

This section is structured as follows.

– Section 3.1 sets out the principles of the IBP approach and provides a worked example.

– Section 3.2 first sets out the key elements of the IBP approach in more detail. Using prototype models developed by Ofwat, the section then compares and contrasts the impact of various configurations of the approach with the outcome under the PR04 RPI – X approach taken at PR04.

– Section 3.3 discusses the incentive properties of the IBP approach and provides a worked example of why companies—if they are assumed to be purely motivated by financial rewards—might face incentives to bid strategically under the this approach.

– Section 3.4 provides an overview of some practical issues encountered in the implementation of the IBP approach.

– Section 3.5 summarises the key findings.

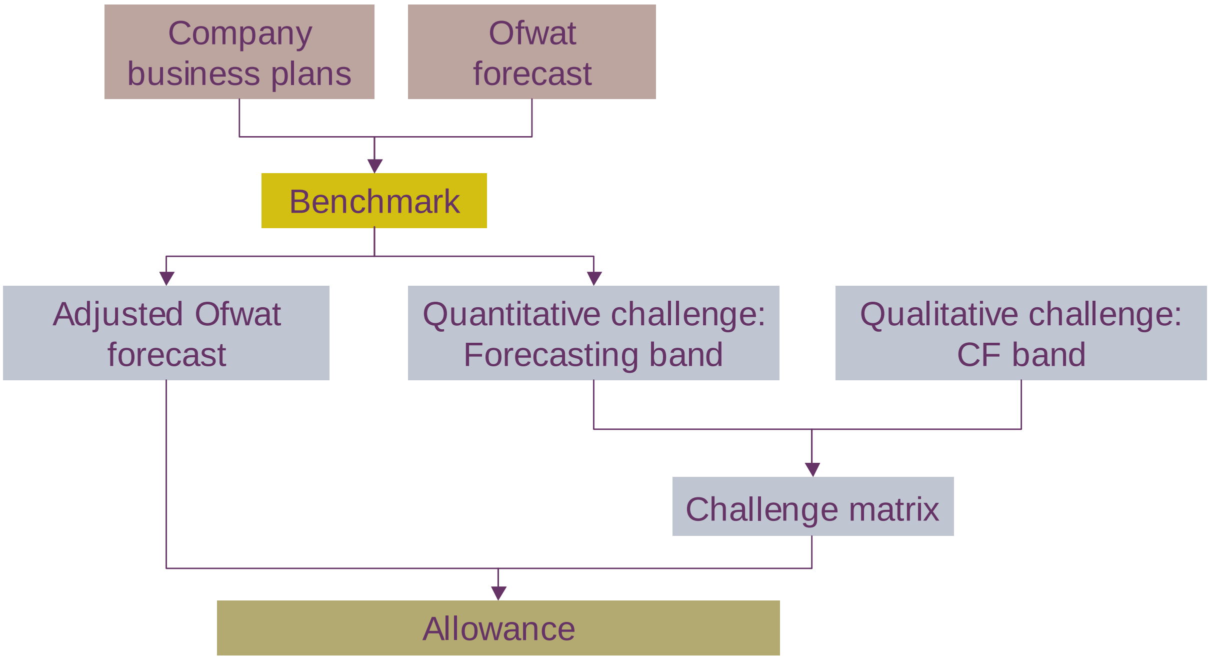
Appendix 6 contains a more detailed assessment of several features of the IBP approach in support of the analysis in this section.

3.1 Description of IBP approach

Ofwat has developed an IBP model that may be applied to OPEX, capital maintenance, or a combination thereof. The structure of the IPB model for capital maintenance expenditure is summarised in Figure 3.1.

[28] Ofwat (2007), 'New Approaches to Expenditure and Incentives: A Discussion Paper', May.

Figure 3.1 Incentive-based business planning approach



Note: CF, company forecast.
Source: Oxera, based on Ofwat (2007),'New Approaches to Expenditure and Incentives: A Discussion Paper', May.

In the first stage the regulator compares companies' submitted business plans with its previous independent assessment, which is based on econometric and unit cost estimates of the expected expenditure required for each firm. The gap between a company's planned expenditure and Ofwat's view is the company's residual, and these residuals are used to determine a benchmark residual. This is the regulator's view of a 'reasonable' degree of discrepancy between the company's business plan and its own econometric projection. There are different options for determining the benchmark residual, including the minimum residual across all firms, the lower quartile, or the average residual.

In the second stage, Ofwat adjusts its forecast to bring it into line with the benchmark residual. For example, if the benchmark residual is 5%, the regulator increases each of its prior forecasts by 5%, producing the adjusted Ofwat forecast.

Finally, the firm's expenditure allowance is determined as a weighted average of Ofwat's adjusted forecast and the company's plan based on a combination of quantitative and qualitative measures. Quantitative analysis determines Ofwat's adjusted forecast, as well as the assignment of the company's plan to a forecasting band according to the magnitude of its residual. Due to the potential inaccuracy of econometric models, such as missing exogenous reasons for variations in expenditure, Ofwat proposes to temper its econometric element using qualitative evidence—assigning the company to a common framework band based on asset management quality. These quantitative and qualitative challenges are combined in a challenge matrix to determine the weight assigned to the company's business plan. The allowed expenditure resulting from this procedure takes the following functional form:

$$\text{allowed expenditure}_i = O_i(1 + \beta)(\alpha_i) + F_i(1 - \alpha_i)$$

where $O_i(1 + \beta)$ is Ofwat's initial forecast (O) expenditure for each firm i adjusted by the benchmark residual β; F_i is each firm's business plan submission; and α_i is the weight placed on the adjusted Ofwat forecast.[29]

The weights of the adjusted Ofwat forecast (α_i) are derived from a function determined by two variables:[30]

– the difference between a company's residual and the benchmark residual; and
– the company's common framework asset management rating.

Hence, the lower α_i is, the more weight is given to Ofwat's forecast O_i relative to the companies' business plan submission F_i.

Companies are placed in a matrix according to scores achieved for each of the two variables. Each variable takes an integer value from 1 to 5. The difference between a company's residual and the benchmark determines the 'forecasting band' to which a firm is assigned, and Ofwat's common framework assessment also assigns firms to a band. Table 3.1 illustrates how these two scores might be combined to determine the value of the adjusted Ofwat forecast (α_i).

Table 3.1 Illustrative challenge matrix with weights of the adjusted Ofwat forecast (α_i, %)

		Band 1: Forecasting				
		1 (<10%)	2 (10–20%)	3 (20–30%)	4 (30–40%)	5 (> 40%)
Band 2: Common framework asset management	1—leading	0	5	15	30	50
	2—above intermediate	5	10	20	35	55
	3—intermediate	15	20	30	45	65
	4—below intermediate	30	35	45	60	80
	5—trailing	50	55	65	80	100

Note: The formula for α for each company i may be deduced from the table. If c_i is the value of the common framework band and f_i is the value of the forecasting band, then $\alpha_i = 2.5*(c_i*(c_i – 1) + f_i*(f_i – 1))$. The forecasting band is the decile by which the firm's residual exceeds the target residual: 1 for less than 10%, 2 for 10–20%, 3 for 20–30%, etc.
Source: Oxera analysis based on Ofwat (2007), 'New Approaches to Expenditure and Incentives: A Discussion Paper', May.

Box 3.1 illustrates the working of the IBP process with a simple example.

[29] As a special case, if Ofwat's adjusted forecast is higher than the company's planned expenditure, α_i is set to zero, so that allowed expenditure is equal to the business plan submission.
[30] α_i takes only certain pre-determined values. See the note to Table 3.1 for further details.

Box 3.1 IBP process example

Suppose that Ofwat's prior econometric estimate for company A's expenditure is £100, and it submits a business plan for spending £120. Most other companies also submit plans higher than Ofwat's forecast, resulting in an average residual of 6%, which for this example is used as the benchmark. Ofwat's adjusted forecast for company A is therefore £106.

Company A's residual of 20% is 14% greater than the benchmark, so it is assigned a forecasting band of 2. Assuming that its common framework band is intermediate (3), the value of α determined by these two band ratings is 20%—ie, 2.5*[3*(3 – 1) + 2*(2 – 1)].

Company A's allowed expenditure is Ofwat's adjusted forecast (£106) weighted at 20% and its own forecast (£120) weighted at 80%, resulting in an allowance of £117.2.

Source: Oxera.

Note that values in Table 3.1 (α_i) and the benchmark residual (β) are functions of Ofwat's forecast and the companies' submitted business plans. Therefore, in choosing its forecast to maximise its allowed expenditure, a company will need to consider the relationship of its forecast with other firms' forecasts, as this determines the benchmark and the firm's forecasting band. This relationship has important incentive implications, as discussed below.

In addition to the elements of the IBP set out thus far, the regulator might consider adding an additional reward for companies with small residuals in order to incentivise accurate submissions. The reward might be offered to the firm with the lowest residual or to firms with residuals below the chosen benchmark. The potential need for such a payment and its possible forms are discussed below in relation to incentive issues.

3.2 Elements of IBP approach and comparison with RPI – X approach

Ofwat has control over the following variables in the allowed expenditure equation set out above:

– econometric forecasts of expenditure requirement (O_i);
– the challenge matrix (α_i); and
– the benchmark residual (β).

3.2.1 Econometric forecasts of expenditure requirement

Ofwat's econometric/unit cost forecasts of future expenditure requirements are taken as a model input in this report, and the approach and methodology have not been reviewed. However, Ofwat clearly also has influence over this in terms of the expenditure estimate derived from the modelling and the weight that this is given in the challenge matrix.

Instead of estimating the residual based on the difference between econometric/unit cost modelling based on historical data and business plan submissions, Ofwat might consider undertaking modelling business plan data directly to estimate the residual. Econometric issues that may arise in this context are discussed in section 3.5.3.

3.2.2 The challenge matrix

There are a number of possible configurations of the matrix, depending on the weight that Ofwat wishes to assign to the quantitative (ie, the forecasting band f in Table 3.1) and qualitative evidence (ie, the common framework band c in Table 3.1). In addition to the weighting, Ofwat also has some discretion over the common framework asset management scoring system that may affect the score itself, giving it further control over the qualitative element of the challenge matrix. These two elements require regulatory judgment and are therefore not considered further in this report.

3.2.3 The benchmark residual

Rationale for adjustments to the benchmark residual

The benchmark residual modifies Ofwat's initial forecasts and may therefore be used to carry out an ad hoc correction for systematic biases that may exist in Ofwat's econometric/unit cost modelling.[31] More generally, an adjustment to the residual may be used to apply a regulatory judgement to allow for uncertainty in the modelling (eg, induced by modelling and measurement errors). This is similar to Ofwat's 10/20% adjustment to residuals from its suite of econometric models used in its efficiency analysis. The benchmark residual approach may therefore be used to uniformly adjust Ofwat's forecasts to allow for any systematic differences. The advantage of such an adjustment would be that it would be transparent and easy to understand. On the downside, uncertainty about forecast accuracies may not be common across different companies, and company-specific adjustments may therefore be more appropriate.

This section presents an analysis of sensitivity of companies' allowed expenditures—the key output of interest in IBP modelling—to changes in the benchmark residual.

The choice of the benchmark residual has an important effect on allowed expenditure. In particular, 'relaxing' the benchmark—eg, setting it as the lower-quartile residual instead of the plan with the smallest residual—is likely to increase the companies' allowed revenue. By definition, the lower quartile is greater than the minimum element of a given distribution. This change would raise the benchmark residual and, therefore, the allowed expenditure for any company with the weights of the adjusted Ofwat forecast (α_i) greater than zero. (In the challenge matrix in Table 3.1, this would be the case anywhere except in the top-left cell.) The regulator may also choose an average benchmark, but this does not challenge companies with expenditures below the average, and is therefore unlikely to be an option for Ofwat. The results presented in this report include the average benchmark to provide a range of outcomes.

The choice of the benchmark residual may also have other important implications in terms of the 'signal' that this sends to companies. The residual implicitly reflects Ofwat's 'confidence' in its econometric forecasts. In particular, a 'strict' benchmark rule (eg, the business plan submission with the smallest residual) may signal that Ofwat is confident about the accuracy of its econometric/unit cost forecasting. Choosing a benchmark rule that results in a lower benchmark residual results in both a lower adjusted forecast and a lower weight assigned to the company's submitted plan.

Impact of changes to residuals

Table 3.2 presents the benchmark residuals (β) for each expenditure category using PR04 data and Ofwat's prototype models for IBP.[32] Note that residuals may take negative values when companies submit business plans for expenditure that are less than Ofwat's independent forecast. Holding the business plan submissions constant, choosing a higher (ie, more generous) benchmark residual (the amount by which Ofwat adjusts its initial forecast) results in larger allowances. Capital maintenance expenditure residuals have greater variance than OPEX residuals, so they are more sensitive to the type of benchmark used. This may reflect greater challenges in deriving appropriate benchmarks due to the

[31] If the regulated companies share characteristics that are omitted in the econometric approach but, are reflected in their expenditure plans, this commonality would appear in the residuals as a systematic difference between Ofwat's initial forecasts and company plans.

[32] Throughout this section on IBP, for the least residual benchmark, CAM, FLK, PRT, and SST are not eligible to be the least residual due to Ofwat rules regarding benchmark companies' minimum turnover requirement.

modelling approach, or greater change in the CAPEX requirement from one year to the next relative to OPEX.

Table 3.2 PR04 benchmark residuals (β) for different types of expenditure (%)

	OPEX	Capital maintenance	Combined
Minimum residual	–11.8	–13.5	–9.1
Lower quartile of residuals	–7.0	4.8	–2.1
Average residual	–1.7	22.5	5.6

Note: This table is based on data for PR04.
Source: Oxera analysis based on Ofwat IBP prototype model.

Note that the analysis in Table 3.2 and in the remainder of this section assumes that companies do not react to changes in the benchmark type. As discussed in section 3.4, firms' changes in their business planning as a result of the selection of the benchmark may be important.

Impact of changes to residuals on OPEX allowance

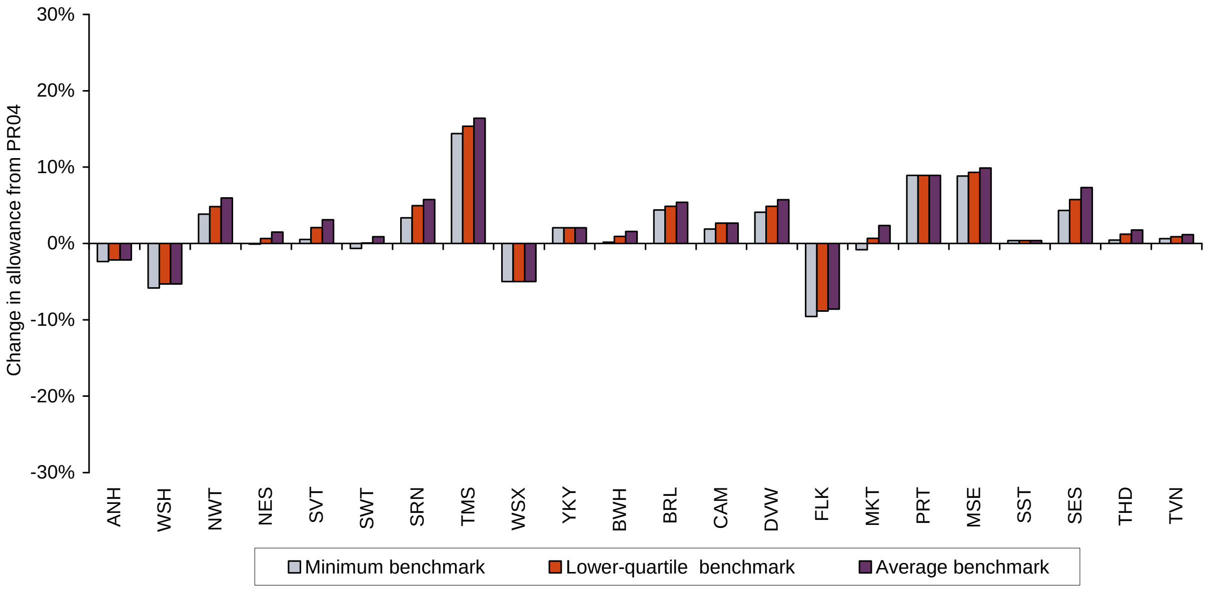
Figure 3.2 shows, for each company, the change in allowed OPEX relative to PR04 for three different benchmarks: minimum residual, lower quartile of residuals, and average residual. Compared with the allowed OPEX in PR04, these benchmark rules imply the following outcomes as shown in Figure 3.2 and summarised in Table 3.3.

– In the 'minimum residual benchmark' scenario, the allowed expenditure is increased by 1.5% over the PR04 expenditure allowance. However, there is considerable company-by-company variance in the change compared with PR04—eg, Thames Water's allowed expenditure increases by over 14%, while Folkestone & Dover's drops by nearly 10%.

– In the lower-quartile residual scenario, the average change and the range in the variation are larger than in PR04. The average allowed expenditure increases by 2.2% compared with the PR04 expenditure allowance. However, there is even greater variance on a company-by-company basis.

– The average residual benchmark provides the greatest increase, raising average allowed expenditure by 2.8% over PR04 final determinations. Again, this also increases the variance.

Figure 3.2 Change in OPEX allowance relative to PR04 OPEX allowance (%)



Source: Oxera analysis based on Ofwat IBP prototype model.

As Figure 3.2 demonstrates, the increase in allowed expenditures due to changing the benchmark residual choice varies significantly between firms:

– in the range of 0% to 1.6% when changing from the minimum residual to the lower-quartile residual; and

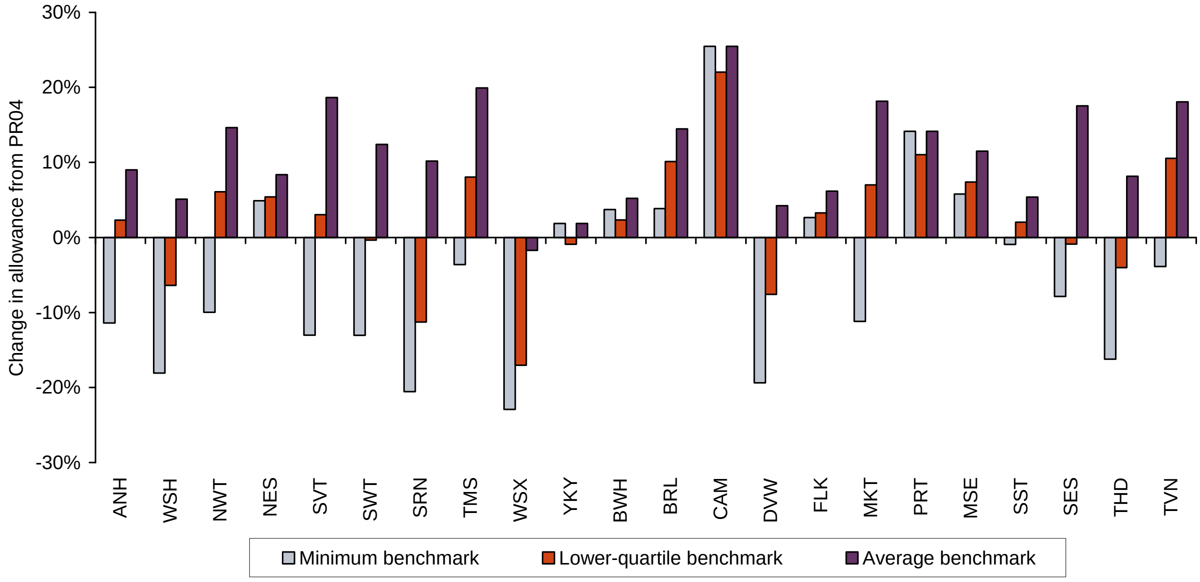
– between 0% and 3.2% when changing from the minimum residual to the average residual.

The impact of the benchmark choice on allowances is much less than the impact on the magnitude of the benchmark residual: while changing from the minimum residual to the average residual moves the benchmark from –11.8% to –1.7% (see Table 3.2), the largest firm-level change in allowed expenditure is a 3.2% increase. This reflects the impact of the weighting factors: only a share of the change in residual is passed through to allowed expenditure. For those firms with low residuals and asset management ratings, an increase in the Ofwat benchmark raises the allowed expenditure by only a small share. For the average company in PR04, only 20% of the impact of a higher benchmark would have passed through to a greater allowance, although the impact would have been greater for firms with higher residuals and poorer asset management ratings. Firms with sufficiently low residuals experience no change, as their business plan expenditure is lower than Ofwat's adjusted forecast.

Impact of changes to residuals on capital maintenance allowance

Figure 3.3 shows the same company-level analysis for the change in allowed capital maintenance expenditure relative to PR04 for the three benchmarks. Due to the very low value of the minimum residual (–13.5%), most firms would receive significantly smaller allowances if that benchmark were used. In contrast, the average residual is large (22.5%), so almost every firm would receive an allowance larger than the PR04 allowance under that benchmark. There is therefore much less variance in the company-level impact of the more generous benchmark.

Figure 3.3 Change in capital maintenance allowance relative to PR04 capital maintenance allowance (%)

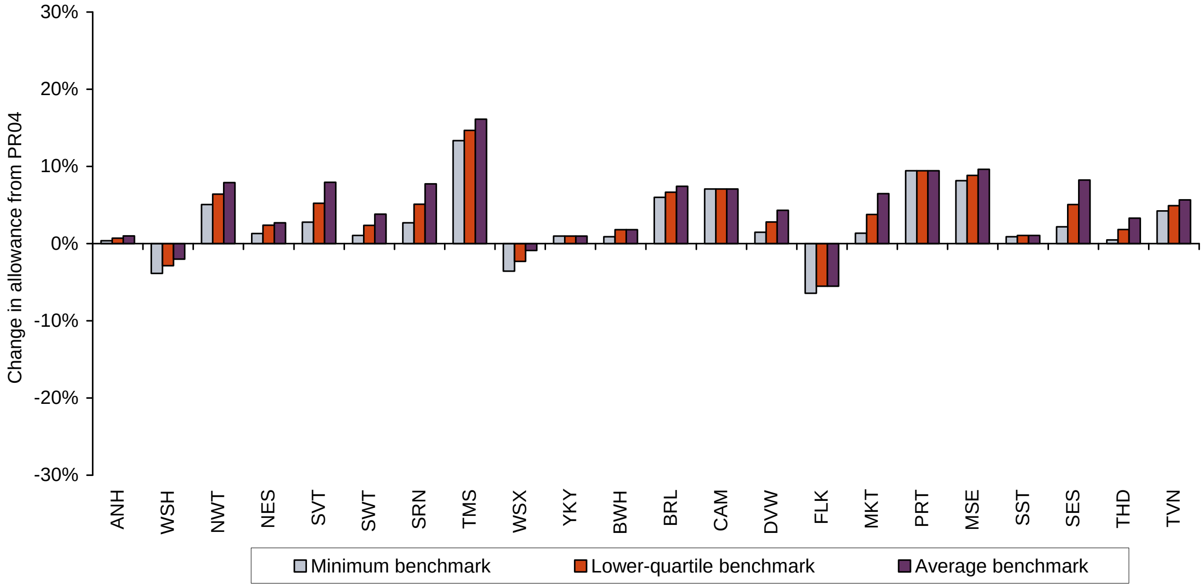


Source: Oxera analysis based on Ofwat IBP prototype model.

Impact of changes to residuals on combined expenditure allowance

Figure 3.4 presents the change in allowance for combined OPEX and capital maintenance relative to PR04 for the three benchmarks.

Figure 3.4 Change in combined allowance relative to PR04 combined allowance (%)



Source: Oxera analysis based on Ofwat IBP prototype model.

While the combined allowance outcomes are more sensitive to the benchmark choice than the OPEX outcomes, they vary less across firms since the aggregation masks some of the large variations for capital maintenance.

Further comparisons

The outcomes for the measures of expenditure under the three benchmark residuals are summarised in Table 3.3, again demonstrating the high variance compared with PR04 across firms for capital maintenance.

Table 3.3 Company-level impact of benchmark residual on expenditure allowance (% change relative to PR04)

	Industry average			Variance		
	OPEX	Capital maintenance	Combined	OPEX	Capital maintenance	Combined
Minimum residual	1.5	–5.0	2.5	26.6	147.5	20.0
Lower-quartile residual	2.2	2.4	3.7	27.4	71.5	19.7
Average residual	2.8	11.2	4.7	29.7	45.8	22.6

Note: This table is based on PR04 data.
Source: Oxera analysis based on Ofwat IBP prototype model.

As also shown in the figures above, the average company would have a greater allowance than under PR04 if the IBP approach were applied to OPEX, while its capital maintenance allowance is highly sensitive to the benchmark residual choice. The average company experiences a 5% reduction in capital maintenance allowance compared with PR04 if the minimum residual benchmarked is used, while it would have an average gain of around 11% if the average residual were chosen.

As well as industry average, Table 3.3 summarises the magnitude of variance in these changes across firms. Applying IBP to capital maintenance would have very uneven effects across companies, while introducing IBP for the combination of the two expenditure categories would have much less variance in impact using the PR04 business plan submissions. The large variance in company-by-company impact of using the IBP approach with capital maintenance expenditure suggests that, to the extent that the current approach is deemed reasonable and consistent across companies, IBP would not be well suited for that category of expenditure. If the regulator wishes to include capital maintenance under the IBP approach, it might do so by applying the framework to the combination of OPEX and capital maintenance, seeking to moderate the significant variance of capital maintenance residuals.

Table 3.4 compares applying IBP to each separate category of expenditure with applying it to the combination of OPEX and capital maintenance, where the regulator's econometric forecasts and companies' business plans for each type of spending are added together before determining the residual. The table demonstrates that combined expenditure modelling results in a lower variance of allowances than the aggregate impact of applying IBP separately. However, this reduction in the variance may be the result of using PR04 data in these calculations and it is not clear whether this would occur in future applications.

Table 3.4 Company-level impact of applying IBP to OPEX and capital maintenance, separately and combined (% change relative to PR04)

	Industry average		Variance	
	Separate	Combined	Separate	Combined
Minimum residual	–2.0	2.5	37.0	20.0
Lower-quartile residual	2.0	3.7	28.0	19.7
Average residual	4.5	4.7	26.6	22.6

Note: Table 3.4 is based on PR04 data.
Source: Oxera analysis based on Ofwat IBP prototype model.

The analysis above considers company-level impacts. Table 3.5 summarises the aggregate impact of various benchmark choices and expenditure categories compared with PR04 allowances.

Table 3.5 Aggregate impact of benchmark residual on expenditure allowance (% PR04)

	OPEX	CAPEX	Combined
Minimum residual benchmark	3.0	–7.7	3.9
Lower-quartile residual benchmark	3.7	2.5	5.1
Average residual benchmark	4.4	12.4	6.3

Note: Table 3.5 is based on PR04 data.
Source: Oxera analysis based on Ofwat IBP prototype model.

Summary

An examination of Ofwat's IBP prototype models provides two key insights. First, the OPEX expenditure allowance is sensitive to the regulator's choice of the benchmark residual. The considerable variance in effect on a company-by-company basis may lead to resistance to the regulator implementing such an incentive scheme. Second, except in the case of using the minimum residual benchmark on capital maintenance expenditure, which varies in its company-by-company impact to such an extent that it may be considered inappropriate, the IBP would have resulted in greater expenditure allowances than under the PR04 approach had firms submitted the same business plans (and assuming that companies' bidding behaviour would not have changed as a result of the introduction of the IBP).

The next section considers how firms might respond to the introduction of IBP.

3.3 Evaluation of incentive properties

Under the IBP approach, firms' allowed expenditure is in part determined by other firms' expenditure forecasts through the benchmark rule adopted by Ofwat. In particular, the gap between each company's residual and the benchmark residual partly determines the 'weight' of the company forecast in the allowed expenditure (see equation above in section 3.1).[33] This implies that when a firm submits its business plan, it may take into consideration the likely plans submitted by other companies. This 'strategic interaction' means that, instead of

[33] The other component in the determination of α is the common framework asset management score.

competing for being the benchmark residual, firms may individually choose to inflate their submitted expenditure figures.

3.3.1 Reasons for strategic bidding

In terms of the equation in section 3.1, increasing the firm forecast (F_i) may have several effects.

First, business plan inflation directly increases the company forecast component (F_i) of the weighted average. Any increase in the company forecast will have a direct impact on the allowance, the size of which will be based on the weight attributed to the company's forecast. This will be highest for firms with lower (ie, better) scores on the forecasting and common framework bands. This may be systematically related to firm characteristics, which could affect strategic bidding motives.

Second, business plan inflation may increase the benchmark residual (β) and therefore increase Ofwat's adjusted forecast component $O_i(1 + \beta)$. To the extent that the firm's own forecast influences the benchmark residual, a higher submission could lead to a higher allowance. This may occur under the following circumstances, depending on which type of residual benchmark is used.

– The firm sets the benchmark under the lowest residual benchmark, in which case its increase passes through fully to the adjusted Ofwat forecast.

– The firm is in and then exits the lower quartile under the lower-quartile benchmark. In this case the benchmark increases by an amount equal to, or less than, the increase in planned expenditure.

– The average benchmark residual is used, in which case the benchmark residual increases by the size of the change in the firm's residual divided by the number of firms.

Third, plan inflation may reduce the weight of the company forecast in the determination of the allowed expenditure. If the increase in the company's business plan submission increases the difference between its residual and the benchmark residual sufficiently to increase its forecasting band, the weight of the adjusted Ofwat forecast (α) increases, and its plan receives less weight in the allowed expenditure calculation.

Firms have incentives to inflate their submissions up to the point at which the third effect becomes greater than the first and second effects. Determining the point at which this occurs is difficult for companies since they do not have the necessary information to know when which effect prevails. However, this will occur when the increase in the submitted plan moves the firm into a higher forecasting band or triggers a lower common framework asset management band rating of sufficient size to outweigh the benefits of inflating the company forecast and benchmark residual.

From a company viewpoint, assuming that companies are motivated purely by financial incentives rather than company reputation or governance incentives to be truthful, the optimal expenditure inflation is substantial. Under the challenge matrix shown in Table 3.1, *if* all other firms submit accurate forecasts (where 'accurate' for the purpose of this example is defined as being equal to Ofwat's estimate) that yield a benchmark residual of zero, an individual firm's optimal response is to inflate its planned expenditure by at least 25%. This is illustrated by the example in Box 3.2. Moreover, each firm that inflates its business plan aids other firms by raising the benchmark residual, encouraging further plan inflation.

Box 3.2 Example of incentive to inflate business plans

For illustrative purposes, suppose that all other companies submit accurate business plans, resulting in a benchmark residual of 0%. What is an individual firm's optimal response? If it submits an accurate expenditure plan—where, for the purpose of the example, 'accurate' is defined as being equal to Ofwat's estimate—it will receive a residual of 0% and an allowance that is 100% of its accurate expenditure. If the company inflates its planned expenditure, it raises the company business plan component of the weighted average in the allowed expenditure equation. At the same time, this will also lower the weight assigned to that share due to forecast band penalties. Table 3.6 shows these relative costs and benefits, assuming that the company has a common framework band of 5 that does not deteriorate as expenditure inflation increases.

Table 3.6 Outcomes of planned expenditure inflation for residual benchmark of 0%

	0%	5%	10%	15%	20%	25%	30%
Forecast band	1	1	2	2	3	3	4
α (%)	50	50	55	55	65	65	80
Allowed expenditure (%)	100	102.5	104.5	106.8	107	**108.8**	106

Note: The hypothetical company has a constant common framework band of 5.
Source: Oxera analysis based on Ofwat IBP prototype model.

Among the options shown in Table 3.6, the company maximises its allowed expenditure by inflating its planned expenditure by 25%, at which point allowed expenditure is increased by almost 9% relative to the point at which a company reveals its true cost. Its optimum is 29.9% (ie, a category not shown in the table), which results in its allowed expenditure increasing by more than 10%. If the firm were in common framework bands 1, 2, or 3, it can be shown that its optimal inflation level would be even higher, at 39.9%. As such, an optimal inflation of 29.9% resulting in allowed expenditure inflated by around 10% can be regarded as the lower bound, assuming that the common framework score and the magnitude of the business plan inflation are not correlated.

The results are similar if the common framework and forecast bands are strongly correlated. If a firm's common framework band is equal to its forecast band, the results of inflating planned expenditure are those presented in Table 3.7. More precisely, the optimal inflation is again 29.9%, and this results in allowed expenditure being inflated by around 20%.

Table 3.7 Outcomes of planned expenditure inflation for residual benchmark of 0%

	0%	5%	10%	15%	20%	25%	30%
Forecast and common framework bands	1	1	2	2	3	3	4
α (%)	0	0	10	10	30	30	60
Allowed expenditure (%)	100	105	109	113.5	114	**117.5**	112

Source: Oxera analysis based on Ofwat IBP prototype model.

The examples in Box 3.2 make a number of assumptions to provide a range of possible outcomes. In the first example, a company is assumed to know in advance which common framework band it would end up in. However, while the exact amount by which a company would find it optimal to inflate its business plan is not unique, it would find it optimal to substantially inflate its business plan given any common framework score. This remains the case regardless of whether companies' asset management scores and forecast bands are independent or correlated. The example also makes the assumption that all companies submit accurate business plans. However, this makes the strong assumption that companies are driven purely by financial incentives. In practice, other considerations are also important, including stakeholder perception and reputation. Assuming that this is the case, a company then needs to make a decision regarding optimal inflation and take all other companies' decisions as given. In practice, all companies are faced with the same strategic decision simultaneously—ie, when asked by Ofwat to submit a business plan. The optimal strategy of a company driven purely by financial incentives, knowing that the other companies face the same decision, is to inflate expenditure by the amount that it would find optimal on its own. A company would always gain more by inflating expenditure than by submitting its true expenditure (regardless of whether this would make its residual large compared with the benchmark residual). As each company (driven purely by financial incentives) has nothing to gain by submitting an accurate forecast, but stands to lose allowed expenditure, it finds it optimal to inflate its bid.

In order to overcome this significant issue, an incentive could be introduced such that companies gain from submitting accurate business plans. This is discussed in the next section.

3.3.2 Options to overcome strategic bidding

Reward for firms with low residuals

Ofwat may want to include a reward for the firm or the group of firms that have the lowest residuals. Such a reward could encourage firms to reveal their true expenditure forecasts, and could take the form of a higher efficiency incentive for outperformance or a more direct form such as a revenue allowance. The reward would need to be sufficiently large to offset the benefit to companies should they choose to inflate their business plans—the high-level calculations above suggest that this would need to be 20% or more of companies' true (and unknown) expenditure requirement.

However, it is not guaranteed that a bonus payment structure would necessarily lead to the desired outcome of incentivising companies to submit their most accurate business plans. In theory, each residual level may be a feasible point at which companies would find it optimal to leave their inflated expenditure unchanged. If each firm inflated its plan by 25%, it would receive the reward (as the residual would be zero for all companies). None of the firms would have an incentive to reduce its forecast, as it would already be receiving the bonus and would only reduce its allowed expenditure by doing so. None would have an incentive to increase its forecast, since it would forgo the bonus payment. It is unlikely in practice that such a situation would arise. However, unless the reward is sufficiently generous, and assuming that companies are driven purely by financial rewards, it is likely that some expenditure inflation will occur.

As the regulator's forecast becomes less predictable, it is more difficult for companies to know their optimal inflation. However, it also means that the regulator's forecast is less informative (it bears less relation to the company's own forecast) and therefore provides a weaker basis for penalising firms whose forecasts exhibit greater discrepancies.

Increasing weight of regulator's view

The regulator might also seek to increase the weight given to its forecast expenditure by increasing α (ie, magnifying the third effect discussed in section 3.2.1). This makes the forecasting band more sensitive to increases above the benchmark residual than in Table 3.1. However, unless α reaches 100% as soon as a firm deviates, some inflation to business plan submission may remain optimal if companies are driven purely by financial rewards.[34] As a consequence, firms may not have a direct financial incentive to reveal their true forecasts.

3.3.3 Summary

The competitive business planning environment introduces strategic interactions that significantly complicate the prediction of firm behaviour. There are likely to be incentives to submit plans above true expectations since these may lead to higher expenditure allowances.

In the absence of bonus payments, some business plan inflation is likely, since it is the profit-maximising opportunity for each firm. There are positive spillovers from one company's business plan inflation to that of others, which is likely to lead to some strategic behaviour. Finally, bonus payments to alleviate these incentive problems need to be sufficiently large to offset the benefit companies receive in terms of higher allowed expenditure from inflating their business plan.

3.4 Practical challenges

3.4.1 Cost categories

The IBP process is centred on the regulator's independent prior forecast of firms' expenditure. As noted previously, the approach corrects for biases in the regulator's econometric modelling if companies submit accurate expenditure plans. As such, the IBP approach may be used even when the regulator's independent estimates are 'noisy', provided that these deficiencies are not systematically biased across companies.

However, IBP is not appropriate for categories of expenditure where the regulator has no means of forming an independent view prior to consulting companies' plans. If the regulator requested that companies submit a first round of business plans prior to entering the competitive planning stage, companies that are able to make a better case at convincing the regulator to adopt an inflated prior view of expected expenditure would do better in the IBP round. As such, the incentive properties of the IBP approach do not appear to be well suited for application to cost categories for which econometric and unit modelling to set the baseline may not be easily implemented (ie, capital enhancement).

3.4.2 Defining and rewarding performance

As under the menu system, the effectiveness of the IBP approach is sensitive to the clarity and complexity of the regulatory processes in defining and rewarding performance.[35] Both companies and the regulator will face uncertainty in formulating plans and forecasts if outputs are not clearly defined. Confusion or disagreement would undermine confidence in the IBP process, just as confidence in the menu system would be undermined by output goals that make defining an appropriate expenditure plan difficult.

Rewarding performance under the IBP framework would be similar to Ofwat's PR04 approach. The competitive planning environment would alter the means of determining allowed expenditure, but not change the financial and regulatory aspects of rewarding firms that outperform their allowed expenditure targets. As such, the incentives for outperformance in the IBP system during the price control period would be the same as under Ofwat's PR04 approach. The important differences in incentives properties are those at the business planning stage.

[34] See proofs in Appendix A6.1 and A6.2.

[35] Sections 2.4.4 and 2.4.5 introduce these issues in the context of the menu system.

3.4.3 Econometric modelling on business plan data

The approach to determining a residual set out in Ofwat's discussion paper involves comparing companies' plans with their (econometrically estimated) efficient cost based on historical data. An alternative approach to incentivising business planning would be to apply econometric analysis to the business plans put forward by companies. If companies' business plans were subject to such modelling, the companies may prefer to set out a lower business plan forecast of expenditure than they may otherwise have done. This would be the case if, for example, companies were ranked according to the efficiency of their forecasts (with efficiency referring to the level of forecast costs compared with other companies' forecasts, while controlling for various cost drivers).

This approach raises several issues, both from a practical and an econometric perspective.

Practical issues

One issue to consider is whether forecasts of different **cost categories** may be sufficiently stable to apply this approach.

- OPEX is more predictable than both capital maintenance and capital enhancement (in terms of expenditure and cost drivers); therefore, using historical information is a useful starting point for forecasting future requirements;
- capital maintenance is less predictable (with regard to the serviceability of assets);
- capital enhancement is less predictable by nature.

Further issues arise in relation to the choice of **cost drivers** used in the modelling.

If cost drivers tend to be historically stable (such as the number of billed households) and can be expected to be so over the five-year price review period), historical data may be used in the modelling of business plan expenditure. Historical data may also be used if cost drivers affect expenditure with a delay (eg, as assumed in Ofwat's capital maintenance models).

On the other hand, if cost drivers display a predictable (eg, linear) trend which is expected to hold over the next price review, historical data may similarly be used as a basis for deriving cost drivers for modelling business plan expenditures. However, if cost drivers are not easily predictable, it may not be possible to forecast business plan expenditure.[36]

The choice of cost drivers, and whether these are likely to yield economically meaningful results (in the sense that business plan expenditure levels are matched with corresponding cost drivers), therefore depends on their predictability. As a result, modelling business plan expenditure may work for some functional models but not others.

A further practical question to consider is whether Ofwat or companies would undertake the cost driver forecasts. Companies could either be required to submit their forecasts as part of their business plan submissions at the price review, or more frequently (eg, annually as part of the June Returns), following an agreed methodology. If company forecasts are used they may have an incentive to systematically over-or underestimate their cost drivers. A further issue to consider would be the implications for regulatory cost and burden.

A high-level check regarding forecastability could be undertaken by examining historical trends in cost drivers.

[36] Cost drivers may also not be predictable if they are not exogenous—ie, management decisions may have some impact on their value. Such cost drivers should not be used for the purposes of efficiency modelling exercises.

Econometric issues

If applying econometric models to planned expenditure (as per company business plan submissions) rather than actual historical expenditure, a key question is whether this is statistically justifiable. The answer to this question depends on what is being modelled. There are two broad possibilities:

– model *planned* expenditure on *historical* output levels—ie, outputs that have been exogenously determined (ie, not by the company) through another process (such as the common framework) to establish their efficient level;

– model *planned* expenditure on *planned* output levels.

If these planned variables contain an error, either because they are difficult to forecast over five years or because they are inflated, there would be an issue of measurement error (ie, noise). The statistical consequences of this differ according to where the mismeasured variables are located—that is, if the measurement error affects the left-hand side of the model (planned expenditure) or the right-hand side (forecast cost drivers or planned output).

In the first instance, there is an issue of measurement error in the dependent variable only. From a modelling perspective, this is acceptable, since the error in the dependent variable does not affect the consistency of the ordinary least squares (OLS) estimates: the only result would be reduced precision in the estimate.

However, if the econometric analysis is carried out on business plans put forward by companies, it is important to ensure the precision of the measurement of key variables such as planned expenditure or planned cost drivers in order to preserve the statistical properties of the analysis.[37]

The question of interest in the present context is how serious the measurement in cost drivers is likely to be for cost estimates, and ultimately for conclusions regarding the relative efficiency of companies based on their business plans.

When one or more of the right-hand-side variables is mismeasured, the coefficients of the regressions are biased. When measurement errors affect explanatory variables, the model is 'not identified' because the value for parameters of interest (ie, the coefficients of the regression equation) cannot be uniquely identified.[38]

All of the above results assume that the analysis would be undertaken using a single cross-section of data. However, the inconsistency can be significantly greater in panel data than in the cross-section case.[39]

Further possible work for impact assessment

No general conclusions can be drawn as regards the impact of measurement errors in cost drivers on the overall validity of conclusions based on forecast data. Should Ofwat wish to pursue this approach, it may consider undertaking further analysis of the predictability of cost drivers and, for example, Monte Carlo analysis of the potential bias resulting from

[37] For further discussion see Bound, J., Brown, C. and Mathiowetz, N. (2001), 'Measurement Error in Survey Data', in: J.J. Heckman and E.E. Leamer (eds.), *Handbook of Econometrics*, Edition 1, Volume 5, Chapter 59, pp. 3705–843, Elsevier.

[38] A general strategy that may be adopted in this case is to obtain bounds rather than point estimates of parameters of interest. The lower bound is defined as the downwards-biased estimate obtained with the standard OLS regression. The upper bound is obtained via the 'reverse regression' that represents an upward-biased estimate of the coefficient of interest. However, these bounds can be very broad in microeconomic data, and it is not possible to infer where the unbiased estimate would lie. Unique identification of the model can also be reached through 'instrumental variables'. The instrument should be highly correlated with the mismeasured variable and uncorrelated with the regression and the measurement error. However, these instruments are not always easy to find, or, if available, they may be 'weak' (ie, with a small degree of explanatory power for the mismeasured variable). In particular, weak instruments lead to poor finite sample properties such as inaccurate standard errors, and therefore, possibly incorrect inference.

[39] The attenuation bias is in fact a positive function of the correlation over time of the regressor for the same company.

measurement errors and the implications for cost modelling. In addition, a comparison between forecast key measures included in business plans and more accurate empirical data could be used to assess the scale of the bias that would occur in the presence of measurement errors.[40]

3.5 Summary of findings and recommendations

Incentive-based business planning would represent a departure from Ofwat's PR04 approach by introducing rewards and penalties based on business planning comparisons. In theory, the approach has the potential to address some concerns about the potential shortcomings of the existing approach to efficiency analysis. For example, if the regulator's econometric projections are flawed across companies, the IBP adjustment process could correct for this. The IBP approach to setting company expenditure would reduce the reliance on historical capital maintenance expenditure at PR04 (see section 4) by using econometric and unit cost models to form Ofwat's view of expenditure requirements. In addition, by increasing the scope of the price determination process that depends on quantitative information and treating company business plan submissions in a predictable, consistent manner, the IBP approach might increase the transparency and credibility of the regulatory review.

The comparisons based on PR04 submissions reveal that there would be considerable variance in the company-by-company impact, which may be perceived as unfair if the PR04 approach is relatively consistent (although these comparisons do not take into account the possible response of companies if they were faced with the IBP approach to setting expenditure).

More importantly, assuming that companies are driven purely by financial incentives, the incentive structure of the 'basic' form of the IBP models (ie, without a reward for having a low residual) may not induce companies to submit accurate business plans. Companies gain individually by inflating their planned expenditure figure, and this inflation also benefits other firms. The dependence on other companies' actions may lead to an increase in the scope for gaming in business plans.

Rewards for firms with low residuals might improve the planning environment by making accurate plans incentive-compatible; however, the reward would need to be sufficiently large to offset the benefit to companies should they choose to inflate their business plans, and this may have to be significant. In addition, the IBP approach introduces strategic interaction between companies, which makes predicting their behaviour more difficult than in a regulatory environment such as under the menu system or the standard RPI – X approach. Ignoring this limitation—ie, assuming that firms submitted the same business plans as at PR04—and using Ofwat's prototype models demonstrates that the IBP approach would have resulted in greater expenditure allowances and thus higher customer bills than the PR04 approach.

Further analysis of the IBP approach would be required to overcome its difficulties and to offer an improvement over the alternative approaches considered in this report (ie, the evolution and menu approaches).

[40] Data on cost drivers and output collected after the price review can be used, along with the planned values included in the business plan, and submitted prior to the price review. Econometric analysis can be applied to both sets of data. The extent of the attenuation bias could be easily recovered from a comparison of the parameter estimates. This kind of analysis is referred to as a 'validation study', and allows the detection of arbitrary patterns of measurement errors—that is, errors for which the assumptions of the errors-in-variables model (such as the one assumed here) do not hold.

4 Evolution of the PR04 approach to expenditure and incentives

The evolution approach would involve Ofwat developing its current approaches by building on the findings of the Independent Steering Group (the Baker Review),[41] the recent UKWIR report on Ofwat's approach to assessing efficiency,[42] and Ofwat's own internal work. In summary, Ofwat would:

– continue to assess capital and operating costs separately (the possibility of jointly modelling OPEX and capital maintenance expenditure is briefly discussed below);

– use actual expenditure in a 'base year' for assessing relative efficiency;

– roll forward past expenditure as the starting point for setting forward allowances; and

– refine the current methods of challenge including the way of assessing the scope for overall efficiency and the continuing efficiency component, and improving the way in which special factors are taken into account.

Ofwat's May 2007 discussion paper discusses developments as part of its evolution approach for OPEX, capital maintenance and enhancement. However, the regulator has asked Oxera to focus on capital maintenance expenditure.[43]

Previous reviews of the Ofwat's PR04 approach to capital maintenance expenditure raised concerns regarding the reliance on historical expenditure levels in setting capital maintenance expenditure allowances.[44] At PR04 an uplift method was used to decide what proportion of expenditure above the benchmark (based on historical expenditure) to allow.[45] The uplift depended on the common framework score. If the same approach were to be used at PR09, companies may exploit this knowledge and attempt to game the system by submitting artificially high expenditure forecasts to obtain a larger allowance.

The key aspect examined as part of this report is the evolution approach to combining companies' and Ofwat's view in setting capital maintenance expenditure allowances including the alternative uplift methods that Ofwat proposes.

The structure of this section is as follows:

– Section 4.1 summarises the main parts of the evolution approach and sets out the principles to setting expenditure using the evolution approach.

– Section 4.2 describes the prototype models for capital maintenance developed by Ofwat.

– Section 4.3 uses Ofwat's prototype models to assess the impact of the proposed approaches to setting expenditure and the uplift methods on allowed expenditure compared with Ofwat's RPI – X approach taken at PR04.

[41] Independent Steering Group (2005), 'Report into the Conduct of the 2004 Ofwat Periodic Review', August.

[42] UKWIR (2007), 'Review of the Approach to Efficiency Assessment in the Regulation of the UK Water Industry', May.

[43] Ofwat (2007), 'New Approaches to Expenditure and Incentives: A Discussion Paper', May.

[44] See UKWIR (2005), 'Capital Maintenance Planning Common Framework: Review of Current Practice', RG/05/14, and Mott MacDonald (2004), 'Capital Maintenance Review: Independent Assessment of Ofwat's PR04 Process,' August.

[45] As shown in Table 1 in Ofwat (2006), 'Developing our Process for Assessing Capital Maintenance Requirements', March, a majority of the maintenance expenditure included in price limits of the industry resulted from the analysis of current and historical information.

– Section 4.4 evaluates the incentive properties of the evolution approach for capital maintenance and discusses some practical issues.

– Section 4.5 summarises the key findings.

4.1 Description of evolution approach

4.1.1 Proposed developments for each expenditure category

Ofwat's May 2007 discussion paper examines options for OPEX, capital maintenance and capital enhancement.

OPEX

The evolution approach for OPEX would aim to respond to the UKWIR efficiency review recommendations including, for example, the potential for using panel data. The approach for OPEX is well understood by Ofwat and is therefore not considered further in this report.

Capital enhancement

The evolution approach for enhancement expenditure could have the following characteristics:

– projects would continue to need to meet a number of criteria for inclusion in price limits, with allowance for projects justified through longer-term cost–benefit analysis;

– a more comprehensive quantification of the benefits;

– in addition to the cost base analysis, a structured approach to assessing companies' capital enhancement cost estimating would be applied.

Given the fact that the changes suggested are relatively minor, as with OPEX, capital enhancement is not considered further.

Capital maintenance

In 2006 Ofwat consulted on developing its process for assessing capital maintenance requirements, publishing its conclusions in 'A Sustainable Water Industry: To PR09 and Beyond' (October 2006). Building on these conclusions, the 'evolution' approach envisaged by Ofwat for capital maintenance would take account of the following.

– At PR04, Ofwat made upward adjustments to expenditure for companies with adverse trends in serviceability to enable companies to restore stability. Ofwat has stated that at PR09 it would not do this, as stable serviceability is a required output and poor performance should not be rewarded.

– An assessment of companies' asset management planning, using a more transparent process, and including the outcome of the joint UKWIR project,[46] and publishing the assessments.

– A more searching challenge to historical levels of expenditure; this would include evidence from quantitative analysis (eg, comparative efficiency analysis) and qualitative criteria.[47]

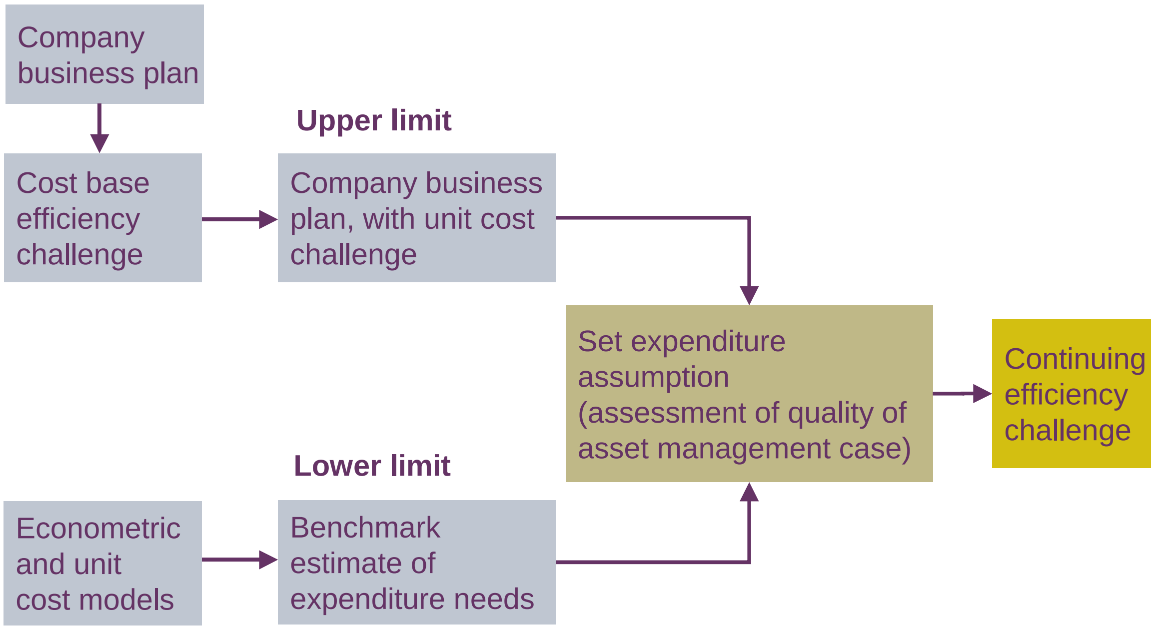
[46] UKWIR, 'RG-05-A: Asset Management Planning Assessment Process', referred to by Ofwat in its May 2007 discussion paper.
[47] Ofwat is consulting on improvements to its suite of capital maintenance econometric models. See Ofwat (2007), 'Capital Maintenance Relative Efficiency Modelling for the 2009 Periodic Review', May.

Since Ofwat is familiar with the issues for OPEX and capital enhancement, the remainder of this section focuses on the evolution approach to setting capital maintenance expenditure allowances.

4.1.2 Proposed process to setting expenditure

Based on the consultation on its approach to capital maintenance, Ofwat developed a proposed strategy for developing the PR04 approach to assessing capital maintenance expenditure.[48] This is illustrated in the figure below.

Figure 4.1 Evolution approach for capital maintenance



Source: Oxera, based on Ofwat (2007),'New Approaches to Expenditure and Incentives: A Discussion Paper', May.

In the **first stage** a possible range for allowed expenditure is set. Ofwat's initial view of expenditure is set using econometric and unit cost modelling to produce a benchmark estimate representing the **lower limit** for Ofwat's range of forward expenditure assumptions.[49]

Following companies' business plan submissions, their expenditure estimates are subject to a cost base challenge. This estimate is then taken as the **upper limit** for Ofwat's expenditure assumption. The assumption, therefore, is that companies will always submit an expenditure bid that is at least as high as that resulting from Ofwat's econometric/unit cost analysis.

The first stage of the approach provides a range within which the true expenditure requirement is assumed to lie (excluding the potential for efficiency savings). To the extent that the econometrically or unit cost-based expenditure estimates are lower than those based on historical expenditure, there is a possibility that a company might receive a lower allowance than under the PR04 approach. A company also has the potential of receiving a higher allowance than under the PR04 approach if the submitted business plan is higher than

[48] Ofwat (2006), 'Developing our Process for Assessing Capital Maintenance Requirements', RD04/06, March.

[49] The modelling approach used to determine this benchmark expenditure has not been reviewed as part of this report.

historical expenditure.[50] This may reflect a true higher expenditure requirement uncertainty or an inflated business plan in an attempt to achieve a higher allowance.

The decision regarding what the allowed expenditure should be is made in the **second stage**. Ofwat undertakes a qualitative assessment of companies' asset management planning following the common framework principles. The more robust the evidence supplied, and the clearer the justification for the proposed expenditure, the greater the uplift companies receive. In order to implement this uplift, Ofwat proposes five possible methods; a description of these and their impact on allowed expenditure is provided in the next section.

In the **third stage** of the evolution approach, adjustments to allowed capital maintenance are made to allow for continuing efficiency (or frontier shift). (Stage 1 already incorporates assumptions regarding catch-up efficiency.)

4.2 Description of prototype models for capital maintenance

Ofwat has developed models that compute the impact of different uplift methods applied to capital maintenance expenditure under the evolution approach ('PR09 approach') and the PR04 approach to capital maintenance expenditure.[51]

The objective of the modelling is to simulate what the expenditure allowance would have been had different uplift methods been applied to PR04 final determination data under both the PR04 approach and the PR09 evolution approach.

The following uplift methods are considered.

– **Base case**—this consists of the PR04 method uplift method whereby the uplift is based on the score of the common framework.

– **Capped uplifts**—the uplift is also based on the common framework score, but a cap is set based on the quality of the capital maintenance expenditure plan (the uplift ranges from 10% to 40%). Under this option companies seeking very large allowances (eg, of 50% or more) may receive a less generous allowance than under the base case.

– **Downside**—this uplift method includes the introduction of more downside for higher business plan submissions. For example, for a company with a common framework ranking in band E (the lowest ranking), a reduction equal to half the uplift sought could be applied.

– **Modified score**—under this approach the common framework score is reduced in proportion to the uplift sought (eg, a score of 50% with an uplift request of 50% may result in an uplift of 45% (50% – 50% x 0.1). The 'modifying parameter', which takes a value of 0.1 in this example, could be substituted for any value between 0 and 1, with 0 equal to the PR04 approach).

[50] At PR04, econometric and unit cost modelling was used to estimate the scope for efficiency *changes* rather than the appropriate *level* of expenditure.

[51] The PR04 approach includes the PR04 efficiency challenge (50% cost base, 50% econometrics); exceptional items and early start as per the final determinations. In the potential PR09 approach, an econometric challenge is applied to historical expenditure (lower limit) and a cost base challenge to the company's plan (upper limit). Exceptional items and early start are also considered. Ofwat also developed an initial version of the models without efficiency challenge. These are not analysed further in this report. In auditing Ofwat's models, one issue identified by Oxera was that the outcome of the PR04 approach does not exactly match the actual allowed expenditure for AMP4. The model underestimates the AMP4 actual by around 3% on average, and for one company by 28%. Ofwat has identified a number of potential explanations in Ofwat (2007), 'PR09 Process: Modelling and Results—Evolution'. A further reason for the discrepancy could be that continuing efficiency may be included in the AMP4 results but not the estimate.

– **Matrix method**—the uplift included is determined by a matrix, depending on the percentage uplift sought and the common framework banding. There is a range of options for how this matrix could be configured. This includes decreasing uplifts as the uplift sought increases and the common framework score received becomes less favourable in order to increase the penalty for poor performance. A worked example of the matrix method can be found in Ofwat's May 2007 discussion paper.

4.3 Comparison of approaches to setting expenditure and uplift methods

4.3.1 Scenarios of interest

There are two key aspects of the evolution approach that can be investigated using the models developed by Ofwat.

– The impact on allowed expenditure (for the industry as a whole and by company) of different uplift methods under a given approach to efficiency (PR04 and PR09).

– The impact on allowed expenditure of the PR09 evolution approach compared with the outcome under the PR04 approach to efficiency (for the industry as a whole and by company).

Of the former comparisons, those involving the PR09 approach are of particular relevance. Assuming that, on the grounds discussed above, the PR04 approach to setting expenditure may lead to bid inflation if used again at PR09,[52] this provides insights as to whether any of the uplift methods are systematically more stringent or lenient than others.

Of the latter comparisons, there are two sets of scenarios of interest. A comparison between the PR09 and PR04 approach for any given uplift method provides insights regarding any differences in expected outcomes from using different approaches to efficiency. Comparisons between each of the PR09 uplift methods to the PR04 base case approach can be cautiously interpreted as the impact on expenditure allowance and ultimately customer bills that would have resulted for AMP4 had the PR09 method and uplift methods been applied at PR04.

However, given that PR04 data is used to simulate the outcome of the PR09 approaches, an important caveat in interpreting the results applies since this data does not take into account possible behavioural responses by companies in light of a different approach to setting expenditure or the different uplift methods (possible implications for incentives are further discussed in section 4.4).

In addition to the scenarios described above, alternative assumptions could be made for the newly proposed uplift methods to investigate the sensitivity of outcomes to these changes. The possibilities include the following.

– **Capped uplifts**—shifting up or down the level at which the cap is set.

– **Downside**—increasing or decreasing the downside for poor performance in the common framework assessment.

– **Modified score**—increasing or decreasing the 'modifying parameter' that reduces the common framework score as the business plan bids increase.

– **Matrix method**—changes to the structure of the matrix.

[52] See UKWIR (2005), 'Capital Maintenance Planning Common Framework: Review of Current Practice', RG/05/14, and Mott MacDonald (2004), 'Capital Maintenance Review: Independent Assessment of Ofwat's PR04 Process, ' August.

Changes in these parameters would lead to an impact on absolute outcomes (ie, total expenditure allowances) and the relative outcomes (ie, changes in the stringency of the assumption of any one uplift method may lead a change in ranking in terms of the total allowance received under each approach). The choice of these parameters requires a regulatory judgment as regards the size of the uplift that a company should receive and which is deemed to be necessary to finance its functions adequately, allowing for sufficient scope for outperformance while ensuring that customers do not pay for inefficiency. A number of possible scenarios could be developed. However, the results presented in this report take the assumptions as developed by Ofwat as given.

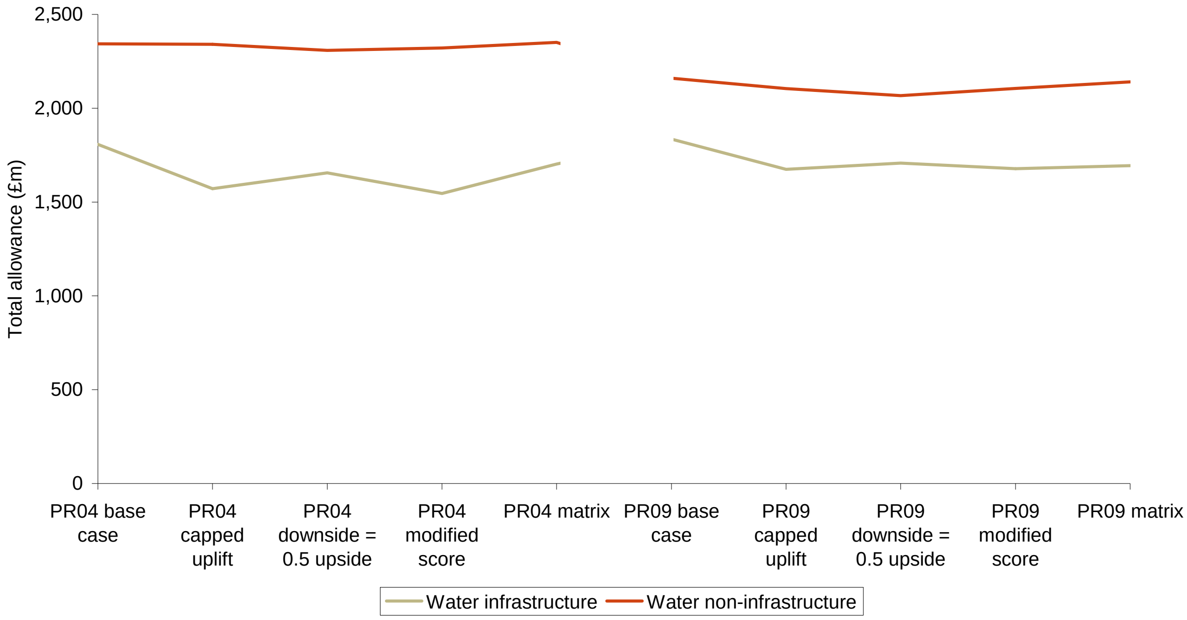
4.3.2 Analysis of industry total allowance and variability in allowance

Figure 4.2 shows the industry allowance for each of the uplift methods for water infrastructure and non-infrastructure capital maintenance expenditure. The figure shows that, for the industry as a whole:

– for **non-infrastructure**, the five uplift methods all give a lower allowance under the PR09 approach, reflecting the fact that the range determined by the econometric/unit cost approach and the company bid, in conjunction with the common framework, tends to give a more generous allowance;

– for **infrastructure**, the PR09 total allowances are centred on the average of the uplift methods under the PR04 approach, such that for some companies the PR09 approach and some uplift methods result in an increase in the allowance (see further discussion below).

Figure 4.2 Industry allowance of different uplift methods under PR04 and PR09 methods



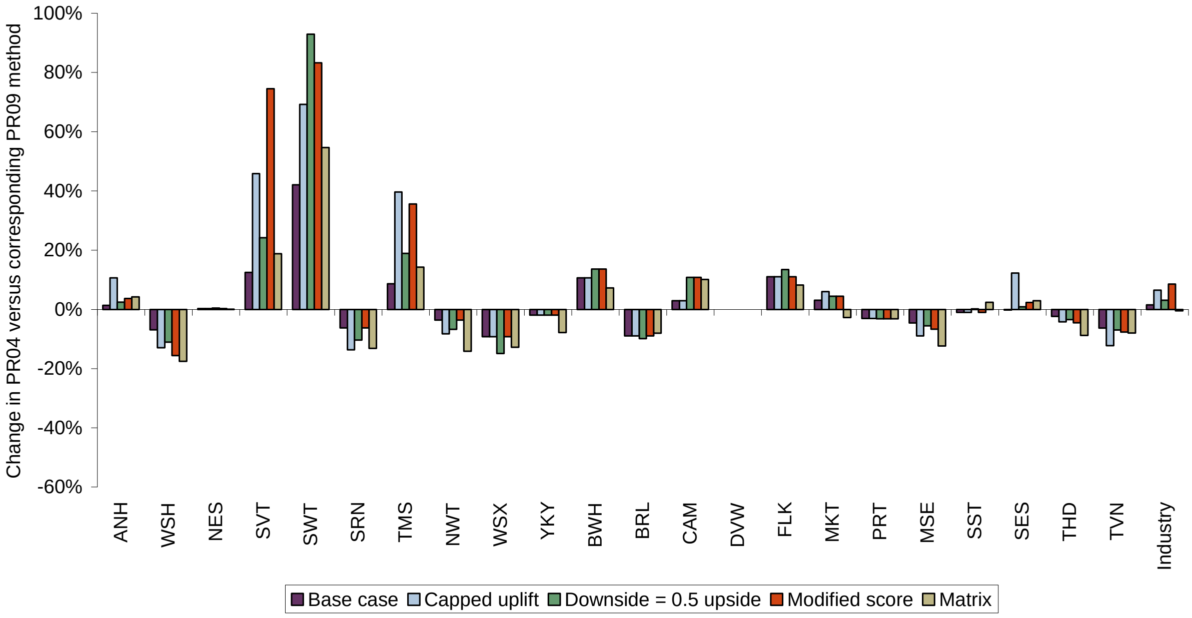
Source: Oxera calculations using Ofwat's capital maintenance evolution model.

The figure above examines the outcome for the industry as a whole; the following sections examine the differences at a disaggregate level by company.

4.3.3 Allowed expenditure by company for PR09 compared with corresponding PR04 method

Figure 4.3 shows the percentage difference in infrastructure expenditure allowance for each of the companies under the PR09 approach compared with the PR04 approach. The figure shows that, for some companies, using the PR09 approach would have led to a significant increase in the allowance compared with the PR04 approach (SVT, SWT and TMS). Ofwat has stated that this may be due to the econometric analysis of historical expenditure giving some support to the large uplifts sought by these companies at PR04, but since they did not fully justify these uplifts, they were not awarded.[53] For other companies there is no clear pattern as to whether they would receive a systematically greater or lower allowance under the PR09 approach, although the size of variances at the company level are significant, with many in the 10–20% range.

Figure 4.3 Change in water infrastructure allowed expenditure of PR04 versus corresponding PR09 uplift method

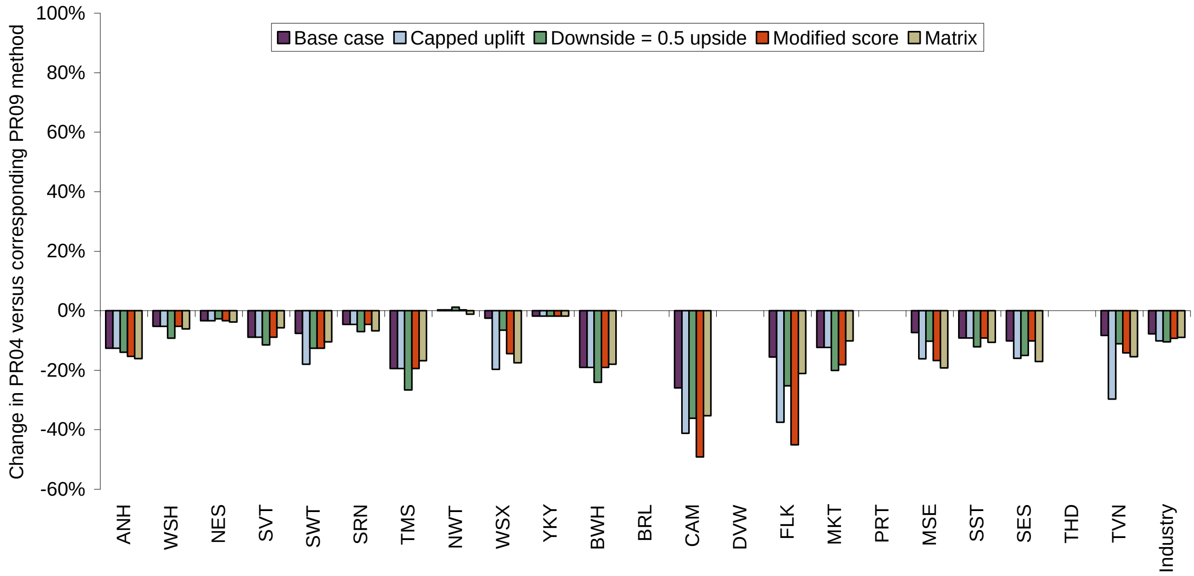


Source: Oxera calculations using Ofwat capital maintenance evolution models.

Figure 4.4 makes a comparison for water non-infrastructure, showing that the allowance under the PR09 approach would have been either similar or lower than under the PR04 approach for all companies.

[53] Ofwat (2007), 'PR09 Process: Modelling and Results—Evolution', internal document provided to Oxera.

Figure 4.4 Change in water non-infrastructure allowed expenditure in PR04 versus corresponding PR09 uplift method



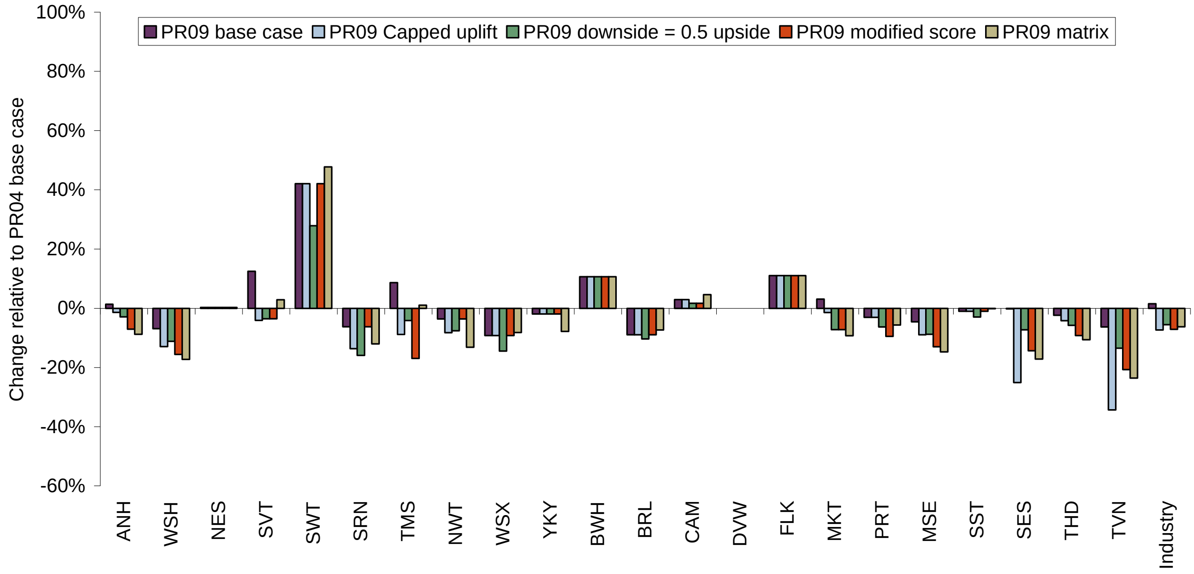
Source: Oxera calculations using Ofwat capital maintenance evolution models.

This suggests that the PR09 approach to setting expenditure may have led to significantly different—lower for water non-infrastructure—allowances (assuming that companies would not have changed their behaviour under the PR09 approach). To the extent that this is driven by the use of a lower bound derived using econometric and unit cost estimates, if Ofwat were to take this approach it would need to have a relatively high degree of confidence in its modelling to justify this outcome. Otherwise there may be implications for the perceived risk of the water sector, and hence implications for the cost of capital.

4.3.4 Allowed expenditure by company relative to the PR04 base case

The difference in allowance from the uplift approaches of PR09 compared with PR04 may be used as a broad indication of the impact that the PR09 approach and uplift method may have on companies' allowance. For infrastructure expenditure, shown in Figure 4.5, the allowance would have been lower for most companies compared with the PR04 outcome—ie, consumers would have benefited from lower prices (assuming that companies would not have changed their behaviour). However, there are several companies for which the expenditure allowance would have been higher (notably SWT).

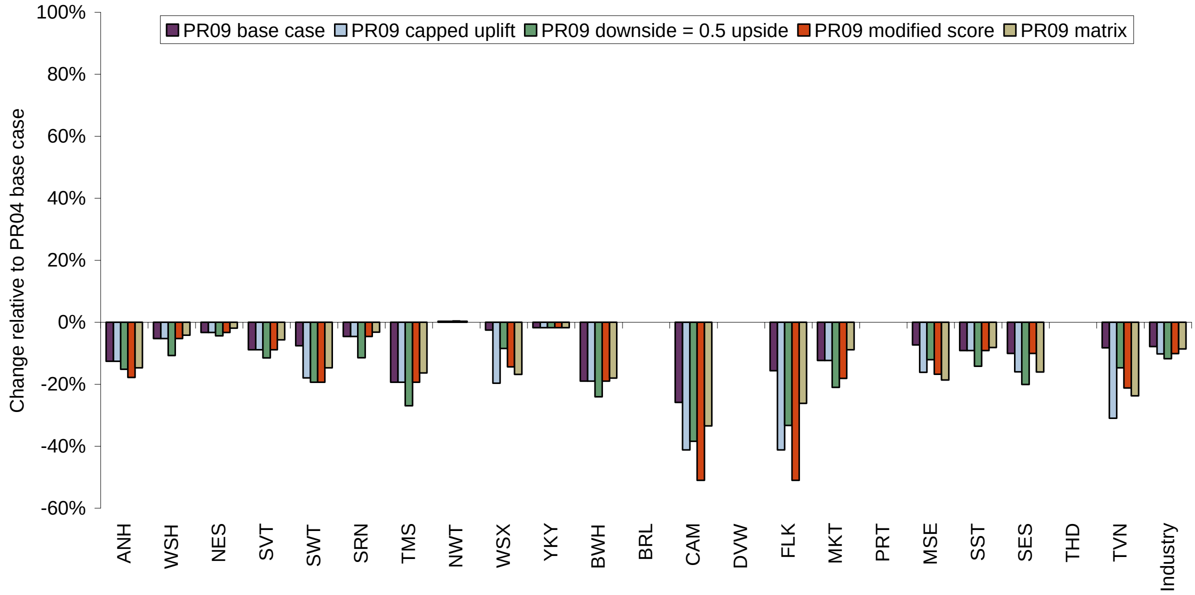
Figure 4.5 Change in water infrastructure allowed expenditure compared with PR04 base case



Source: Oxera calculations using Ofwat capital maintenance evolution models.

The same comparison is shown for non-infrastructure expenditure in Figure 4.6. This shows that under any of the uplift approaches under PR09, companies' allowances would have been consistently lower than under the PR04 base case. For Cambridge and Folkestone & Dover the allowance is shown to be significantly lower.

Figure 4.6 Change in water non-infrastructure allowed expenditure relative to PR04 base case



Source: Oxera calculations using Ofwat capital maintenance evolution models.

4.4 Evaluation of incentive properties and practical challenges

4.4.1 Evaluation of incentive properties

The PR04 approach to setting expenditure involved making the expenditure uplift over historical levels of expenditure dependent on companies' common framework score. This is likely to incentivise companies to submit inflated business plans to boost their allowances, and may lead to bid inflation if used again at PR09. As such, the development of an alternative is necessary.[54]

The evolution approach for capital maintenance attempts to address this shortcoming by reducing the reliance on historical expenditure. This involves constructing a range of expenditure allowances, based on a lower bound derived from econometric/unit cost modelling and an upper bound based on companies' business plans incorporating a cost base efficiency challenge. The relative weight given to companies' bids and Ofwat's estimate depends on the qualitative assessment of companies' asset management planning and the uplift method used. Companies therefore still have a financial incentive to inflate their business plans. However, if they are unable to provide evidence and justification for their bid expenditure, they risk receiving only a small uplift. Moreover, since Ofwat econometrically estimates a lower bound of expenditure, the potential downside of receiving a small uplift is greater than at PR04, since the small uplift may apply to a lower-bound estimate rather than historical levels. The extent to which the evolution approach is therefore likely to succeed in identifying true expenditure requirements depends critically on the degree of correlation between the degree of bid inflation and Ofwat's assessment of companies' asset management.

There do not appear to be any major differences in the incentive properties between the uplift methods (eg, in terms of incentivising companies to submit higher or lower bids). All the new uplift methods (capped, downside, modified score, challenge matrix uplift approaches) incorporate a challenge based on both the size of the uplift sought and the quality of asset management. However, companies may perceive some methods as fairer than others if they fare better under certain approaches.

4.4.2 Practical challenges

As with the other approaches discussed in this report, Ofwat's view of companies' expenditure requirements—the baseline—is fundamental to this approach. It relies on econometric and unit cost modelling to assess expected cost requirements, and it is therefore essential for Ofwat to develop robust models for this purpose.[55] Should the industry lack confidence that the models are sufficiently robust to set the lower bound of the initial range of expenditures, the perceived risk to the water industry, and therefore the cost of capital, may increase compared with PR04, where greater weight was attributed to historical data).

4.5 Summary of findings

The evolution approach for capital maintenance reduces the reliance on historical expenditure. Instead, a range of expenditure allowances is constructed, with a lower bound derived from econometric/unit cost modelling and an upper bound based on companies' business plans incorporating a cost base efficiency challenge; the uplift is then determined using an assessment the quality of the asset management case.

[54] As shown in Table 1 in Ofwat (2006), 'Developing our Process for Assessing Capital Maintenance Requirements', March, a majority of the maintenance expenditure included in price limits of the industry resulted from the analysis of current and historical information.

[55] Ofwat (2007), 'Capital Maintenance Relative Efficiency Modelling for the 2009 Periodic Review', May.

Ofwat's evolution approach for capital maintenance expenditure addresses one of the key criticisms of the PR04 approach, which, if used again, could incentivise companies to inflate their bids in order to boost their allowance. Companies may still have an incentive to inflate their bids, but this would only be successful to the extent that Ofwat's assessment of the asset management would not be able to detect whether expenditure plans have been inflated.

The modelling shows that, for water infrastructure-non-enhancement, a majority of companies would have received a lower allowance at the last price review had the PR09 approach been applied. For water non-infrastructure, all companies would have received a lower allowance under the PR09 approach than under the PR04 approach. Therefore, assuming that companies would not have changed their behaviour had they been faced with this approach, customers would have benefited from lower prices.

There do not appear to be any differences in the incentive properties between the new uplift methods considered by Ofwat, so they are unlikely to be the cause of changes in company bidding behaviour. However, certain companies may perceive some methods to be fairer than others if they fare better under some approaches.

Like the other approaches discussed in this report, the baseline estimate of companies' expenditure requirements is essential. If the industry perceives that the modelling is not sufficiently robust, the perceived risk of the water industry, and therefore the cost of capital, may increase.

5 Additional aspects of new approaches to expenditure and incentives

This section discusses some additional aspects of relevance to Ofwat in the context of the consultation on new approaches to expenditure and incentives.

– **Enhanced bottom-up challenge**. This was presented as a separate option as part of Ofwat's discussion paper. However, responses to the paper revealed little support for this. The approach taken in section 5.1 is therefore not to analyse this as a stand-alone option (eg, as a substitute for the top-down modelling of the evolution approach), but to present some of its key aspects should Ofwat wish to consider using it in conjunction with the other options (eg, in order to set the baseline for the three approaches).

– **OPEX/CAPEX modelling**. As part of the evolution and the incentive-based business planning approach, Ofwat is interested in exploring whether a joint modelling (and a combined target) for CAPEX and OPEX may be preferable on the grounds that incentives to make trade-offs between capital and operating costs may be reduced. Section 5.2 discusses the advantages and disadvantages of both approaches.

5.1 Enhanced bottom-up challenge

This section first considers some of the aspects of the bottom-up challenge and then examines how and where such an approach could be used as part of the other options in order to set the baseline for the three approaches.

5.1.1 Key aspects of bottom-up challenge

The advantages of using bottom-up benchmarking techniques, especially when included within a formalised process benchmarking approach, include the following.

– A clearer understanding of the causality behind costs.

– A clearer understanding of the impact of cost reductions in different areas of the business.

– Individual cost-reduction targets can be identified in specific areas.

– Process benchmarking across several sectors allows a company to move beyond the efficiency frontier that currently exists in its own industry.

– Process benchmarking can answer questions that top-down modelling cannot—eg, explaining historical performance or adjusting a cost base for future exceptional costs.

One key disadvantage, however, relates to the greater informational requirements of the approach. In addition, most of the above advantages are more relevant to a company than to the regulator, either from the perspective of identifying how to achieve the regulator's efficiency targets, or in terms of submitting evidence as part of the consultation process. Ofwat needs to set an efficiency target only at a high level, and it is for the companies to identify how and where such improvements can be made. Ofwat becoming involved in this level of detail could result in concerns about micro-management.

Nonetheless, it is feasible to selectively apply bottom-up benchmarking approaches and to obtain many of the benefits without incurring the full cost of information collection.

5.1.2 Range of applications

The following summary of applications of the bottom-up challenge begins with the most complete, and then considers the more selective applications.

– **Model company**. The model company approach seeks to develop a standard cost for the operation of a company, similar to the way in which a standard cost can be developed for the manufacture of a single item, by using, for example, theoretical assumptions on times and costs. Applying the approach to a whole company involves creating a complex model and incurs considerable effort in updating the standard times and costs to reflect current practice.[56]

– **Full process model**. A full process modelling approach requires the disaggregating of a company into its constituent processes, themselves comprising activities. The company's costs are then allocated to these activities for comparison between utilities. The difficulty is obtaining a consistent allocation between companies with different accounting systems and allocation rules. A necessity for this approach is a common process model and supporting activity dictionary to ensure comparable allocation of costs. Ensuring this comparability *between* companies is difficult; consistency is more easily achieved *within* companies, so this approach is often used to support sub-company modelling.[57]

– **Partial process model**. A common use of bottom-up benchmarking is its partial application to those functions where reliable process benchmarks can be calculated without undue modelling effort. This applies in particular to indirect costs. Ofwat currently allocates indirect costs to its econometric models and has a separate business activities econometric model; however, the costs can be kept separate and benchmarked separately using bottom-up approaches. Such bottom-up challenges are undertaken in most UK regulated industries. One advantage of employing process benchmarking of indirect costs of functions such as HR and finance is that it becomes possible to benchmark practice outside the sector in question, and allows targets to be set beyond the efficiency frontier for the sector. However, careful consideration would then need to be given to the relationship with Ofwat's frontier shift assumption.

– **Dual application**. It is possible to unite bottom-up and top-down approaches into a cohesive whole. Bottom-up approaches can be used to enhance top-down modelling by eliminating outliers, checking for data consistency, and identifying and selecting cost drivers.[58]

– **Adjusting base costs**. Whichever means of comparative efficiency assessment is used, there is often a need to adjust the base costs to account for anticipated changes in costs due to external factors. The required adjustment may be established using a bottom-up approach.

– **Special factors**. Special factor claims are a recurrent feature in the water industry and can be assessed using process analysis approaches.

[56] A model company approach has been used in the Chilean water sector to identify the level of efficiency investment required to meet a stipulated demand.
[57] This can be a useful tool for the regulator if there are few comparators. This is because variation in activity costs across different regions of the company can demonstrate the potential for improvement.
[58] The Water Industry Commission for Scotland has developed an 'alternative' approach to the assessment of Scottish Water's comparative efficiency, which provides an asset-based view of cost levels by identifying the activities required to operate certain types of asset and the expected cost of those activities. This is used as a cross-check on Ofwat's top-down approach and the use of both approaches in unison could be considered a hybrid approach to comparative efficiency assessment.

– **Continuous improvement**. Bottom-up approaches are frequently used by corporate management to improve performance. Examples in the water industry include the 'benchmarking clubs' set up by the Netherlands Waterworks Association and the Scandinavian Six Cities group. The advantage of this approach is that there can be agreement on the realistic rate of change that is possible, as well as the expected changes in unit costs, because continuous improvement in benchmarking typically seeks to understand the differences in the processes and working practices that underlie differences in performance.

– **Maintenance and renewals costs**. Bottom-up benchmarking has been used to analyse the maintenance and renewal cost efficiency of Network Rail.[59] Maintenance costs can be difficult to benchmark using top-down approaches because of uncertainty about the asset condition and difficulties in defining a unit of maintenance and renewal work where the asset condition is unknown. The approach undertaken was to use bottom-up benchmarking at the sub-company level, adjusting for exogenous factors in order to obtain a view on the potential for efficiency gains within each region.

5.1.3 Practical challenges and potential areas of application

Given the multitude of potential uses for bottom-up assessments, an important question is how the bottom-up challenge could be best applied in the England and Wales water industry.

As discussed above, a key disadvantage of the approach from the regulatory perspective is the additional informational requirements and complexity of analysis required when multiple companies are involved. Thus, there seems to be little advantage to Ofwat in using such approaches as a wholesale replacement of its top-down approaches.

The question then arises as to where the bottom-up challenge could be applied if Ofwat wished to extend the use of it in combination with its existing techniques, or in combination with the new approaches discussed in this report. The following sets out some possibilities.

– The cost base approach, whereby the unit costs of 120 standardised capital projects are currently compared across the industry, is a bottom-up approach and thus both capital maintenance and capital enhancement efficiency assessments are already undertaken using a bottom-up approach (with the former using a dual approach since the cost base is combined with Ofwat's top-down econometric modelling).

– Other areas where the bottom-up challenge could be applied are those involving few comparators and/or where the bottom-up approach is relatively simple to implement. Such areas include sewerage OPEX for business activities and capital maintenance management and general (and, if applied to sewerage, it is likely to make sense to extend to water services).

– Base-cost adjustments may warrant some use of bottom-up analysis, but this might be best undertaken as an industry-wide exercise with appropriate challenge from Ofwat, as undertaken at PR04, or as a joint exercise.

– The capital maintenance uplift methodology is being reconsidered as part of the evolution approach. Ofwat currently undertakes a structured qualitative assessment of companies' asset management planning (the more robust the evidence supplied and the justification for the proposed expenditure, the greater the uplift companies receive). This approach involves Ofwat qualitatively appraising companies' own bottom-up assessment. There may be potential to extend such assessments by the companies, using sub-company benchmarking and making adjustments for exogenous factors, in order to obtain a view on the potential for efficiency gains within each region. Such

[59] LEK (2003), 'Regional Benchmarking: Report to Network Rail, ORR and SRA', July.

bottom-up qualitative challenge to higher capital maintenance forecasts and quantitative company evidence remains appropriate regardless of which uplift method currently being considered is ultimately adopted.

5.1.4 Summary of findings

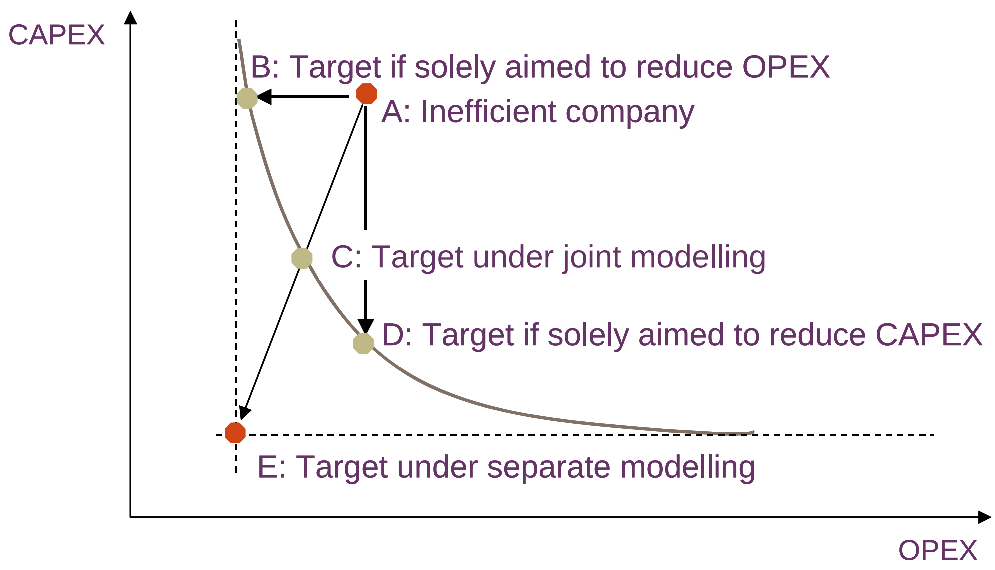
Bottom-up benchmarking techniques can provide useful support to other (top-down) approaches to benchmarking, and to the three main approaches considered in this report, even if such techniques are not exclusively relied on (as this does not seem appropriate). There are a number of examples on which to draw, both in the water industry and the wider UK regulated industries, where such approaches have been used to enhance the measurement of comparative efficiency.

5.2 OPEX/CAPEX modelling: jointly or separately?

Combined OPEX and CAPEX modelling is theoretically justified if trade-offs between the two cost categories are deemed to be important. Indeed, modelling OPEX and CAPEX separately can potentially result in a misleading impression of companies' efficiency, and may lead to unachievable targets being set—for example, if the minimum OPEX from one company is used as a benchmark together with the minimum CAPEX from another. Alternatively, a stringent target could be set in one cost area when a cost reduction in the other may be a more efficient route.

This issue is illustrated in Figure 5.1. If an inefficient company (point A) were set two separate targets for OPEX and CAPEX, the corresponding target under separate models (point E) would be outside the possible combinations of OPEX and CAPEX that, if efficiently spent, yield a given level of output (represented by the curved line). In contrast, a joint modelling target (point C) that takes into consideration the trade-off between CAPEX and OPEX will guarantee that the company at point A is set an achievable target (C).

Figure 5.1 CAPEX–OPEX trade-off



Source: Oxera.

Thus, there may be problems with the standard approach of modelling costs separately, especially at the company-specific level, if trade-offs between the two types of expenditure are large. Attempts to avoid these problems by taking these trade-offs into account have been made within the regulatory context in the following ways:

– by modelling OPEX and CAPEX as a single input under a similar approach to that currently adopted for OPEX comparative efficiency modelling (ie, econometric modelling);

– using data envelopment analysis (DEA) with two inputs, one being OPEX and the other CAPEX;

– modelling OPEX and CAPEX separately, but ultimately accounting for the trade-off by combining OPEX and CAPEX ex post to set targets for companies;

– using total factor productivity (TFP) to compare total cost trends for companies, rather than relative efficiency. TFP is the converse of total unit costs, and extends the notion of a single factor productivity measure to include all factor inputs.

Compared with separate analysis of OPEX and CAPEX, the main potential benefits of a joint approach are that it avoids:

– a potentially misleading picture of a firm's overall efficiency position;
– difficulties that may arise as a result of accounting policy trade-offs between OPEX and CAPEX.

However, total cost modelling does present several problems related to:

– the complexity of determining the cost drivers of the total costs, which are a combination of the OPEX and CAPEX cost drivers;

– the difficulty of establishing an appropriate capital cost that corresponds to a given category of OPEX;

– correctly accounting for the marginal rate of OPEX–CAPEX substitution, which is not necessarily done when modelling total cost;

– the dynamics of CAPEX relative to OPEX, including the lagged effects of capital in the sense that today's OPEX is affected by CAPEX of many years ago which built a capital base. The issue then to be addressed is how far back to go;

– learning-curve effects—more recent or current capital investments may raise rather than lower OPEX through the disruption they cause, the need for training and the need to gradually build up experience in order to become more proficient in undertaking it;

– motivation to build up capital—the greater the investment in capital stock today, the greater the potential for OPEX savings in the future. How regulators should take this into account would need to be considered;

– the tax reasons for allocating expenditure to CAPEX or OPEX—however, this may not be a significant issue as companies operate within accounting standards, regulatory accounting guidelines and tax regulations. The other trade-off is spillovers between types of expenditure and the relationship between cost reduction and operational risk;

– size of cost category—if one of the cost categories is larger than the other (ie, OPEX compared with capital maintenance expenditure), and different cost drivers apply to the cost categories, those of the larger category may dominate.

As a result, a total cost methodology may be best applied in those areas where there is a high degree of substitutability between the two inputs. In other instances it may be preferable to model OPEX and CAPEX separately, but to account for the trade-off ex post to avoid setting infeasible targets.

Ultimately, there are a few choices for the efficiency framework:

- model OPEX–CAPEX trade-offs directly through some form of total cost modelling;
- account for these trade-offs in more ad hoc ways—eg, by ensuring that the targets are broadly equivalent, or considering how the capital maintenance and OPEX targets need to be made consistent with the use of other evidence within Ofwat's regime, such as TFP; or
- taking account of OPEX–CAPEX trade-offs ex post but in an objective and quantitative way.

Previous work has indicated that achieving robust models of joint OPEX and CAPEX can be difficult. However, it may be that joint OPEX and capital maintenance modelling could be easier. It might be possible to incorporate OPEX/capital maintenance modelling at the functional level if some one-for-one mapping can be achieved—for example, as in Table 5.1.

Table 5.1 The equivalence between OPEX and capital maintenance models

OPEX model	Potentially equivalent capital maintenance model
Water	
Business Activities	Water Management and General
Resources & Treatment	Water Resources & Treatment
Distribution	Water Distribution Infrastructure
	Water Distribution Non-infrastructure
Power	
Sewerage	
Sewerage Network	Sewerage Distribution Infrastructure
	Sewerage Distribution Non-infrastructure
Large Sewage Treatment Works	Sewage Treatment
Small Sewage Treatment Works	
Sludge Treatment and Disposal	Sludge Treatment and Disposal
Business Activities	Sewerage Management and General

Source: Oxera.

However, this assumes separability of the functions. If the mapping is not strictly accurate, a number of cost allocation issues may still arise. An alternative, and indeed simpler, approach may be to model at the aggregate level. Such an approach would be greatly enhanced through the use of panel data. In the South East Water and Mid Kent Water merger case, panel data analysis was shown to be applicable for both OPEX and capital maintenance separately.[60]

[60] Competition Commission (2007), 'South East Water Limited and Mid Kent Water Limited: A Report on the Completed Water Merger of South East Water Limited and Mid Kent Water Limited', May.

6 Summary

This report has examined Ofwat's proposed new approaches to expenditure and incentives.

– The menu approach to regulation departs from the standard RPI – X approach of giving a 'take it or leave it' allowed expenditure offer, and instead provides companies with a range of options from which to choose. Companies are incentivised to reveal their true expectations of expenditure requirements. The approach is taken by Ofgem for both the electricity sector (at DPCR4 in 2004) and the gas sector (GDPCR for 2008). The experience of this approach in the electricity sector is too limited to allow a full assessment of the likely impact, but there are indications that some expenditure bids have been reduced as a result. However, it is too early to determine what the longer-term effects might be. As discussed in section 2.6, there are a number of issues concerning the menu approach still to be investigated, including how to address under- or outperformance; the implications for financeability; and ensuring that quality of service is clearly specified in the regulatory contract. However, the assessment in this report has shown that the menu approach could be an alternative to the standard RPI – X approach when used in conjunction with established (or new) methods of efficiency analysis to form the baseline estimates of company expenditure.

– Ofwat's evolution approach for capital maintenance expenditure overcomes one of the major criticisms of the PR04 approach. Were this approach to be employed again, this might incentivise companies to inflate their bids in order to boost their expenditure allowance. The evolution approach reduces the reliance on purely historical expenditure levels; rather, econometric and unit cost modelling is used to estimate a lower bound of an allowed expenditure range. The upper bound is determined by companies' business plans (with a cost base efficiency challenge applied). Allowed expenditure is based on the quality of the asset management case and an uplift method. While companies might still have an incentive to inflate their bids, this would be successful only to the extent that Ofwat's asset management assessment would not be able to detect the inflating of expenditure plans. As with the other approaches discussed in this report, Ofwat's view of companies' expenditure requirements is important. Here, these requirements are estimated using econometric and unit cost techniques, and the modelling therefore needs to be sufficiently robust to be used for this purpose. Assuming that this is the case, this method would be a useful development of the RPI – X approach taken at PR04.

– The incentive-based approach to business planning (IBP) introduces penalties and rewards according to comparisons of business planning. This approach has some desirable properties that represent an improvement over the PR04 RPI – X approach, including a reduction in the reliance on historical capital maintenance expenditure estimates. However, under the strong assumption that companies are driven purely by financial incentives and put little weight on other important considerations (including stakeholder perception and reputation), if the IBP approach were to be implemented without a system that rewards companies for submitting low business plans, this is unlikely to induce them to submit accurate business plans. Such a reward system might incentivise companies to submit accurate bids, but the reward offered might need to be significant in order to offset the benefit that companies might receive from inflating their business plans. This suggests that further development of the IBP approach would be required to overcome these issues and to offer an improvement compared with the alternative approaches considered in this report (ie, the evolution and menu approaches).

– Ofwat is already making use of bottom-up modelling in assessing capital maintenance and capital enhancement expenditure efficiency via the cost base approach. While bottom-up modelling was not considered as a stand-alone option, section 5.1 reviewed some of the key aspects should Ofwat wish to consider using it in conjunction with the other options (eg, in order to set the baseline).

This report discussed each of the options separately. However, Ofwat may also consider employing more than one option (or parts thereof) per expenditure category, or use different approaches for different types of expenditure. In particular, given the importance of the baseline in menu regulation, there is a case for using the econometric and unit cost modelling, as per the evolution and IBP approaches, to set the baseline.[61]

In considering which approach to use, the distinct nature of different expenditure categories needs to be taken into account. One of the most important dimensions that differentiates the cost categories is their variability, which determines the uncertainty about cost levels.

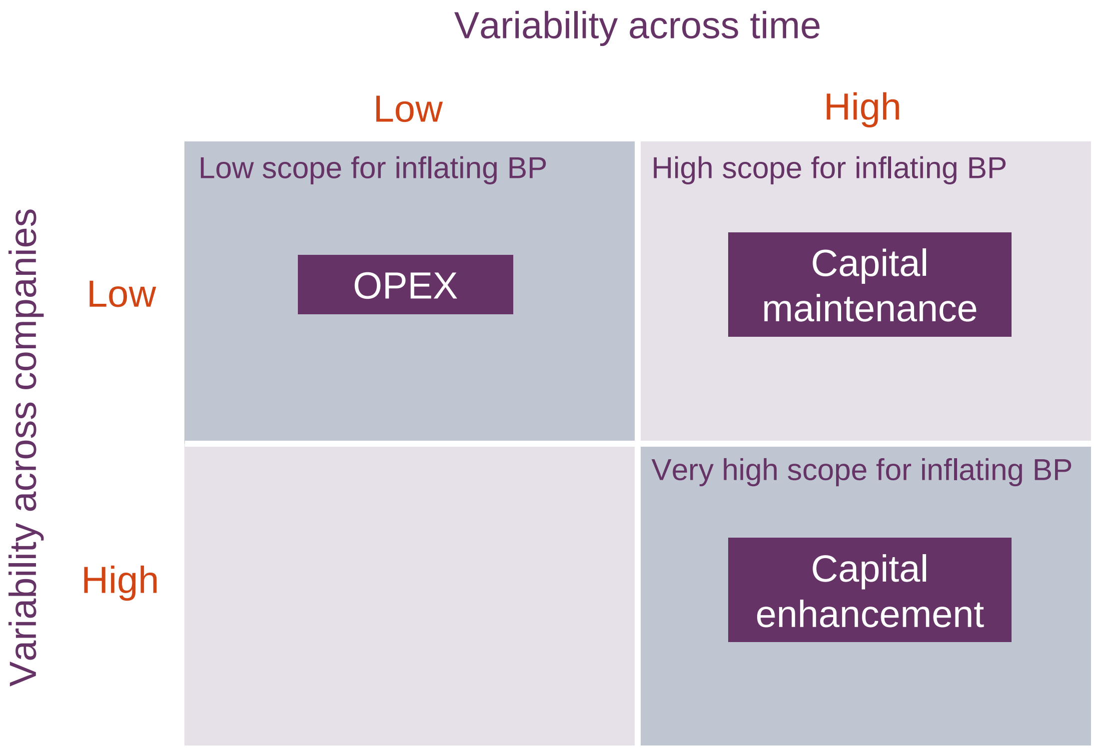
– **Variability across companies**. This can be defined in terms of the type of activity or function for which the expenditure is used, which in turn determines the likelihood of finding several costs that allow like-for-like comparisons to be made. The greater the variability, the more difficult it is to categorise expenditures in order to make them comparable.

– **Variability across time**. If the nature of an activity or function is such that expenditure is required only at discrete and/or irregular intervals, historical data becomes less useful in making projections about future expenditure requirements.

The greater the variability across those two dimensions, the greater the issue of information asymmetry between regulator and companies, and hence the larger the scope for inflating business plans. This is illustrated in Figure 6.1.

[61] The case for using more than one approach per expenditure category is likely to be limited. In the presence of significant uncertainty regarding expected expenditure requirements, having several approaches as a cross-check may be beneficial. However, this is likely to increase the regulatory burden. Most importantly, the incentives provided by the different approaches may be inconsistent across approaches, and hence the impact on outcomes when using a combination of approaches is unclear.

Figure 6.1 Variability of cost categories



Note: BP, business plan.
Source: Oxera.

For OPEX, the scope for inflating business plans is likely to be small compared with other categories. This is owing to the relatively low levels of uncertainty surrounding future expenditure requirements, allowing Ofwat to obtain more accurate estimates of these requirements. There is some variability across companies, which is currently not captured by Ofwat's models, and this is addressed through special factors. For capital maintenance, companies have more scope to claim higher future requirements, as capital maintenance costs are less stable over time and across companies, and there are difficulties in modelling this expenditure category to arrive at requirement estimates. As such, Ofwat may need to rely more heavily on companies' bids, increasing the scope for inflating business plan bids. For capital enhancement the scope for comparison tends to be limited as costs tend not to be comparable between companies since there is high variability both across companies and time, and hence the scope for inflating business plans is significant.

On the basis of the above and the discussion in this report, the following approaches may be employed for different expenditure categories.

– **Capital maintenance**. Setting the baseline for this expenditure category based on comparisons between companies is feasible but more challenging than for OPEX. Given the relatively high level of uncertainty regarding expenditure requirements, using a menu to encourage companies to reveal their expenditure requirement may provide a useful new regulatory tool. Although comparisons of capital maintenance are more difficult than for OPEX, capital maintenance modelling involving comparisons between companies has been carried out for a number of years. While still leaving some incentives to inflate business plans, the approach therefore appears to be well suited to this expenditure category.

– **Capital enhancement**. Of the three expenditure categories, setting the baseline for capital enhancement is the most challenging. Drivers of the size of the capital programmes are more sensitive to company-specific factors or variations, leading to differences in the required scale of expenditure. However, this is also a challenge that

Ofwat currently faces in employing its RPI – X-based approach and is addressed by using the cost base approach alongside the bottom-up challenge of expenditure plans. The relatively high uncertainty regarding expenditure requirements would make the menu approach a useful tool in providing companies with incentives to reveal their true expenditure requirements (providing that the existing approaches of expenditure assessment are retained in order to ensure that reasonable baselines can be established).

– **OPEX**. The development of a baseline estimate is relatively straightforward for OPEX, owing to its low variability, and hence the standard RPI – X regulatory offer is likely to be reasonably accurate. The evolution approach, although not discussed in this report, may therefore be a viable approach for PR09. The principal objective of the menu approach is to encourage business plans that best reflect companies' expectations. A menu approach may therefore not represent a significantly improved outcome over and above that of the RPI – X outcome through lowering the degree of uncertainty around companies' requirements. However, if Ofwat considers that it could use the menu approach to encourage companies to opt for more challenging productivity targets than they otherwise would have considered, this approach may deliver benefits to customers.

Additional bottom-up modelling may also be used to further enhance the robustness of the baseline estimate, which may be particularly useful for capital maintenance and capital enhancement.

Appendix 1 Ofgem sliding scale case study

A1.1 Ofgem's sliding scale mechanism

Ofgem introduced the sliding scale mechanism for distribution network operators (DNOs) for DPCR4 (2005–10), and has proposed the introduction of a similar mechanism for gas DNs in 2008.[62] The sliding scale mechanism, also known as the information quality incentive, is intended to induce companies to reveal their expectations about future expenditure requirements, and thereby to help overcome the issues of asymmetric information prevalent in the regulation of utilities.

Ofgem had traditionally relied on RPI – X price caps to encourage distribution companies to reduce costs. Ofgem highlighted a number of concerns regarding the incentives that companies face under the traditional model, such as incentives to reduce investment or to overstate expenditure requirements during business planning with the aim of receiving a higher allowance from the regulator.[63] Investment was an important issue at DPCR4 since a significant proportion of electricity network assets were in need of replacement or enhancement. In addition, distribution companies were charged with new responsibilities, such as the uptake of distributed generation. Ofgem anticipated a requirement for investment of £5.2 billion during DPCR4, compared with £3.9 billion actual expenditure during 2000–05.[64]

The sliding scale mechanism was designed to:

– allow for more flexible CAPEX;
– retain the normal incentive to minimise costs;
– reward companies for delivering reasonable cost forecasts; and
– reduce the reliance on Ofgem's estimates.

Ofgem's sliding scale mechanism for electricity

At DPCR4, Ofgem asked DNOs to submit forecasts of their CAPEX requirements for the next review period. It commissioned PB Power to review DNOs' proposals and form a baseline cost estimate for each DNO.[65] DNOs' bids were then compared with PB Power's baselines. According to the construction of the menu, the DNO:PB Power ratio determined the following:

– the CAPEX allowance;
– the incentive rate for under- or outperformance;
– an item referred to as 'additional income', designed to ensure that the menu was incentive-compatible—that is, that companies would choose the contract which best reflected their expectations of actual costs.

The Ofgem menu used for DPCR4 is presented in Table A1.1.

[62] Ofgem (2007), 'Gas Distribution Price Control Review Initial Proposals', May, p. 66.
[63] Ofgem (2004), 'Electricity Distribution Price Control Review Initial Proposals', June, para 6.92, p. 89.
[64] Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, Table 7.5, p. 84.
[65] Baseline expenditure is what companies will need to spend to maintain current network performance and risk levels.

Table A1.1 Ofgem's sliding scale mechanism for electricity (DPCR4)

DNO: PB Power ratio	100	105	110	115	120	125	130	135	140
Incentive rate (%)	40	38	35	33	30	28	25	23	20
Additional income	2.5	2.1	1.6	1.1	0.6	–0.1	–0.8	–1.6	–2.4
Allowed expenditure	105	106.25	107.5	108.75	110	111.25	112.5	113.75	115
Rewards and penalties									
Actual expenditure									
70	16.5	15.7	14.8	13.7	12.6	11.3	9.9	8.3	6.6
80	12.5	11.9	11.3	10.5	9.6	8.5	7.4	6.0	4.6
90	8.5	8.2	7.8	7.2	6.6	5.8	4.9	3.8	2.6
100	4.5	4.4	4.3	4.0	3.6	3.0	2.4	1.5	0.6
105	2.5	2.6	2.5	2.3	2.1	1.7	1.1	0.4	–0.4
110	0.5	0.7	0.8	0.7	0.6	0.3	–0.1	–0.7	–1.4
115	–1.5	–1.2	–1.0	–0.9	–0.9	–1.1	–1.4	–1.8	–2.4
120	–3.5	–3.1	–2.7	–2.5	–2.4	–2.5	–2.6	–3.0	–3.4
125	–5.5	–4.9	–4.5	–4.2	–3.9	–3.8	–3.9	–4.1	–4.4
130	–7.5	–6.8	–6.2	–5.8	–5.4	–5.2	–5.1	–5.2	–5.4
135	–9.5	–8.7	–8.0	–7.4	–6.9	–6.6	–6.4	–6.3	–6.4
140	–11.5	–10.6	–9.7	–9.0	–8.4	–8.0	–7.6	–7.5	–7.4

Source: Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, Table 7.6, p. 87.

The table shows the reward (which may take positive or negative values) that a company would face depending on the ratio of its business plan costs relative to the PB Power estimate, and the achieved level of costs.

The incentive rate and allowed expenditures can be formulated as:[66]

Incentive rate = 0.5 × (180 – DNO:BP ratio)

Allowed expenditure = 80 + 0.25 × DNO:BP ratio.

However, Ofgem did not appear to adopt a formulaic approach to the calculation of additional income, which was introduced to ensure that the pay-off matrix was incentive-compatible.

The reward is then calculated according to:

Reward = (allowed expenditure – actual expenditure) × incentive rate + additional income.

The pay-off matrix is incentive-compatible—ie, it is designed to encourage DNOs to be as accurate as possible about their future CAPEX requirements. It works in the following way. Suppose that a DNO believes that it will need to invest 110% of PB Power's forecast. To find the best strategy, the DNO looks at row '110' to find out what the rewards are for spending

[66] Ofgem does not publish these formulae for the sliding scale mechanism. The rounding of numbers in Table A1.1 disguises the formulae behind its components. For example, in column '105', the incentive rate is 37.5%, not 38% as shown. If 38% were used in calculating the reward values, a forecast of 105 and an actual expenditure of 100 would achieve a reward of 4.5 after rounding, and the table would not appear to be incentive-compatible. Theoretically, the additional income is a quadratic function of the forecast ratio. The DPCR menu reports additional income payments that do not fit a quadratic function. Quadratic approximations of the numbers in the DPCR menu are not incentive-compatible. Ofgem either did not follow a formulaic approach or adopted a different functional form.

that amount. The maximum pay-off in this case is 0.8, which is found in the third column. This column corresponds to a declared forecast of 110. Hence, the best strategy for this DNO is to declare its true expected level of CAPEX.

In general, low-cost companies would choose low allowances with high-powered incentives; while high-cost companies would prefer high allowances with low-powered incentives. The best strategies for each type of company, assuming that they behave rationally, are highlighted in the matrix. After contracts are chosen, companies still have an incentive to further minimise costs. For example, the DNO that declared '110' may find that it needs to invest only 105. The DNO would optimally restrict its expenditure to 105. Given the contract in the third column, the DNO's reward would increase from 0.8 to 2.5. Hence, DNOs have an ex post incentive to minimise costs.

In principle, the sliding scale mechanism would provide companies with appropriate incentives (both to invest and to save costs), elicit accurate information about their expenditures, and reduce the regulatory burden.

In the electricity sector, Ofgem has implemented this mechanism by making 'revenue adjustments' to the existing regulatory asset value (RAV) additions at the end of each regulatory period. For example, a pre-tax cost of capital of 6.9% and an asset life of 20 years would imply that DNOs retain 47% of the present value of any CAPEX under-spend. If the sliding scale mechanism requires that the incentive rate is 30%, Ofgem would then adjust revenues downwards by 17%.[67]

Ofgem's sliding scale mechanism for gas

For gas DNs, Ofgem intends to use a pay-off matrix similar to that of electricity (Table A1.2).

Table A1.2 Ofgem's sliding scale mechanism for gas

GDN: Ofgem ratio	100	105	110	115	120	125	130	135	140
Incentive rate (%)	40.0	37.5	35.0	32.5	30.0	27.5	25.0	22.5	20.0
Additional income	2.50	1.97	1.38	0.72	0.00	–0.78	–1.63	–2.53	–3.50
Allowed expenditure	100	101.25	102.5	103.75	105	106.25	107.5	108.75	110
Rewards and penalties									
Actual expenditure									
70	14.50	13.69	12.75	11.69	10.50	9.19	7.75	6.19	4.50
80	10.50	9.94	9.25	8.44	7.50	6.44	5.25	3.94	2.50
90	6.50	6.19	5.75	5.19	4.50	3.69	2.75	1.69	0.50
100	2.50	2.44	2.25	1.94	1.50	0.94	0.25	–0.56	–1.50
105	0.50	0.56	0.50	0.31	0.00	–0.44	–1.00	–1.69	–2.50
110	–1.50	–1.31	–1.25	–1.31	–1.50	–1.81	–2.25	–2.81	–3.50
115	–3.50	–3.19	–3.00	–2.94	–3.00	–3.19	–3.50	–3.94	–4.50
120	–5.50	–5.06	–4.75	–4.56	–4.50	–4.56	–4.75	–5.06	–5.50
125	–7.50	–6.94	–6.50	–6.19	–6.00	–5.94	–6.00	–6.19	–6.50
130	–9.50	–8.81	–8.25	–7.81	–7.50	–7.31	–7.25	–7.31	–7.50
135	–11.50	–10.69	–10.00	–9.44	–9.00	–8.69	–8.50	–8.44	–8.50
140	–13.50	–12.56	–11.75	–11.06	–10.50	–10.06	–9.75	–9.56	–9.50

Source: Ofgem (2007), 'GDPCR Initial Proposals', May, Table 6.1, p. 66.

[67] Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, para A1.21–5, pp. 144–45.

GDPCR is expected to come into effect from April 2008. The sliding scale formulae for gas companies are:

$$\text{Incentive rate} = 0.5 \times (180 - \text{GDN:Ofgem ratio})$$

$$\text{Allowed expenditure} = 75 + 0.25 \times \text{GDN:Ofgem ratio}$$

$$\text{Additional income} = -0.5 + 0.14 \times \text{GDN:Ofgem ratio} - 0.0012 \times (\text{GDN:Ofgem ratio})^2$$

The sliding scale mechanism is tighter for gas than for electricity, in terms of a smaller CAPEX allowance and additional income. However, the incentive rates, which determine companies' strategies, are identical in the two matrices. Hence the two menus (DPCR and GDPCR) will have very similar impacts on company behaviour.

Cost categories

For both electricity and gas distribution companies, the sliding scale mechanism is applied to CAPEX and not OPEX. Ofgem has traditionally used differential incentives for CAPEX and OPEX. DNOs are permitted to retain OPEX savings for five years. Effectively, this is equivalent to a 100% incentive rate. They therefore have an incentive to make 'efficiency savings' by reporting OPEX as CAPEX.[68] Ofgem proposed to treat all costs on the same basis, but this was met with strong opposition from DNOs, which argued that this approach would weaken the overall incentive.[69] As an alternative, therefore, Ofgem is seeking to apply a robust cost categorisation scheme to overcome the risk of companies 'capitalising' costs. It has made progress in this area by publishing cost reporting guidelines (eg, the cost reporting rules for electricity in published in April 2005; furthermore, it is expected to publish similar rules for gas in December 2007).[70] The regulator is confident that further improvements in data quality will be delivered in future years.

A1.2 Timetable for the sliding scale mechanism

The sliding scale mechanism for electricity came into effect on April 1st 2005, after the DNOs submitted their initial business plans. An annual cost reporting process was introduced in conjunction with this, designed in part to monitor year-on-year changes in costs on a consistent basis. In addition, companies had the opportunity to revise their CAPEX projections subsequently, before Ofgem's final decisions.

A1.3 Assessment

Impact on company behaviour

Most DNOs supported the sliding scale mechanism in theory and commented that the DPCR4 process was a substantial improvement on previous reviews, particularly in terms of transparency.[71] For most DN ownership groups, Ofgem's CAPEX allowances were in line with company forecasts. EC and WPD obtained more allowances than their forecast expenditures. The major exceptions were EDF and SP, whose forecasts were around 10% above Ofgem's allowances.[72]

[68] Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, para 7.83, p. 89.

[69] Ibid, para 7.85, p. 89.

[70] Ofgem (2005), 'Electricity Distribution Price Control Review: Price Control Cost Reporting Rules', April; and Ofgem (2007),'GDPCR Initial Proposals', May, p. 99.

[71] Ofgem (2005), 'Assessment of Electricity Distribution Price Control Review Process', July, p. 1.

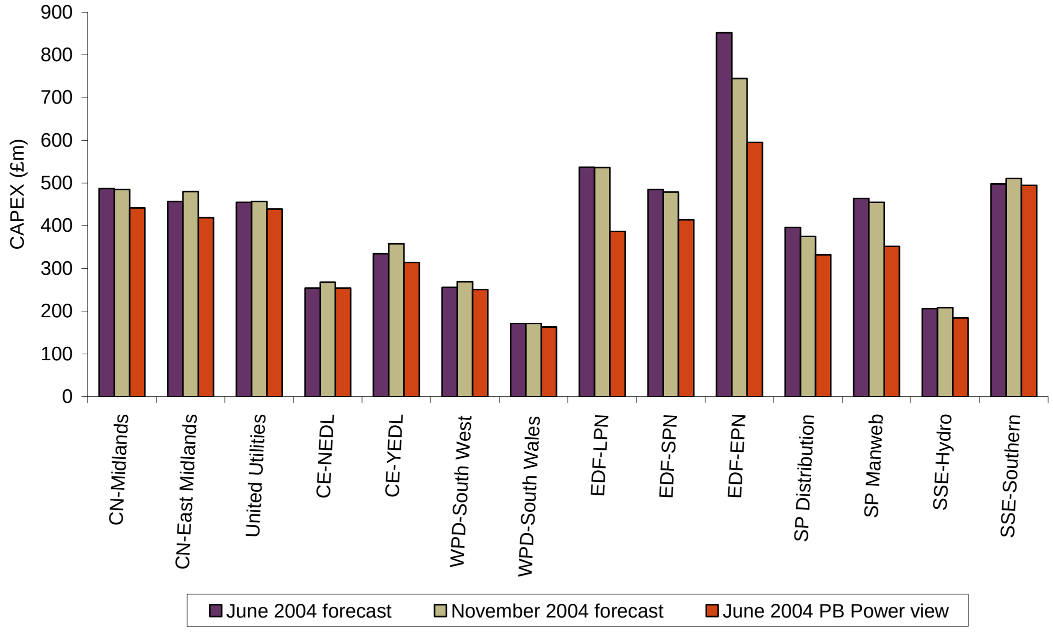
[72] Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, Table 7.5, p. 84.

According to Ofgem, the sliding scale mechanism 'led some of the companies with the largest gap between their forecast and PB Power's view to rethink their own forecast'.[73] Notably, EDF-EPN adjusted its base case CAPEX projection downwards by 12%.

Impact on expenditure allowances

Figure A1.1 illustrates the adjustments to CAPEX forecast for individual companies; of the 14 DNOs, seven increased their forecasts slightly. Industry-wide, the total CAPEX forecast fell marginally by around 1%.[74] However, the movements in CAPEX forecasts should be interpreted with caution, since DNOs are likely to adjust their forecasts for reasons other than the sliding scale regulation. For example, EDF-EPN experienced a significant reduction because the company was able to transfer some expenditure associated with performance improvement from the base case to the DNO alternative scenario.[75]

Figure A1.1 CAPEX forecast, June–November 2004



Source: Ofgem (2004), 'Electricity Distribution Price Control Review Initial Proposals', June, Table 6.7, p. 84; and Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, Table 7.5, p. 84.

In 2005/06, the total actual CAPEX for the industry amounted to £1,117m. While there was a 4% increase over 2004/05 levels, the total CAPEX was 20% below the allowances. There were significant variances between actual costs and allowance in the companies. Substantial under-expenditure (more than 25% below Ofgem's allowance) was observed in SSE group. CE YEDL experienced 4% over-expenditure relative to allowance.[76]

Importance of the baseline

The baseline against which company forecasts were compared was based on analysis from PB Power's engineering model. It is beyond the scope of this study to comment on the modelling approach. It is important to note that one of the concerns raised by DNOs at

[73] Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, para. 7.82, p. 88.

[74] Ofgem (2004), 'Electricity Distribution Price Control Review Initial Proposals', June, Table 6.7, p. 84; and Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, Table 7.5, p. 84.

[75] DNOs are required to provide CAPEX forecasts against three scenarios: the base case, the Ofgem scenario and the DNO alternative scenario. Ofgem (2004), 'EDF (EPN) DPCR4-FPBQ Analysis and CAPEX Projections', December, Executive Summary.

[76] Ofgem (2007), 'Electricity Distribution Cost Review 2005–2006', January, Table 2.4, p. 10.

DPCR4 was that PB Power took insufficient account of fundamentals and company-specific CAPEX requirements, and they therefore argued for higher CAPEX allowances. The DTI (now the Department for Business, Enterprise and Regulatory Reform) commented that:

> Ofgem has clearly acknowledged that extra investment to replace infrastructure is needed. The regulator may not have gone as far as we wished. But a gradual approach is justifiable.[77]

The sliding scale mechanism rewards DNOs for agreeing with PB Power's baseline. As Table A1.1 shows, if actual expenditure exceeds 115% of PB Power's estimate, DNOs would receive a negative reward even if they declare their true expected expenditure. In response to DPCR, two DNOs commented that the sliding scale mechanism still relies heavily on PB Power's estimates, and disproportionately penalises companies that have differences in their engineering plan.[78] One DNO suggested that since PB Power does not have a standard way of forecasting CAPEX, it is difficult for companies to predict what PB Power will forecast. The mechanism may therefore encourage low, inaccurate forecasts.

The outcome for companies is sensitive to the benchmark, since, although this should not affect the level of costs chosen (due to the incentive-compatible nature of the menu), the net rewards or penalties are sensitive to the level of the benchmark set for each company. However, this is not an issue specific to the menu approach, since any price control approach is also subject to debate on how benchmarks should be established.

Impact on company returns

On average, DNOs chose menu contracts that deliver positive rewards if the outturn expenditure turns out to be equal to actual expenditure at the end of the price review period. The industry-wide CAPEX forecast for DCPC4 was 111% of PB Power's estimate. Only three DNOs (EDF–LPN, EDF–EPN and SP Manweb) declared forecasts above 115% of PB Power's baseline, which would result in negative rewards (ie, these companies would earn less than the regulatory cost of capital).[79] This reflects a combination of the particular nature of the set of contracts established by Ofgem and the selection of levels of cost by many firms that were relatively close to the benchmark levels. However, some firms that considered that they faced a significant CAPEX requirement (compared with the baseline) selected a part of the menu where returns were expected to be below the cost of capital for the industry.

Impact on incentives

The average incentive for companies under the menu approach, as reflected by the share of the NPV of outperformance that the firm is entitled to retain, is 34%.[80] This is somewhat lower than the outcome under Ofgem's standard price control (ie, without the sliding scale mechanism), which is 47%.[81] In addition, in order to make the menu incentive-compatible, Ofgem provided additional income equivalent to 0.12% of the total CAPEX allowance.

[77] House of Commons, Trade and Industry Committee (2004), 'Trade and Industry: First Report', November, para 96.

[78] Ofgem (2004), 'Electricity Distribution Price Control Review: Summary of Responses to the September Update Document', November, para 3.33–.35, p. 16.

[79] Ofgem (2004), 'Electricity Distribution Price Control Review Final Proposals', November, Table 7.7, p. 88.

[80] Ibid.

[81] Ibid., Table A1.1, p. 154.

Type of expenditure

Ofgem applied the menu to CAPEX, but not to OPEX, mainly because of DNOs' opposition to it. A potential risk of this regime is that DNOs may be tempted to capitalise costs. Ofgem seeks to overcome this risk by establishing robust cost reporting guidelines.[82]

Assumptions about companies' attitude to risk and time preference

The functioning of the sliding scale mechanism rests on two assumptions:

– the companies are neither risk-loving nor risk-averse;
– Ofgem knows the time preference of the companies.

Time preference and risk attitude determine how individual companies interpret the rewards and penalties in Table A1.1. The regulator needs to know companies' time preference in order to set the rewards/penalties appropriately. Companies are risk-neutral and seek to maximise expected returns. If these assumptions are not satisfied, the incentive scheme may not achieve its objective.

An additional problem with the sliding scale mechanism is time-inconsistency. Under this approach, the choices by companies often reveal their true expenditure requirement. Based on this revealed information, the regulator may seek to reset the RPI – X price cap within the review period—ie, a tighter mechanism would have been preferable ex post. Hence menu regulation can 'raise serious commitment problems'.[83] Companies would not have the incentive to reveal their true forecasts if they anticipate that the regulator is unable to commit to the mechanism.

[82] Ofgem (2007), 'Price Control Cost Reporting Rules: Instructions and Guidance (Version 2.21)', March.

[83] Vogelsang, I. (2002), 'Incentive Regulation and Competition in Public Utility Markets: A 20 Year Perspective', *Journal of Regulatory Economics*, **22**:1, pp. 5–27.

Appendix 2 Oxera Menu model simulation outputs

This appendix presents insights and quantifications derived using the Simulation worksheet of the Oxera Menu model. The results introduced in this part of the report complement the more general results presented in section 2.2 and the general description of the different worksheets of the model provided in Appendix 3.

The following aspects are covered.

– The impact on total allowance and rewards of setting the baseline at a different level ie, setting the level of expenditure that represents the regulator’s initial view (see section A2.1).

– The impact of adjusting the parameters of the Oxera Menu model to reflect the regulator’s confidence in the baseline. This involves a regulatory decision regarding the point in the menu where a business plan:baseline ratio should yield a total reward of zero—ie, where companies earn the allowed cost of capital (see section A2.2).

– The impact of the regulator’s views about the accuracy of business plans—the regulator may freely determine the parameter that sets the profitability or generosity of the menus system (see section 2.2.1).

– A comparison of the menu and the RPI – X approaches (see section A2.4).

These aspects are key to determining the total reward obtained by the firms. Therefore, a clear understanding of them is important for Ofwat to be able to investigate further the implications of the menu approach.

All scenarios employ the menu used by Ofgem for gas DNs,[84] and use PR04 capital maintenance data for the water sector. The menu model also includes the possibility of modelling Ofgem’s menu for DNOs.[85] Similar conclusions to those presented in this appendix are reached when choosing the DNO menu or selecting parameters that are broadly in a similar range to the gas DN menu parameters.[86]

The above list (and this appendix) covers only some of the key aspects. A number of possible further avenues for analysis may be of interest to Ofwat and could be investigated using the model. For example, further scenarios/simulations may be run to investigate:

– the uncertainty in the companies’ bids;
– the impact of changing the upper/lower bound of the menu;
– the impact of using menus with configurations that are different to Ofgem’s menus;
– the impact of using different approaches to setting the baseline (the scenarios presented in this appendix use as baselines the econometric benchmark as provided by Ofwat).

[84] Source: Ofgem (2007), ’GDPCR Initial Proposals’, May.

[85] Source: Ofgem (2004), ‘Electricity Distribution Price Control Review Final Proposals’, November.

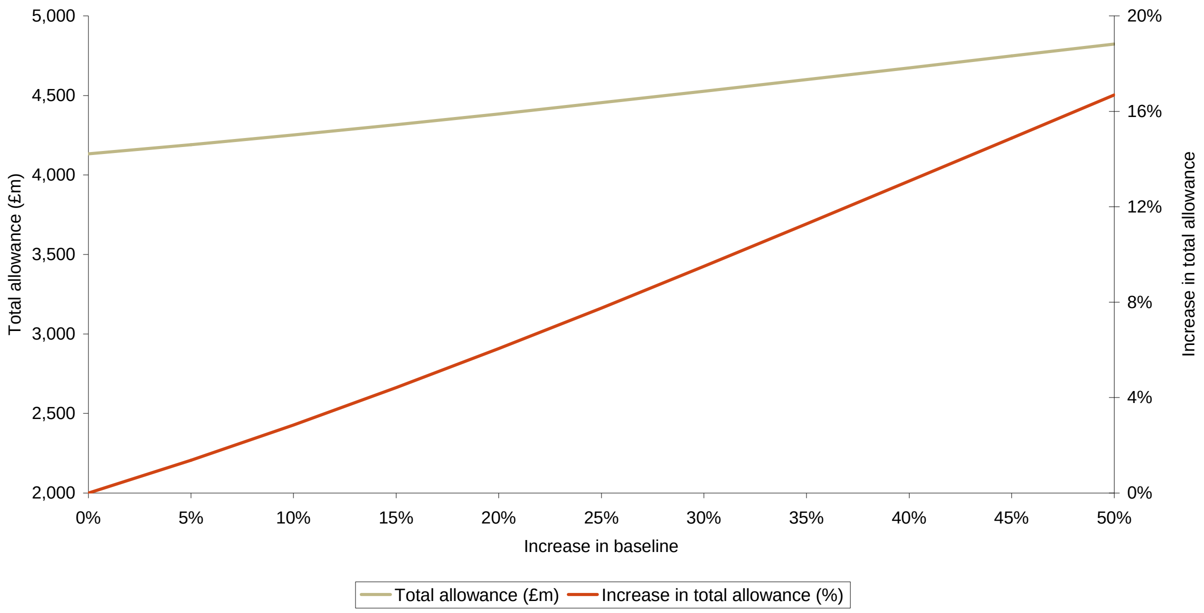
[86] The electricity menu differs from the gas, although the differences affect only the overall generosity of the menu’s pay-off matrix (each cell is 2 times greater), and do not affect the menu’s incentive properties or sensitivity to various assumptions.

A2.1 Setting the level of the baseline

For any menu, it is possible to simulate the impact on allowed expenditure when adopting a more generous baseline. The figures below show the impact on total allowance (Figure A2.1) and rewards (Figure A2.2) of increasing the baseline forecasts by up to 50%.

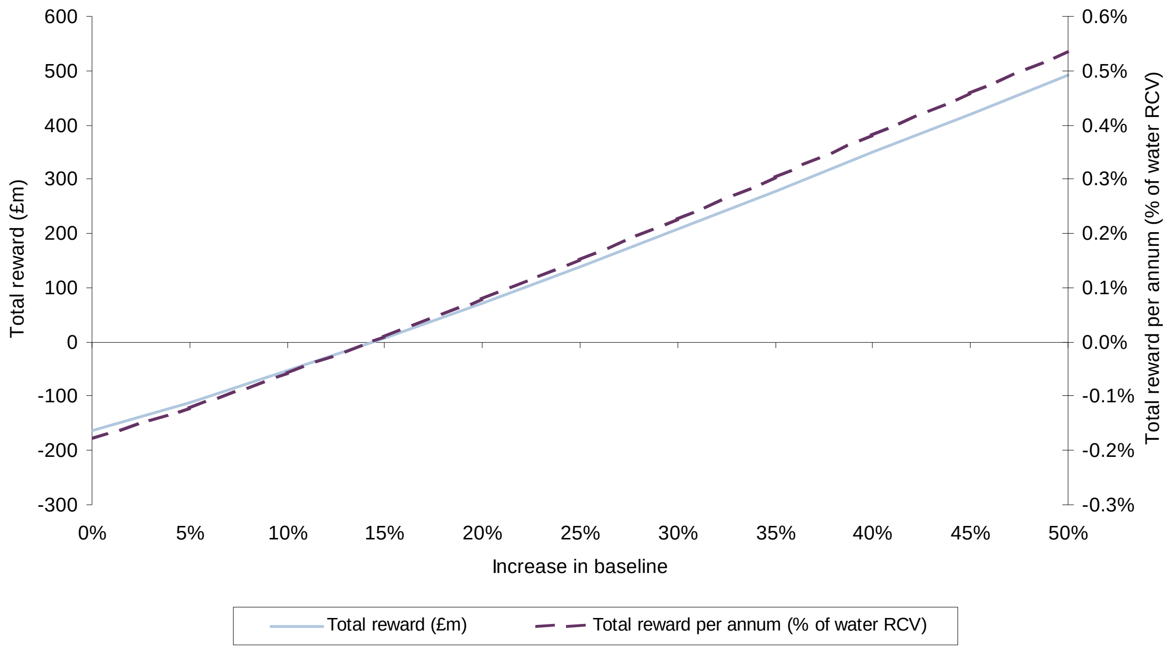
The impact of increasing the baseline is to decrease the business plan: baseline ratio. This yields a higher incentive rate and greater additional income payment for each firm. As a result, a company's total reward, and hence the total allowance, increases.

Figure A2.1 Impact of increase in baseline on total allowance



Note: Simulations use Ofgem's gas DN menu as per its initial proposals, and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

Figure A2.2 Impact of increase in baseline on total reward



Note: Simulations use Ofgem's gas DN menu as per its initial proposals and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

The simulations show that raising the baseline by 25% increases the total allowance by almost 8% (Figure A2.1), which translates into a transfer of nearly £300m (Figure A2.2) from customers to companies. To show the stylised impact of the increase in the allowance on the water industry's bottom line, the ratio of the annual total reward:industry RCV can be examined. Figure A2.2 shows that, for example, an increase of 25% in the baseline leads to an increase of 0.3% of the annual reward as a percentage of the RCV. These figures indicate that customers' bills and firms' profits are sensitive to the regulator's choice of baseline.

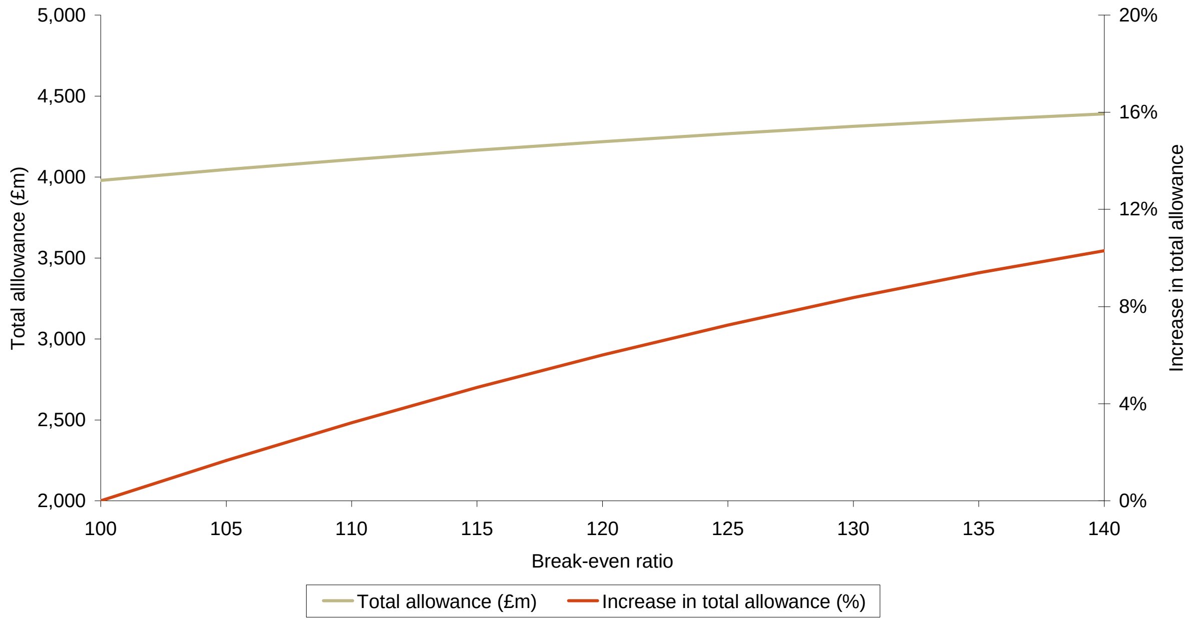
A2.2 Setting break-even business plan:baseline ratios

The menu approach provides choice over the parameters that set the business plan:baseline ratio at which a firm will obtain a zero total reward (ie, by changing certain menu parameters, any cell within the indicative matrix can be made to equal zero). This allows the regulator to set a menu that is in line with the confidence it has in its benchmark. The less confident it is, the higher the zero-reward (or break-even) business plan:baseline ratio it may choose.[87]

As Figures A2.3 and A2.4 illustrate, increasing the generosity of the menu by increasing the business plan:baseline ratio at which a firm obtains zero reward can be quite costly for the consumer. The simulations show that increasing the break-even ratio from 100 to 140 increases the total allowance by more than 10% (Figure A2.3), which, in terms of total reward, implies more than £400m, or an increase of almost 0.45 percentage points of the annual reward expressed as a percentage of the RCV (Figure A2.4).

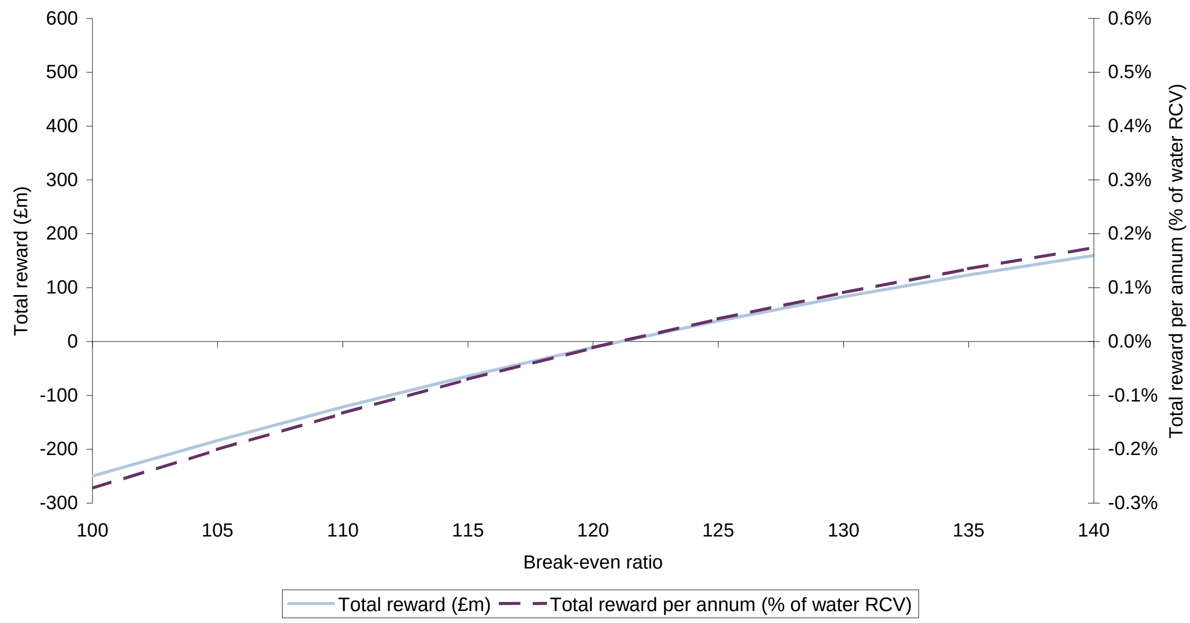
[87] Where the Oxera Menu model is concerned, the choice of the zero-reward business plan:baseline ratio can be accomplished by modifying the additional income payment's intercept parameter, thereby altering the total allowance and total reward figures.

Figure A2.3 Impact of break-even business plan:baseline ratio choice on total allowance



Note: The simulations use Ofgem's gas DN menu as per its initial proposals, and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

Figure A2.4 Impact of zero-reward business plan:baseline ratio choice on total reward



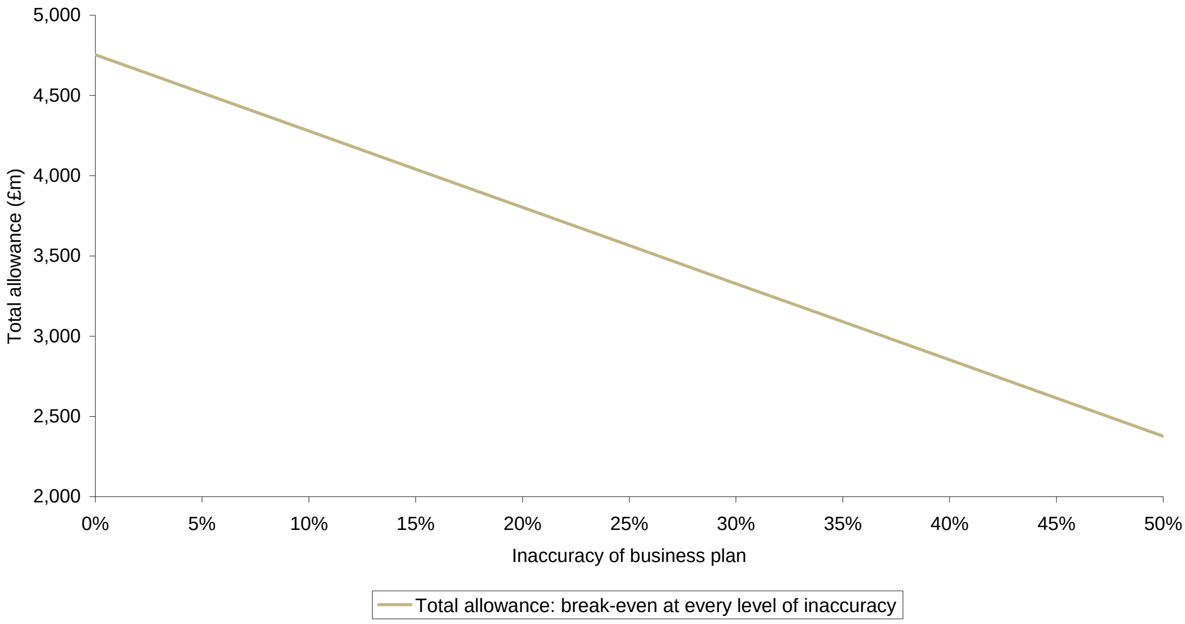
Note: The simulations use Ofgem's gas DN menu as per its initial proposals and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

A2.3 Impact of the regulator's views about the accuracy of business plan submissions

A possible implementation of the menu system may involve the regulator setting the menu parameters after receiving the first round of business plan submissions (see section 2.4.3 for a discussion of the timing of the options). In such a case, it is worthwhile examining the sensitivity of outcomes to the regulator's assumptions about the inaccuracy of companies' first business plan bids.[88] In practice, the regulator's views about the inaccuracy of company business plans are likely to vary between companies. This is simplified in the model by assuming that the regulator makes a common inaccuracy assumption across all companies. Figure A2.5 shows what the total allowance would be were Ofwat to have prior knowledge of the inaccuracy of the first business plan submissions and choose to optimise the menu so that companies earn the allowed cost of capital.

This line is obtained within the Oxera Menu model by undertaking a simulation that changes the 'inaccuracy of bids' parameter in the control panel. Each time the inaccuracy of bids parameter is changed, the menu is automatically calibrated by changing the constant of the additional income:baseline ratio in order to guarantee that the sum of the total reward obtained by the companies is zero (ie, the menu is break-even at every level of inaccuracy).

Figure A2.5 Total allowance under perfect information



Note: Simulations use Ofgem's gas DN menu as per its initial proposals, and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

However, in practice, Ofwat cannot set such a menu because it has to be constructed before receiving the second business plan submissions (ie, Ofwat does not know the inaccuracy of the business plans at the time of constructing the menu). Therefore, it has to set the menu assuming a particular level of inaccuracy.

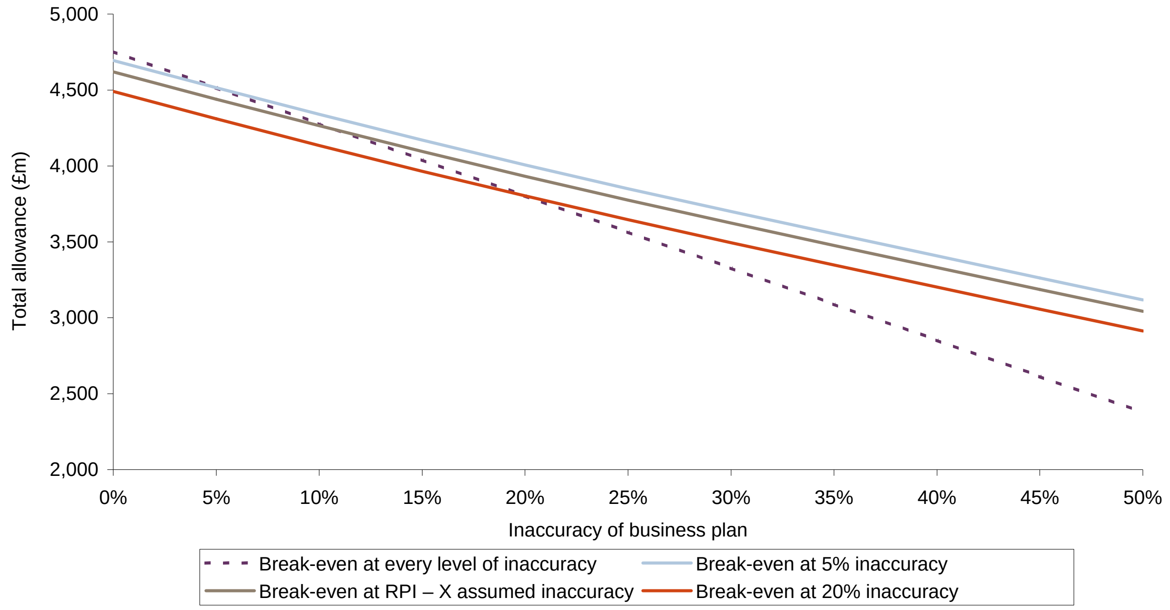
The figures below show the total allowance (Figure A2.6) and total reward (Figure A2.7) for three different menus constructed assuming different levels of anticipated inaccuracy: 5%, estimated PR04 RPI – X inaccuracy, and 20%. The estimated PR04 RPI – X assumed inaccuracy level is the amount by which Ofwat's final determinations reduced companies' capital maintenance expenditure bids, which was around 11%.[89]

[88] The inaccuracy of the business plans is the percentage difference between the first business plan submission and the second business plan submission (which, in the Oxera Menu model, is assumed to be accurate).
[89] Source: Oxera calculations based on data provided by Ofwat.

The optimisation of the menu at a given level of inaccuracy implies that if the ex ante inaccuracy assumptions are correct, the average company just earns its allowed cost of capital (ie breaks even). This can be seen in Figures A2.6 and A2.7 when the solid lines cross the dashed line (a replication of the line shown in Figure A2.5).

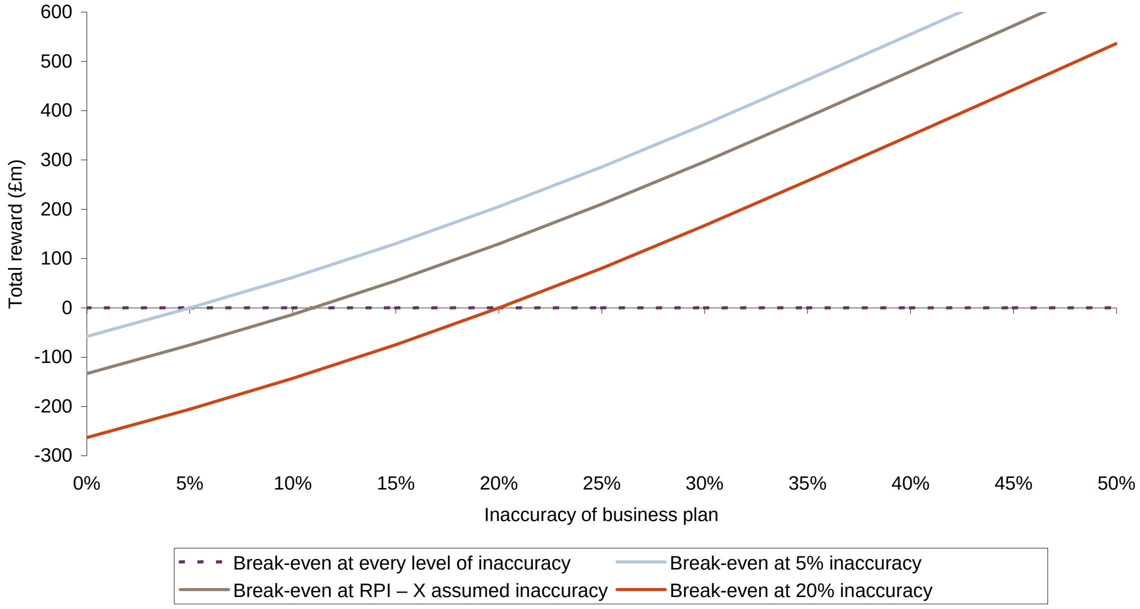
The results of the simulations show that assuming 5% inaccuracy instead of, for example 20%, is equivalent to a transfer of more than £200m from customers to companies. These figures highlight the importance of accuracy when making assumptions about the level of inaccuracy embedded within the first business plan submissions.

Figure A2.6 Total allowance sensitivity to anticipated inaccuracy



Note: Simulations use Ofgem's gas DN menu as per its initial proposals, and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

Figure A2.7 Total reward sensitivity to anticipated inaccuracy



Note: Simulations use Ofgem's gas DN menu as per its initial proposals, and water capital maintenance PR04 data provided by Ofwat.
Source: Oxera Menu model applied to capital maintenance data.

A2.4 Comparisons of menu approach with RPI – X

Comparing the outcomes of the RPI – X approach with those of the menu approach is essential to help Ofwat decide if it is worthwhile implementing the menu approach in terms of leading to a lower allowance than under the PR04 approach. However, financial measures of the outcomes are not the only factor to be considered by Ofwat. There are number of factors, such as the benefit of the companies owning their business plans, which are not quantified by the model but which would be considered by Ofwat.

To compare the menu approach with RPI – X, it is important to simulate scenarios that are comparable (ie, the key assumptions must be similar for both systems). For example, to compare the Ofgem gas DN menu with RPI – X it would be necessary to:

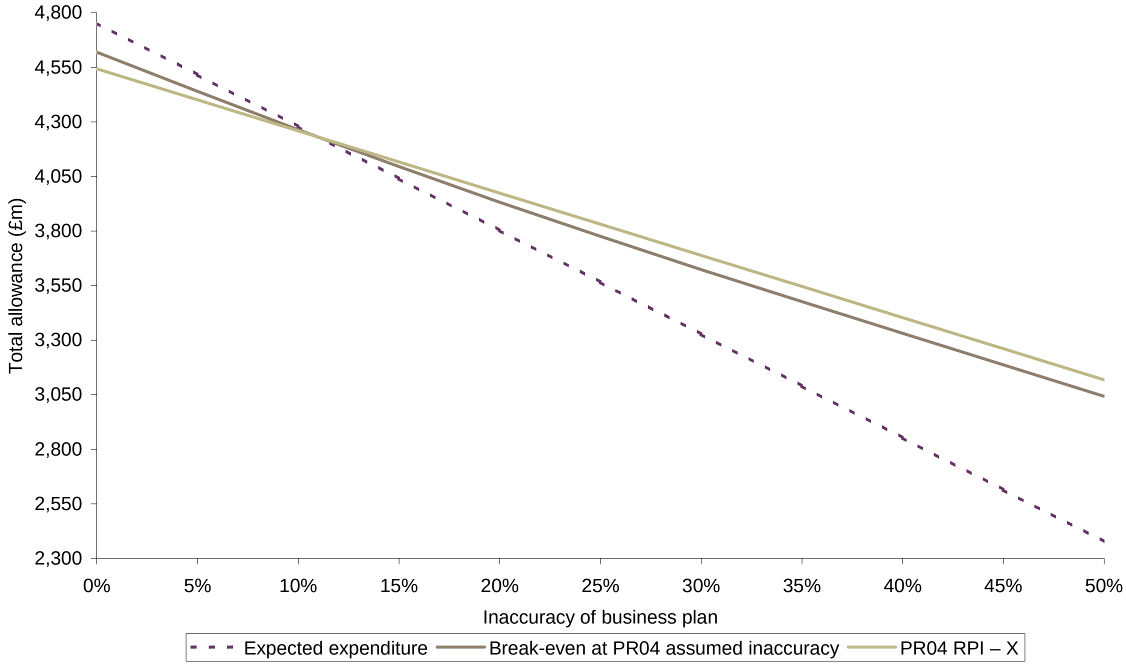
– **adjust the efficiency incentive of RPI – X** to make it similar to Ofgem's gas DN menu efficiency incentive (eg, by setting a symmetric efficiency incentive of 40%);

– **adjust the profitability of the Ofgem gas DN menu** to make it compatible with the inaccuracy of bids assumed in RPI – X (eg, by changing the constant of the additional income:baseline ratio in order to create a break-even menu, assuming 11% of inaccuracy in the first business plan submissions). This is the menu described in Figure 2.1 and Table 2.3, menu 2.

The Oxera Menu model shows that if the second business plan submission under the menu approach were in line with the regulator's expectations (ie, 11% below the first business plan submissions), both systems would yield a total allowance of £4.230m. However, as the second business plan submission is not known by the regulator at the time of constructing the menu, scenarios in which the second business plan submission is above or below the value assumed could also be assessed.

Figure A2.8 shows the total allowance under both the menu and the RPI – X approaches, for different scenarios of inaccuracy of business plans.

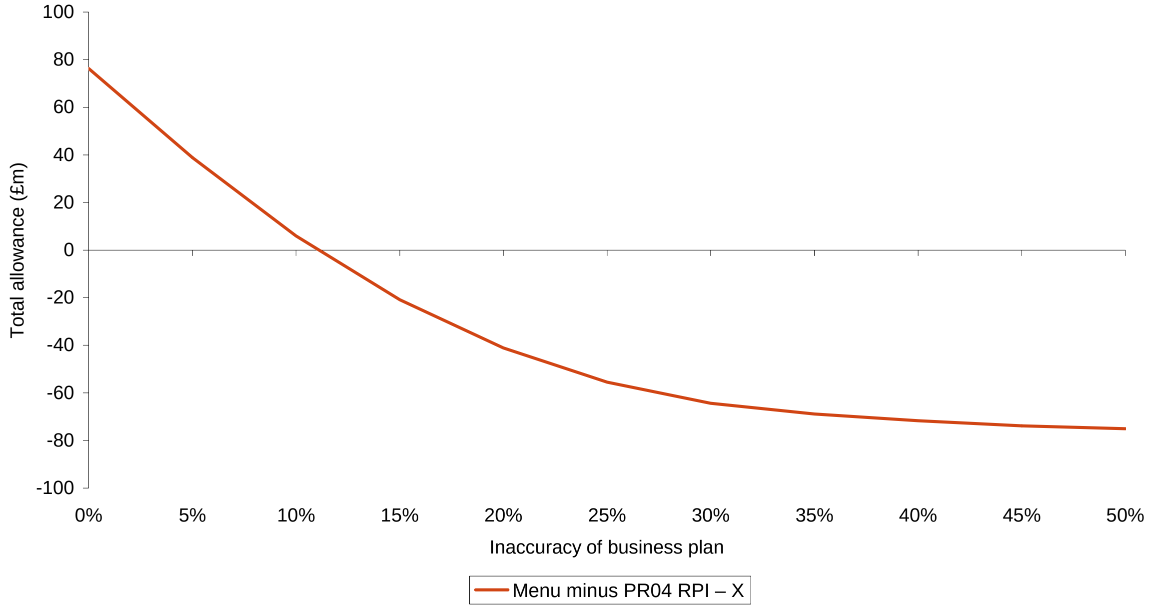
Figure A2.8 Total allowance for menu versus PR04 RPI – X



Note: Simulations use Ofgem's gas DN menu as per its initial proposals, and water capital maintenance PR04 data provided by Ofwat. A symmetric 40% efficiency incentive was assumed for PR04 RPI – X.
Source: Oxera Menu model applied to capital maintenance data.

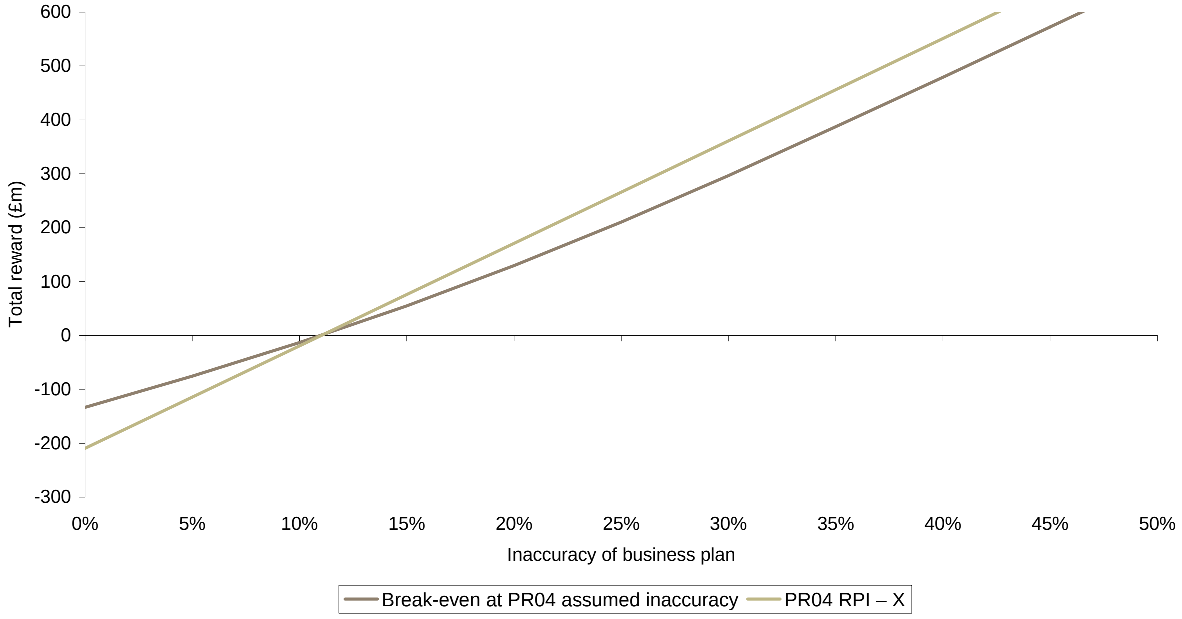
The difference in total allowance between the two approaches is shown in Figure A2.9. For the values to the left of 11% inaccuracy, the menu delivers a higher total allowance than RPI – X (almost £80m more at zero business plan inaccuracy). For the values to the right of 11% inaccuracy, the menu allowance is lower (converging to £80m as the inaccuracy of business plans increases). The same results, expressed in terms of total reward, are shown in Figure A2.10.

Figure A2.9 Difference in total allowance



Note: Simulations using Ofgem's gas DN menu and water capital maintenance PR04 data. A symmetric 40% efficiency incentive was assumed for PR04 RPI – X.
Source: Oxera Menu model applied to capital maintenance data.

Figure A2.10 Difference in total reward



Note: Simulations use Ofgem's gas DN menu as per its initial proposals and water capital maintenance PR04 data provided by Ofwat. A symmetric 40% efficiency incentive was assumed for PR04 RPI – X.
Source: Oxera Menu model applied to capital maintenance data.

Appendix 3 Oxera Menu model user guide

Section A3.1 provides a general description of the content of each of the six spreadsheets that constitute the Oxera Menu model, and explains how they interact with each other. Sections A3.2–A3.5 explain how to use the model via the control panel. Section A3.6 explains the simulation capabilities of the model.

A3.1 The model

The menu model comprises six worksheets:

– **Control panel**—allows the user to build the menu and choose simulation settings, displays the resulting menu, and summarises key simulation results;

– **Graphs**—visually displays the menu components and outcomes;

– **Simulations**—produces counterfactuals for PR04 outcomes under the menu approach;

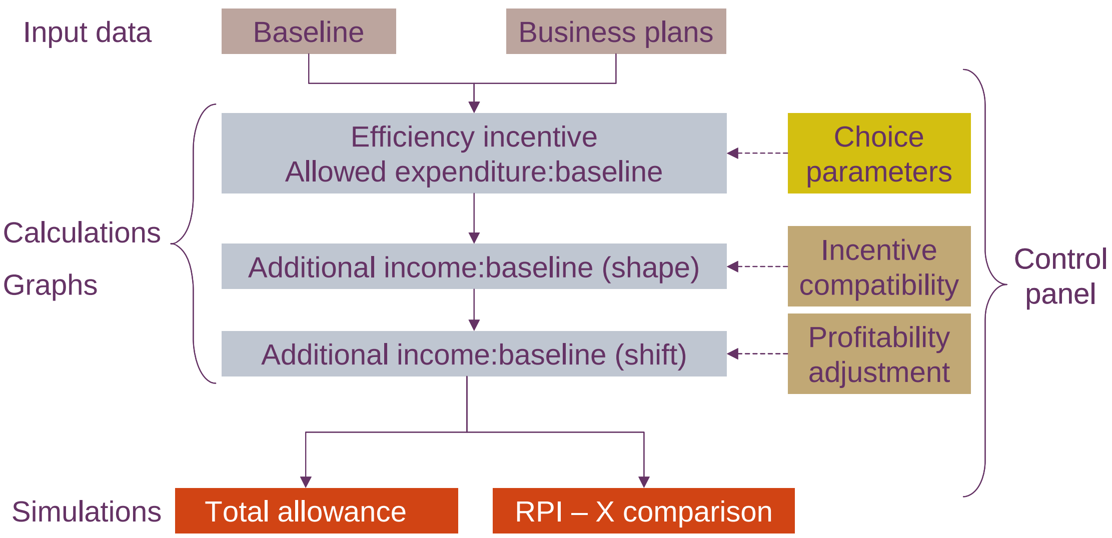
– **Calculations**—calculates detailed results for all the companies;

– **Input data**—includes input data required to carry out the calculations;

– **RPI**—includes RPI information to adjust prices in the input data.

Figure A3.1 presents a graphical interpretation of the interaction of the worksheets within the high-level structure of the model.

Figure A3.1 High-level structure of the model and its worksheets



Source: Oxera.

The Calculations, Input data, and RPI worksheets are the engine of the model's simulation capabilities, and therefore should be edited only for structural changes to the model. Usage of the model via the Control panel, Graphs, and Simulations worksheets is described in the following sections of this appendix.

A3.2 Control panel: introduction

The Control panel worksheet, as depicted in Figure A3.2, is the core of the Oxera menu model. In this worksheet, users:

– input their choices controlling menu construction and simulation;
– view the menu's payoff matrix; and
– receive output summarising simulations of the menu implementation.

Figure A3.2 Control panel

Menu parameters

Efficiency incentive (slope)	-0.0050	σ_2
Efficiency incentive (constant)	0.9000	σ_1
Allowed expenditure:baseline (slope)	0.2500	γ_2
Allowed expenditure:baseline (constant)	75.0000	γ_1
Additional income:baseline (second order parameter)	-0.0012500	α_3
Additional income:baseline (first order parameter)	0.1500000	α_2
Additional income:baseline (constant)	0.0000000	α_1
Menu lower bound (Business plan:baseline)	100	
Menu upper bound (Business plan:baseline)	140	

Note: values in red can be changed by the users of the model

Preset models

Ofgem GDNs

Ofgem DNOs

Option 1

Note: press buttons to simulate preset models

Incentive compatibility restrictions on additional income

Apply ☑ Automatic adjustment

Note: press button or use automatic adjustment

Simulation parameters

Baseline used	Econometric
Baseline increase	0.00%
Inaccuracy of bids	11%
Uncertainty of bids (+/-)	10%
RPI – X efficiency incentive (Outperformance)	40%
RPI – X efficiency incentive (Underperformance)	40%

Note: values in red can be changed by the users of the model

Indicative matrix (Total reward:baseline)

Business plan:baseline	100	105	110	115	120	125	130	135
Efficiency incentive	40.00%	37.50%	35.00%	32.50%	30.00%	27.50%	25.00%	22.50%
Allowed expenditure:baseline	100.00	101.25	102.50	103.75	105.00	106.25	107.50	108.75
Additional income:baseline	2.50	1.97	1.38	0.72	0.00	-0.78	-1.63	-2.53
Actual expenditure:baseline								
70	14.50	13.69	12.75	11.69	10.50	9.19	7.75	6.19
80	10.50	9.94	9.25	8.44	7.50	6.44	5.25	3.94
90	6.50	6.19	5.75	5.19	4.50	3.69	2.75	1.69
100	2.50	2.44	2.25	1.94	1.50	0.94	0.25	-0.56
105	0.50	0.56	0.50	0.31	0.00	-0.44	-1.00	-1.69
110	-1.50	-1.31	-1.25	-1.31	-1.50	-1.81	-2.25	-2.81
115	-3.50	-3.19	-3.00	-2.94	-3.00	-3.19	-3.50	-3.94
120	-5.50	-5.06	-4.75	-4.56	-4.50	-4.56	-4.75	-5.06
125	-7.50	-6.94	-6.50	-6.19	-6.00	-5.94	-6.00	-6.19
130	-9.50	-8.81	-8.25	-7.81	-7.50	-7.31	-7.25	-7.31
135	-11.50	-10.69	-10.00	-9.44	-9.00	-8.69	-8.50	-8.44
140	-13.50	-12.56	-11.75	-11.06	-10.50	-10.06	-9.75	-9.56

Note: values highlighted in blue represent the maximum reward that can be obtained for a given actual expenditure:baseline ratio

Source: Oxera calculations

Key result (£m)

Total allowance	4,065.2

Source: Oxera calculations

Other results

Incentive income (£m)	-145.3
Additional income (£m)	-19.3
Total reward (£m)	-164.5
Total reward per annum (% water of RCV)	-0.18%
Allowed expenditure (£m)	3,604.5
Actual expenditure (£m)	4,229.8
Total allowance assuming underestimated BPs (£m)	4,055.0
Total allowance assuming overestimated BPs (£m)	4,058.0

Source: Oxera calculations

RPI – X results

Inaccuracy of bids assumed in RPI – X	11%
Total allowance RPI – X (£m)	4,229.8
Total reward RPI – X (£m)	0.0
Total reward RPI – X per annum (% of water RCV)	0.00%
Total allowance RPI – X assuming underestimated BPs	4,229.8
Total allowance RPI – X assuming overestimated BPs	4,229.8
Menu - RPI – X (£m)	-164.5
Menu - RPI – X (assuming underestimated BPs) (£m)	-174.7
Menu - RPI – X (assuming overestimated BPs) (£m)	-171.8

Note: RPI – X results are only comparable to menu results if the menu has been optimised assuming the same inaccuracy of bids assumed in RPI – X

Source: Oxera calculations

Source: Oxera Menu model.

All user input occurs in the upper half of the Control panel worksheet, where the user chooses menu and simulation parameters. Cell values that the user may input directly are displayed in red. These choices create the menu payoff matrix displayed below and also drive the calculations and simulations that appear in other worksheets of the model. Some of the simulation outcomes are summarised by the results tables at the bottom of the Control panel worksheet.

A3.3 Control panel: menu parameters

The three main components that give shape to a menu are as follows:

– the efficiency incentive rate;
– the allowed expenditure:baseline ratio;
– the additional income:baseline ratio.

One of the key characteristics of the menu approach is that the components are not determined freely. Instead, each is a function of the business plan:baseline ratio. Table A3.1 shows the functional forms for the three components of the menu.

Table A3.1 Functional forms of the menu components

Component	Type of function	Functional form
Efficiency incentive rate	Linear	$\sigma_1 + \sigma_2 f$
Allowed expenditure:baseline ratio	Linear	$\gamma_1 + \gamma_2 f$
Additional income:baseline ratio	Quadratic	$\alpha_1 + \alpha_2 f + \alpha_3 f^2$

Note: f denotes the business plan:baseline ratio, and the Greek symbols denote key parameters defining each component.
Source: Oxera Menu model.

The regulator constructing a model determines these components by choosing the menu parameters (ie, the Greek symbols). The menu parameter panel is replicated in Figure A3.3 below.[90]

Figure A3.3 Menu parameters

Menu parameters

Efficiency incentive (slope)	-0.0050	σ_2
Efficiency incentive (constant)	0.9000	σ_1
Allowed expenditure:baseline (slope)	0.2500	γ_2
Allowed expenditure:baseline (constant)	75.0000	γ_1
Additional income:baseline (second order parameter)	-0.0012500	α_3
Additional income:baseline (first order parameter)	0.1500000	α_2
Additional income:baseline (constant)	0.0000000	α_1
Menu lower bound (Business plan:baseline)	100	
Menu upper bound (Business plan:baseline)	140	

Note: values in red can be changed by the users of the model

Source: Oxera Menu model.

Three menus—or more precisely, parameter packages that define a menu—are included with the model. The models are specified via the 'Preset models' panel. The menus and their assumptions are described below.

– **Ofgem gas DN menu**. At the baseline forecast of 100, it sets an incentive rate of 40%, which declines at a rate of 0.5% of the business plan:baseline ratio, and an allowed expenditure of 100, which increases at a rate of 0.25% of the business plan:baseline ratio. Under this menu, firms with business plan:baseline ratios greater than 106.5 earn negative rewards.

[90] Menu lower and upper bounds have been also included as Menu parameters.

– **Ofgem DNO menu**.[91] It has the same incentive rate structure as the gas DN menu, but its allowed expenditure constant (γ_1) is greater by 5, meaning that firms earn positive rewards for business plan:baseline ratios that are as high as 112.

– **Ofgem gas DN menu with a profitability adjustment (Option 1)**.[92] This adjustment, assuming an 11% inaccuracy of business plans, provides zero reward at the industry level (ie, it makes the companies break even at 11% inaccuracy of business plans).

The user may also create a custom menu by editing the menu parameters—ie, by editing the cells displayed in red text. For example, a user might load the Ofgem gas menu preset model and then wish to increase the efficiency incentive by 10% at each forecast level. The user would click the *Ofgem GDNs* button and change the constant of the efficiency incentive (σ_1) from 0.9 to 1.0. This change is reflected in the menu matrix. (see Figure A3.4). Graphs of the functions defined by the current parameters are displayed in the Graphs worksheet.

By default, the first- and second-order parameters for the additional income function are set automatically to ensure incentive compatibility via the *Automatic adjustment* checkbox. Turning off the incentive compatibility adjustment by unchecking the *Automatic adjustment* box will change the first- and second-order parameters field from black to red, indicating that the user may alter their values.

In addition to the seven parameters defining the menu components functions, there are two further parameters defining a menu: the upper and lower bounds. Forecasts that are outside the menu bounds are treated by the menu system as forecasts at the limits of the menu. For example, in the Ofgem gas DN menu, firms submitting forecasts above 140 still receive an allowed expenditure of 110 and an incentive rate of 20%, the values applying at 140. A user might extend the upper bound to 180, where allowed expenditure is 120 and the incentive rate is 0%.

The above parameter choices generate a matrix of pay-offs and are replicated in Figure A3.4 below. (The values of the matrix are independent of any data. The data is used to produce outputs that are further discussed below.)

Figure A3.4 Indicative matrix

Indicative matrix (Total reward:baseline)

(I)	Business plan:baseline	100	105	110	115	120	125	130
(II)	Efficiency incentive	40.00%	37.50%	35.00%	32.50%	30.00%	27.50%	25.00%
(III)	Allowed expenditure:baseline	100.00	101.25	102.50	103.75	105.00	106.25	107.50
(IV)	Additional income:baseline	2.50	1.97	1.38	0.72	0.00	-0.78	-1.63
	Actual expenditure:baseline							
	70	14.50	13.69	12.75	11.69	10.50	9.19	7.75
	80	10.50	9.94	9.25	8.44	7.50	6.44	5.25
	90	6.50	6.19	5.75	5.19	4.50	3.69	2.75
	100	2.50	2.44	2.25	1.94	1.50	0.94	0.25
	105	0.50	0.56	0.50	0.31	0.00	-0.44	-1.00
	110	-1.50	-1.31	-1.25	-1.31	-1.50	-1.81	-2.25
	115	-3.50	-3.19	-3.00	-2.94	-3.00	-3.19	-3.50
	120	-5.50	-5.06	-4.75	-4.56	-4.50	-4.56	-4.75
	125	-7.50	-6.94	-6.50	-6.19	-6.00	-5.94	-6.00
	130	-9.50	-8.81	-8.25	-7.81	-7.50	-7.31	-7.25
	135	-11.50	-10.69	-10.00	-9.44	-9.00	-8.69	-8.50
	140	-13.50	-12.56	-11.75	-11.06	-10.50	-10.06	-9.75

Note: values highlighted in blue represent the maximum reward that can be obtained for a given actual expenditure:baseline ratio

Source: Oxera calculations

Source: Oxera Menu model.

The row labelled (I) lists forecast values. Rows (II), (III) and (IV) display the resulting efficiency incentive rate, allowed expenditure, and additional income payment that are functions of the menu parameters and the forecast in that column. In the matrix of pay-offs, each cell is a function of actual expenditure (the row) and announced forecast (the column).

[91] This preset differs slightly from Ofgem's published version of the menu, which makes additional income payments that cannot be written as a quadratic function of the forecast ratio.

[92] The modification consists of an increase in the constant of the additional income:baseline ratio from zero to 4.8.

The blue highlighting indicates the forecast providing the maximum pay-off for each amount of actual expenditure (the cell in each row with the highest value). In the case of incentive compatibility, the profit-maximising announced forecast will equal actual expenditure, and is shown in the shaded diagonal above.

A3.4 Control panel: simulation parameters

The user controls simulation parameters via the panel shown in Figure A3.5.

Figure A3.5 Simulation parameters

Simulation parameters	
Baseline used	Econometric
Baseline increase	0.00%
Inaccuracy of bids	11%
Uncertainty of bids (+/-)	10%
RPI – X efficiency incentive (Outperformance)	40%
RPI – X efficiency incentive (Underperformance)	40%

Source: Oxera Menu model.

The simulation parameters are defined as follows.

– **Baseline used** allows the user to specify which baseline to employ in simulations. Either the 'econometric' baseline or the 'business plan' baseline for each company may be used.

– **Baseline increase** changes the parameter to increase each company's baseline by a uniform percentage. This may be used to examine the impact of offering a more generous baseline.

The next two parameters control aspects of the counterfactual simulations of using the menu system during PR04.

– The **inaccuracy of bids** parameter specifies the percentage by which the menu model reduces the companies' submitted PR04 bids. If this is equal to 0%, the companies' submitted bids are taken as their expected expenditures in simulating their forecast choices.

– The **uncertainty of bids** parameter controls the magnitude of error used when simulating under- and overestimation in companies' forecasts.

– The final two parameters control the simulation of the RPI – X approach where the regulator may set **asymmetric outperformance and underperformance** efficiency incentive rates. The option to specify asymmetric out-and underperformance is not available in the menu system, for reasons explained in section A4.4 of Appendix 4.

A3.5 Control panel: results

Results summarising the simulated counterfactual menu and PR04 outcomes are replicated in Figure A3.6 below.

Figure A3.6 Results

Key result (£m)

Total allowance	4,229.7

Source: Oxera calculations

Other results

Incentive income (£m)	-145.3
Additional income (£m)	145.2
Total reward (£m)	-0.1
Total reward per annum (% water of RCV)	0.00%
Allowed expenditure (£m)	3,604.5
Actual expenditure (£m)	4,229.8
Total allowance assuming underestimated BPs (£m)	4,219.5
Total allowance assuming overestimated BPs (£m)	4,222.4

Source: Oxera calculations

RPI – X results

Inaccuracy of bids assumed in RPI – X	11%
Total allowance RPI – X (£m)	4,229.8
Total reward RPI – X (£m)	0.0
Total reward RPI – X per annum (% of water RCV)	0.00%
Total allowance RPI – X assuming underestimated BPs	4,229.8
Total allowance RPI – X assuming overestimated BPs	4,229.8
Menu - RPI – X (£m)	-0.1
Menu - RPI – X (assuming underestimated BPs) (£m)	-10.3
Menu - RPI – X (assuming overestimated BPs) (£m)	-7.4

Note: RPI – X results are only comparable to menu results if the menu has been optimised assuming the same inaccuracy of bids assumed in RPI – X

Source: Oxera calculations

Source: Oxera Menu model.

The outputs are summarised in Box A3.1. The aim of the model and this report is to examine the impact on the water industry as a whole. The model could also be used to examine the impact on individual companies.

Box A3.1 Outputs from the Oxera Menu model

Given a menu and set of assumptions about PR04 data, the Oxera Menu model simulates the outcome of applying the menu, and produces the following outputs.

Total allowed expenditure is the aggregate industry allowed expenditure, and is determined by the companies' expenditure forecasts and the menu parameters.

Total actual expenditure is the amount companies spend after submitting their business plans. In simulations, business plans are assumed to be accurate forecasts of actual expenditure.

Total allowance—ie, the total cost allowance that is passed on to customers—is the sum of companies' expenditure and rewards:

total allowance = total actual expenditure + total reward

While the total allowance captures the NPV impact of the menu on customers, it should be noted that it abstracts from timing issues, such as the fact that outperformance is rewarded in the next review period.

Incentive income is the aggregate value of industry-wide rewards (penalties) for outperformance (underperformance) relative to allowed expenditure at the efficiency incentive rate over the price control period. It is derived as follows:

incentive income = (allowed expenditure – actual expenditure)*efficiency incentive rate

Additional income is the aggregate value of industry-wide additional income payments made to companies based on their simulated business plan forecast submissions.

Total reward is the aggregate value paid to companies for outperformance plus their additional income payments. This amount represents a net transfer from the customers to the companies, and is necessary to provide incentives both to submit accurate business plans and to improve efficiency and managerial effort. The total reward is calculated as follows.

total reward = incentive income + additional income

Total reward per annum, expressed **as a percentage of RCV**, is the total reward annualised and reported as a share of the total RCV of the water companies' water assets.

Source: Oxera.

The RPI – X results panel reports the same statistics for the simulated RPI – X approach, and the difference in total allowance between the menu and RPI – X.

A3.6 Graphs worksheet

The Graphs worksheet graphically displays menu components and outcomes.

The first three graphs display the menu components that are functions of the business plan:baseline ratio – the efficiency incentive rate, allowed expenditure, and additional income.

The last two graphs display two menu outcomes. The fourth graph on the worksheet displays expected total reward as a function the company's forecast (which, by incentive compatibility, is its outturn). If the user has set an incentive-incompatible menu, total reward is a function of actual outturn rather than the submitted forecast, as the profit-maximising forecast announcement will not equal the company's expected expenditure.

The fifth graph compares the menu and RPI – X systems chosen by the user in terms of a single company's outcome. The model automatically sets the RPI – X allowed expenditure level to the break-even point of the menu. Under both systems, a firm forecasting and spending this amount earns only the allowed cost of capital. The graph shows the total allowance and total reward for each approach as the firm's expenditure varies from the zero-reward point.

A3.7 Simulations worksheet

The Simulations worksheet provides simulations of various outcomes for the chosen menu.[93] It does so by systematically varying one of the menu or simulation parameters in the Control Panel and recording the results attributable to the values. These variations are repeated for a number of parameters. The outcomes are presented graphically for ease of interpretation.

The worksheet generates simulations for the menu described by the parameters set in the Control panel each time the user accesses the Simulations worksheet. The simulations include scenarios describing the following:

– the generosity of the regulator's baseline estimate by varying the baseline increase parameter from 0% to 50%;

– the generosity of the payoff matrix by varying the break-even business plan:baseline ratio (ie, the ratio at which the sum of the total reward obtained by all companies equals zero) from 100 to 140; and

– the accuracy of PR04 business plans by varying the assumed inaccuracy parameter from 0% to 50%.

Where applicable, these outcomes are compared with the RPI – X results. The key results, total allowance and total reward, are displayed graphically.

Graphical outputs from the Simulation worksheet are shown and discussed in Appendix 2.

[93] The Simulations worksheet is available only if incentive compatibility is ensured by checking the *Automatic adjustment* box on the Control panel worksheet.

Appendix 4 Menu components functional forms

A4.1 Introduction

Under a menu system, companies face a pay-off matrix that is a known function of their forecast announcement and the actual expenditure they will incur. The regulator designs the menu such that the most profitable forecast is the firm's expected expenditure. This appendix describes

– the functional forms of the components of the menu (section A4.2);

– the necessary conditions for incentive compatibility (section A4.3); and

– implementing more complicated functional forms (sections A4.4 and A4.5).

A4.2 Components

The menu model is driven by three components:

– the efficiency incentive rate;
– the allowed expenditure;
– the additional income payment.

The firm is rewarded (penalised) for outperformance (underperformance) of its allowed expenditure at the efficiency incentive rate and is guaranteed the additional income payment. The first two components may be chosen by the regulator to suit various objectives. They determine the incentive-compatible value of the additional income equation:

Reward = (allowed – actual expenditure) * Incentive rate + additional income

One of the key characteristics of the menu approach is that the components are not determined freely.[94] Instead, each is a function of the business plan: baseline ratio. Table A4.1 shows the functional form for the three components of the menu.

Table A4.1 Functional forms of the menu components (replication of Table A3.1)

Component	Type of function	Functional form
Efficiency incentive rate	Linear	$\sigma_1 + \sigma_2 f$
Allowed expenditure:baseline ratio	Linear	$\gamma_1 + \gamma_2 f$
Additional income:baseline ratio	Quadratic	$\alpha_1 + \alpha_2 f + \alpha_3 f^2$

Note: f denotes the business plan:baseline ratio, and the Greek symbols denote key parameters defining each component.
Source: Oxera Menu model.

[94] The regulator's range of possible parameters is wide, but not unrestricted. The technical requirement for a valid set of parameters using the method described here is a concave profit function, which requires that σ_2 be negative. The efficiency incentive rate may not increase with the announced forecast.

If a denotes actual expenditure outturn, profits are:

$$\pi(f,a) = (\gamma_1 + \gamma_2 f - a)*(\sigma_1 + \sigma_2 f) + \alpha_1 + \alpha_2 f + \alpha_3 f^2$$

A4.3 Incentive compatibility

Given this profit function, the regulator expects firms to maximise profits and constructs an incentive-compatible menu that requires the companies to announce a forecast that is the same as their expected expenditure.

In choosing the value of f, the firm maximises its expected profit, which is:

$$E(\pi) = (\gamma_1 + \gamma_2 f - E(a))(\sigma_1 + \sigma_2 f) + \alpha_1 + \alpha_2 f + \alpha_3 f\hat{\ }2$$

Maximising expected profit with respect to announced forecast:

$$d\pi/df\text{: } \gamma_1\sigma_2 + 2\gamma_2\sigma_2 f + \gamma_2\sigma_1 - \sigma_2 E(a) + \alpha_2 + 2\alpha_3 f = 0$$

Rearranging,

$$2f(\gamma_2 + \alpha_3/\sigma_2) + \gamma_1 + \gamma_2\sigma_1/\sigma_2 + \alpha_2/\sigma_2 = E(a)$$

The company reveals its true expected costs when the optimal choice of f is its expectation of a. This occurs when the parameters satisfy two restrictions:

$$\gamma_1 + \gamma_2\sigma_1/\sigma_2 + \alpha_2/\sigma_2 = 0$$

and:

$$(\gamma_2 + \alpha_3/\sigma_2) = 0.5$$

If the regulator has chosen the values of γ_1, γ_2, σ_1, and σ_2, incentive compatibility requires that the additional income parameters take the values:

$$\alpha_2 = -\sigma_2\gamma_1 - \gamma_2\sigma_1$$

$$\alpha_3 = (0.5 - \gamma_2)\ \sigma_2$$

These parameters determine the shape of the additional income payment function. Its intercept term (α_1) may be varied freely. Therefore, the shape of the additional income function is restricted by the need for incentive compatibility, but the overall reward level is set by the regulator.

A4.4 Implementing more complicated functional forms

Regulators seeking to implement more complicated functional forms than those set out above are likely to encounter difficulties. For example, Ofwat currently uses an efficiency incentive rate that is asymmetric—outperformance is rewarded at a different rate from that at which underperformance is penalised. This section demonstrates the difficulty of introducing such a complication into the menu system.

Adopting more general notation, the profit function becomes:

$$\pi(f,a) = (\Gamma(f) - a)(\Sigma(f,a)) + \alpha(f)$$

where π is profit, f is announced forecast, a is actual (realised) expenditure, Γ is allowed expenditure, Σ is the efficiency incentive rate, and α is additional income.

First consider the simple symmetric case where the incentive rate does not depend on realised expenditure. When Σ is not a function of a, π is linear in actual expenditure and expected profit is a linear function of expected actual expenditure, as the menu components are non-stochastic. As demonstrated above, when $\Sigma(f)$ and $\Gamma(f)$ are linear functions of f, it is easy to choose parameters such that profit maximisation by firms results in f = E(a).

This does not hold more generally. In the general form, expected profit is:

$$E(\pi(f,a)) = \Gamma(f)E(\Sigma(f,a)) - E(a\Sigma(f,a)) + \alpha(f)$$

Note that $E(a\Sigma(f,a))$ and/or $E(\Sigma(f,a))$ must be non-linear in a. In general, for a non-linear function g(x), $E(g(x)) \neq g(E(x))$.[95] Therefore, the value of f that maximises $E(\pi(f,a))$ does not maximise $\pi(f,E(a))$. Since expected profit is non-linear in a, maximisation requires information about a's 'higher-order moments' (eg, the variance of probability distribution function). Even with sufficient knowledge of these properties, in many cases it may not be possible to choose parameters such that the optimal forecast equals the expectation of actual expenditure.

Designing an incentive-compatible menu that rewards firms non-linearly in terms of actual expenditure, such as an asymmetric incentive rate depending on whether actual expenditure is above or below the allowed expenditure level, requires making significant assumptions about the distributional form of a firm's expected expenditure. The regulator is unlikely to have such information and would therefore find constructing such a menu extremely difficult. The linear case is both easier to understand and a lighter informational burden.

A4.5 Implementing kinked functional forms

The regulator may wish to implement 'kinked' menu components that cannot be written as polynomial functions, such as an efficiency incentive rate that changes slope at a specified point (such that linear segments of the linearly declining efficiency rate function are joined). Constructing such a menu is equivalent to constructing two menus that share a bound. One menu's upper bound is the other's lower bound, and the efficiency incentive rate, allowed expenditure, and additional income are equal at the shared bound. This approach may be extended, so that a menu could be made of three or more adjacent 'sub-menus' that share bounds at the points where functions are kinked.

For example, suppose that the regulator wanted to use different efficiency incentive rates above and below the business plan:baseline ratio of 100. With $\gamma_1 = 75$, $\gamma_2 = 0.25$, and α_2 and α_3 determined automatically, the regulator would like a business plan equal to the baseline to yield an efficiency incentive rate of 30%, an allowed expenditure of 100 and an additional income payment of 0. There are many sets of parameters that might produce those results, with some examples shown in Table A4.2.

[95] In the cases of strictly convex and strictly concave functions, this is derived from Jensen's inequality.

Table A4.2 Possible parameter sets for a given shared bound

	Set 1	Set 2	Set 3	Set 4	Set 5
σ_1	0.55	0.80	1.05	1.30	1.55
σ_2	–0.0025	–0.005	–0.0075	–0.01	–0.0125
α_1	1.25	–5.00	–11.25	–17.50	–23.75

Source: Oxera.

The regulator could construct a menu by applying one set of parameters below 100 and another above.

Appendix 5 Technical details of menu features and outcomes

This appendix provides mathematical reasoning to explain some of the features and outcomes of the menu system.

A5.1 Incentives to reduce expenditure

The incentive rate for performance during the price control period under the menu system is a linear function of the firm's announced forecast. However, this is not the incentive rate for lowering costs during the period in which a firm makes its expenditure forecast. This section shows that a firm's return from lowering its expected expenditure will always be less than the incentive rate for performance at the lower announced forecast. For example, using the Ofgem gas DN menu, a firm announcing a forecast of 100 faces an incentive rate of 40%, but in reducing its expected expenditure from 125 to 100, it earns only 33.75% of the cost savings.

Suppose that the firm considers reducing its expected expenditure from x to y. Recalling the profit function π(f,a) from Appendix 4, the return on an expenditure reduction can be written as:

$$[\pi(y,y) - \pi(x,x)] / [x-y]$$

Writing out π(y,y) and π(x,x) in full, the expression becomes:

$$[(\gamma_1 + \gamma_2 y - y)*(\sigma_1 + \sigma_2 y) + \alpha_1 + \alpha_2 y + \alpha_3 y\hat{}2 - (\gamma_1 + \gamma_2 x - x)*(\sigma_1 + \sigma_2 x) - \alpha_1 - \alpha_2 x - \alpha_3 x\hat{}2] / [x-y]$$

cancelling and combining terms:

$$[(\gamma_1\sigma_2 + (\gamma_2 - 1)\sigma_1 + \alpha_2)*(y-x) + ((\gamma_2 - 1)\sigma_2 + \alpha_3)(y\hat{}2 - x\hat{}2)] / [x - y]$$

dividing:

$$-\gamma_1\sigma_2 + (1 - \gamma_2)\sigma_1 - \alpha_2 + ((1 - \gamma_2)\sigma_2 - \alpha_3)(y + x)$$

As shown in Appendix 3, the incentive-compatible values of α_2 and α_3 are $-\sigma_2\gamma_1 - \gamma_2\sigma_1$ and $(0.5 -- \gamma_2)\ \sigma_2$, respectively. Thus, the above simplifies to yield:

$$\sigma_1 + 0.5*\sigma_2*(y + x)$$

The return (incentive rate) to reducing expected expenditure is the average of the incentive rate at the two expenditure levels. Since incentive compatibility requires that the incentive rate be downward-sloping (σ_2 is negative), this means that the incentive to reduce expected expenditure is less than the incentive rate at the lower expenditure level, which is $\sigma_1 + 0.5*\sigma_2*y$.

A5.2 Total allowance

For an incentive-compatible menu that results in forecasts equal to expected expenditure, the expected total allowance is the sum of the expenditure forecast and the firm's expected profit:

$$f + E(\pi) = f + (\gamma_1 + \gamma_2 f - f)(\sigma_1 + \sigma_2 f) + \alpha_1 + \alpha_2 f + \alpha_3 f^2$$

Plugging in the incentive-compatible values of α_2 and α_3 and cancelling terms yields:

$$= \quad \alpha_1 + \gamma_1\sigma_1 + (1 - \sigma_1)*f - 0.5*\sigma_2 f^2$$

Three important insights emerge from this equation.

– First, firm profit, and therefore total allowance, is not a function of γ_2. The rate at which the allowed expenditure increases with the forecast ratio plays no role in an incentive-compatible matrix of pay-offs. Therefore, the regulator may vary this freely to suit another objective, although its choices may be constrained by concerns about the values taken by α_2 and α_3.

– Second, since incentive compatibility requires $\sigma_2 < 0$, the total allowance function is convex. This means that if the total allowance under a menu approach is lower than total allowance under a symmetric RPI – X approach for a certain range of forecasts, it must be greater than the linear function over another range.

– Third, as σ_2 approaches 0, the total allowance function becomes nearly linear. The less variation in the incentive rate across a menu, the more it resembles an RPI – X system with the same constant incentive rate.

A5.3 Sensitivity to time preference

This section examines the consequences of a menu design that incorrectly anticipates a firm's time preference.

The profit function may be rewritten as:

$$\pi(f,a) = \gamma_1 + \gamma_2 f - a + (\gamma_1 + \gamma_2 f - a)*(\sigma_1 + \sigma_2 f - 1) + \alpha_1 + \alpha_2 f + \alpha_3 f^2$$

where the first two terms are allowed expenditure; the third is actual expenditure; the fourth is out- or underperformance × the pass-through rate; and the last three terms constitute the additional income payment.

Suppose that after announcing their forecasts, firms are awarded tariffs that will provide an income stream equal to the amount of allowed expenditure, and the additional income payment and outperformance (underperformance) rewards (penalties) are assessed at the end of the price control period. The parameter β is defined as the ratio of the firm's actual discount factor to the menu designer's assumed discount factor for the regulation period.[96] When $\beta < 1$, the firm discounts the future at a higher rate than assumed by the regulator designing the menu. When $\beta > 1$, the firm discounts the future at a lower rate than the regulator. The profit function is rewritten to include this discounting of the end of period payments:[97]

$$\pi(f,a) = \gamma_1 + \gamma_2 f - a + [(\gamma_1 + \gamma_2 f - a)*(\sigma_1 + \sigma_2 f - 1) + \alpha_1 + \alpha_2 f + \alpha_3 f^2]*\beta$$

[96] β is not the firm's discount factor since it describes the degree of discrepancy.

[97] In this simple stylised example, the firm discounts the end-of-period payment differently than the regulator's assumption, but the regulator can correctly describe the income stream from tariff earnings in NPV terms. Describing the valuation of the income stream representing a more systematic discrepancy in discount factors, rather than the one-time disagreement explored here, would significantly complicate the maths without offering substantially more insight.

The profit-maximising choice of f is found by setting the derivative of expected profits equal to zero:

$$dE(\pi)/df: \gamma_2 + (\sigma_1 + \sigma_2 f - 1)\gamma_2\beta + (\gamma_1 + \gamma_2 f - E(a))\sigma_2\beta + \alpha_2\beta + 2\alpha_3\beta f = 0$$

Plugging in the incentive-compatible values of α_2 and α_3 yields:

$$\gamma_2(1 - \beta) - \sigma_2\beta E(a) + \sigma_2\beta f = 0$$

rearranging:

$$f = E(a) + \gamma_2(\beta - 1) / \sigma_2\beta$$

The greater the discrepancy in discount factors, the further the profit-maximising forecast is from expected expenditure. As β approaches zero, f approaches infinity.[98]

In another scenario, after announcing their forecasts, firms are awarded tariffs that will provide an income stream equal to the amount of allowed expenditure plus the additional income payment, and outperformance (underperformance) rewards (penalties) are assessed at the end of the price control period. The profit function is then:

$$\pi(f,a) = \gamma_1 + \gamma_2 f – a + [(\gamma_1 + \gamma_2 f – a)*(\sigma_1 + \sigma_2 f - 1)]*\beta + \alpha_1 + \alpha_2 f + \alpha_3 f\text{^}2$$

Taking the derivative of expected profit with respect to the forecast, plugging in the incentive-compatible values of α_2 and α_3, and rearranging to solve for f yields:

$$f = (1 - \beta)*(\sigma_2\gamma_1 + \gamma_2\sigma_1 - \gamma_2) / (\sigma_2 – (1 - \beta)\gamma_2\sigma_2) + E(a)*\beta / (1 – 2(1 – \beta)\gamma_2)$$

The profit-maximising forecast equals the expected expenditure when β equals 1.

A5.4 Compact notation

Thus far it has been assumed that the menu approach comprises three equations. However, it can be reduced to a three-parameter system. Recall the profit function:

$$\pi(f,a) = (\gamma_1 + \gamma_2 f – a)*(\sigma_1 + \sigma_2 f) + \alpha_1 + \alpha_2 f + \alpha_3 f\text{^}2$$

Plugging in $\alpha_2 = –\sigma_2\gamma_1 – \gamma_2\sigma_1$ and $\alpha_3 = (0.5 – \gamma_2)\ \sigma_2$ yields

$$\pi(f,a) = \gamma_1\sigma_1 + \alpha_1 + 0.5*\sigma_2*f\text{^}2 – (\sigma_1 + \sigma_2 f)*a$$

α_1 and γ_1 both may be freely chosen and only alter the intercept of the function, so one is redundant. The equation, with appropriate adjustment of α_1, may therefore be written as:

$$\pi(f,a) = \alpha_1 + 0.5*\sigma_2*f\text{^}2 – (\sigma_1 + \sigma_2 f)*a$$

In this three-parameter menu system, σ_1 and σ_2 define the incentive rate and α_1 determines general profitability. It is always incentive-compatible under standard assumptions.

[98] Assuming that $\gamma_2 > 0$. If $\gamma_2 < 0$, f goes to negative infinity. The firm announces the forecast that yields the maximum allowed expenditure.

Appendix 6 Incentive-based business planning: game-theoretic models

This appendix uses basic game theory to illustrate the incentive properties of incentive based business planning. It assumes no error in Ofwat's initial forecast, although equivalent results could be derived using expected value theory if Ofwat's initial forecasts were errant but unbiased.

A6.1 Planned expenditure inflation

In the absence of a bonus payment structure rewarding companies with low residuals, they have an incentive to increase their submitted forecasts. If all firms submit business plans that produce residuals of equal size, each individual firm prefers to submit a higher business plan. This means that all firms submitting the same residual are not equilibrium outcomes.

Proof

Let there be *n* firms. Let a residual of *x* for each firm be a candidate symmetric equilibrium. Then for each firm, since the target residual is *x*, the allowed expenditure is:

$$O(1 + x)\alpha + F(1 - \alpha)$$

All firms have a forecasting band of 1, so α is 50% or less, as shown in Table 3.1. Each firm has submitted a forecast F equal to O(1 + x), so its allowed expenditure is simply:

$$O(1 + x)$$

No firm will defect to a lower F, since the payoff would be strictly less than O(1 + x). For each firm, an increase in forecast of $\varepsilon > 0$ is a profitable deviation as:

$$O(1 + x)\alpha + F(1 - \alpha) < O(1 + x)\alpha + (F + \varepsilon)(1 - \alpha)$$

and for sufficiently small ε, the value of α does not change.[99]

If the benchmark residual is the average of *n* residuals, then a deviation of ε also raises the benchmark residual and the deviation is even more profitable.

$$O(1 + x)\alpha + F(1 - \alpha) < O(1 + x)\alpha + (F + \varepsilon)(1 - \alpha) < O(1 + x + \varepsilon/n)\alpha + (F + \varepsilon)(1 - \alpha)$$

Since a profitable deviation exists, *x* is not a symmetric Nash equilibrium.

A6.2 Planned expenditure inflation with strict α

The regulator may seek to deter expenditure inflation by making α increase significantly in response to upward deviation from the benchmark residual. The only increase sufficient to deter all expenditure inflation is to set α to 100%. Moreover, if the average residual is the benchmark, there is no value of α that deters inflation.

[99] If all firms submit plans with a residual of *x*, a forecast with a residual ε greater than *x* does not change α by moving the defector to a higher forecasting band so long as $\varepsilon < 0.1$*O.

Proof

Assume a symmetric equilibrium at a residual of x. Then each firm earns O(1+x). A firm deviating by ε would earn:[100]

$$O(1+x) + O(\varepsilon)(1-\alpha(\varepsilon-x))$$

where $1 \geq \alpha(\varepsilon-x) \geq 0$; $\alpha'(\varepsilon-x) \geq 0$.

$\varepsilon < 0$ is a loss-making defection. Any $\varepsilon > 0$ is strictly profitable when $\alpha(\varepsilon-x) < 1$.

A6.3 Planned expenditure inflation and asymmetric equilibria

The incentive to defect upwards is not confined to symmetric equilibria. For example, if half the firms had residuals of 5% and half had 15%, the firms with residuals of 5% would prefer to defect upwards and have a residual of 15%. This is due to the fact that the 15% firms would still be in the best forecasting band, as the target residual is 5% for the least residual and lower-quartile residual benchmarks and 10% for the average. Neither of those is more than 10% different from the 15% firms' residual. Moreover, the firms at 15% would do better by forecasting higher.

Proof

The half of firms that have 5% residuals receive payoffs of O(1.05) because their forecast is less than the adjusted Ofwat forecast.

The half of firms that have 15% residual receive payoffs of:

$$O(1 + \beta)\alpha + O(1.15)(1 - \alpha) = O(1+\beta) + O(.15 - \beta)(1 - \alpha)$$

Since $0.15 > \beta \geq 0.05$ and $1 \geq \alpha \geq 0$, this payoff is greater than O(1.05).

If a 5% residual firm changes its forecast to O(1.15), β may stay constant or increase, while α will not increase since $0.15 - \beta \leq .1$. Therefore each firm with a residual of 5% would gain by inflating its bid to 15%.

[100] If benchmark residual rule is such that ε changes x, x increases when $\varepsilon > 0$. Thus $\varepsilon > 0$ is strictly profitable for any possible value of α.

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