



Rolling Schemes in Price Control Reviews

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10 June 2003



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EXECUTIVE SUMMARY

- 1 In consultation documents on the price control reviews for electricity distribution, water and sewerage, both Ofgem and Ofwat have proposed that efficiency benefits achieved in the current control period should be retained by companies for a “rolling” period of fixed duration. The purpose of such a rolling scheme is to reduce the periodicity of incentives and to improve consistency of treatment between operating and capital expenditures.
- 2 This paper considers the practical implementation of this policy principle. The analysis is based on a review of the approach adopted by Ofwat in the 1999 periodic review of water and sewerage price limits. We have identified some shortcomings in Ofwat’s approach at the 1999 review, and addressed them to develop a scheme which ensures consistency of incentives, a smooth profile of price limits over time, and a greater level of transparency.
- 3 Our recommended scheme involves the introduction of an additional building block to complement the existing price control review methodology. In line with Ofwat’s approach in 1999, we propose the addition (or subtraction) of a rolling allowance to revenue limits, to reflect past deviations from regulatory assumptions on a rolling basis. This provides for the retention of out-performance for a fixed period whilst permitting regulatory assumptions for expenditures to be set as realistic forecasts based on recent information, including inferences from comparative efficiency analysis on the potential for catch-up.
- 4 Our approach adds a number of important elements to Ofwat’s 1999 scheme:
 - (a) To improve the transparency of the regime, thus enhancing its credibility and its incentive properties, we have defined the concept of a “regulatory reserve”, which is used as a “store” for efficiency out-performance that has been accrued but has yet to be passed on to customers.
 - (b) To ensure structural consistency of incentives between operating and capital expenditures, independently of any assumptions on discount rates or the risk appetite of investors, we propose that deviations from regulatory assumptions on capital expenditure be returned through the operation of the regulatory reserve rather than through a “rolling” regulatory capital value (RAB).
 - (c) To avoid an artificial roller-coaster in price limits (both within and between price control periods), we have designed the scheme to return all efficiency benefits to customers progressively over a relatively long period of time, using a similar time profile as for the remuneration of a notional investment in the network.
- 5 The structural consistency of incentives in our proposed scheme, together with its long-term consistency and compatibility with the use of comparative efficiency analysis, also enables it to be applied symmetrically to all deviations from expenditure projections, irrespective of their direction. The removal of asymmetry would free companies to minimise total life-time costs without the artificial constraints placed on management by regulatory projections that act as effective ceilings on expenditure in particular categories.



1 OVERVIEW AND CONCLUSIONS

Scope and Structure

- 1.1 This paper discusses possible methodologies for implementing the principle of rolling pass-through to customers of out-performance of regulatory expenditure assumptions.
- 1.2 A form of rolling pass-through was first introduced by Ofwat in the 1999 periodic review of water and sewerage charges. This was intended to enable companies to retain the benefit of lower than expected expenditure on capital and operating expenditures for a period of five years, irrespective of whether lower expenditure occurred early or late in the price control period.
- 1.3 In recent consultation documents, Ofgem has suggested using a rolling regulatory capital value (rolling RAB), and a rolling allowance for operating expenditure, for the forthcoming price control review for electricity distribution. Ofgem has not yet specified a detailed methodology for the application of these concepts.
- 1.4 The paper is structured as follows. The remainder of this Section 1 highlights the main conclusions of the paper. Section 2 considers the problems associated with the rolling scheme introduced by Ofwat in the 1999 review of water and sewerage charges. Section 3 outlines the design of our proposed scheme, based on an analysis of the constraints that apply to the design of a rolling methodology to ensure consistency of incentives, and issues relating to revenue profiling and the strength of incentives. Section 4 sets out in algebraic form the rules of the proposed rolling scheme, including the definition of the regulatory reserve, a tool which we have developed to improve transparency and the credibility of regulatory commitment to the rolling methodology.

Objectives of Rolling Scheme

- 1.5 Our analysis has been based on the following objectives for possible rolling schemes:
 - (a) feasibility without additional data;
 - (b) sustainability of the methodology over time (not just the next control period);
 - (c) consistency of efficiency incentives across time (no periodicity);
 - (d) consistency of efficiency incentives between operating and capital expenditures;
 - (e) consistency of incentives between expenditure and quality;
 - (f) minimisation of the risk of an artificial roller-coaster time profile for revenue limits; and
 - (g) transparency and ability to attract credibility.



- 1.6 Ofwat's aim in implementing its rolling pass-through scheme was mainly to address objectives (c) and (d). As discussed in Section 2, Ofwat's scheme is not entirely successful in meeting these objectives. Our previous work had addressed these difficulties, but not criteria (f) and (g). The present paper draws together previous work and new analysis and develops an approach that meets all the above criteria.
- 1.7 The transparency criterion (g) is critical to the success of any regulatory regime in meeting its objectives. This is reflected in our emphasis on the regulatory reserve, a concept defined in Section 4.

Proposed Scheme

- 1.8 We have concluded that Ofwat's rolling scheme, which is in part based on a rolling regulatory capital value, cannot provide complete consistency of incentives between operating and capital expenditures. Instead, we believe that it is necessary to use the same pass-through rule for deviations on both operating and capital expenditures. Our analysis shows that the main constraints on the design of the scheme relates to the treatment of operating expenditure rather than that of capital expenditure.
- 1.9 Rather than reflecting deviations from projections on capital expenditure through the regulatory capital value, our proposed scheme therefore captures them in a new regulatory reserve, from where they are passed through to customers as rolling allowances after a pre-specified lag. Operating expenditure deviations are reflected in the same regulatory reserve and passed through to customers with the same lag.
- 1.10 The time lag need not be unique, and our scheme incorporates the possibility that out-performance may be returned to customer in several instalments, spread over a number of years. This enables any artificial roller-coaster of price limits to be avoided. Thus, a general rolling scheme can be defined by a weight profile, that is, a set of weights associated with different lag periods determining the pass-through of deviations.
- 1.11 The strength of incentives, the amount of risk shared with customers and the extent of smoothing the impact on revenues of over- or under-spend can all be adjusted by varying the weight profile. We propose a profile for the return of out-performance to customers that reflects a possible depreciation profile for a network asset. Using a notional asset life of 20 years, and a minimum lag of six years, our scheme provides a roughly equal split of incentives and risks between companies and customers, and avoids artificial price roller-coasters. A shorter notional asset life would reduce the strength of incentives.
- 1.12 Whilst the assessed strength of incentives will depend on the assumptions made about the relevant discount rate and the potential for efficiency improvements, the structure of our proposed scheme ensures that consistency of incentives between operating and capital expenditures is always maintained.
- 1.13 It should be noted that our scheme achieves an improvement and strengthening of efficiency incentives without lengthening the period between price control reviews or reducing the scope to use comparative efficiency analysis as part of the reviews.



The Regulatory Reserve

- 1.14 Effectiveness of the regulatory incentive regime specified above requires regulatory commitment to the methodology. This raises significant issues when the price control review methodology is specified as a set of relatively complex algebraic formulae spanning periods of up to 20 years.
- 1.15 Whilst regulatory risk should be a significant concern, it is important not to overstate the extent to which companies discount long-term regulatory promises. Incentive regulation is always dependent on some long-term regulatory commitment, and no company would be able to invest in new assets if there was not a fairly solid expectation that a reasonable return will be allowed on these assets over periods of up to 40 years. That trust is underpinned by the regulatory capital value concept, but also depends on an expectation that the regulator would not reschedule depreciation allowances in the future without reason. Thus, the remuneration of enhancements is an example of a set of relatively complex rules that seems able to sustain a degree of trust in regulatory commitment.
- 1.16 In order to facilitate a credible regulatory commitment to the rolling scheme, we have designed a concept similar to the regulatory capital value, which we term “regulatory reserve”, to record amounts owed under the rolling scheme. The regulatory reserve acts as a mechanism to record the net amount of rolling credits and debits that the company has accumulated over the past and will be entitled to receive (or repay) in the future.
- 1.17 Under our scheme, deviations from regulatory projections on capital expenditure would feed through the regulatory reserve and would not affect the regulatory capital value, which would be calculated solely on the basis of regulatory assumptions for capital expenditure and depreciation allowances.
- 1.18 Section 4 provides an algebraic specification of the rules that govern rolling allowances, the regulatory reserve and the regulatory capital value under our scheme.
- 1.19 Regular calculation and publication of the regulatory reserve would meet the following objectives:
- (a) It would provide information to investors about the value embedded in companies in the form of entitlements to future rolling allowances in revenue limits. As this value would otherwise be hidden, this information improves the transparency of the price control regime, and therefore its effectiveness in providing incentives to management.
 - (b) It would help underpin trust in future rolling allowances, and therefore ensure that companies and managers respond in practice to the efficiency incentives that rolling allowances provide.
 - (c) It would limit the risk of opportunism by future regulators, since renegeing on the payment of rolling allowances in the future would be revealed through a continually rising regulatory reserve, as the company’s rights would accumulate without being consumed through the inclusion of rolling allowances to revenues.



Interaction with Comparative Efficiency Analysis

- 1.20 Our proposed scheme is entirely consistent with the use of comparative efficiency analysis for the purpose of setting efficiency improvement projections for each company that reflect the estimated ability of “efficiency laggards” to “catch-up”.
- 1.21 However, consistency of incentives will only be achieved if the rolling pass-through scheme is implemented together with a clear and consistent approach to setting expenditure assumptions, which does not introduce other distortions. In particular:
- (a) A clear distinction must be drawn between “recurring expenditures”, defined as a set of expenditures which relate to the ongoing provision of services, and “forward-looking expenditures”, defined with a link to the provision of additional or enhanced outputs. Assumptions for recurring expenditures must be based on past expenditure levels, without ad hoc adjustments, rolled forward to reflect the assessed potential for efficiency improvement. Assumptions for forward-looking expenditure must be based on a forward-looking assessment of the work required to deliver the additional or enhanced outputs.
 - (b) Any comparative efficiency analysis used to assess the potential for “catch-up” efficiency improvement by individual companies must (insofar as is possible) recognise the scope for trade-offs between quality and expenditure and between expenditures in different categories or in different periods, as well as any differences in the nature and state of the physical assets of each company.
 - (c) Assumptions for “forward-looking expenditure” relating to new outputs or obligations must be set on a “yardstick” basis without reference to past expenditure levels of the specific company (but industry-wide benchmarks can of course be used).
 - (d) The overall methodology must be sufficiently robust and transparent to provide the requisite level of commitment and confidence that future regulators would not renege on promises or deviate from established principles without good cause.
- 1.22 Improving the consistency of incentives through a rolling scheme as specified in this paper could also facilitate comparative efficiency analysis by removing some of the incentives for companies to distort their accounting practices.

Potential Additional Elements

- 1.23 The scheme specified in this paper achieves consistency of incentives on a pre-tax basis, assuming, for ease of exposition, a simplified regulatory regime without explicit revenue drivers or quality incentive schemes in the price control formula. Elements such as the effect of revenue drivers, the incorporation of service levels incentive schemes, or a different set of rules for the pass-through of industry-wide and company-specific deviations from regulatory projections, could all be added to the scheme without undermining its incentive properties.



2 OFWAT'S METHODOLOGY

- 2.1 In the 1999 review of water and sewerage charges, Ofwat introduced a rolling allowance scheme with a view to improving the quality of incentives given to companies in two respects:
- (a) It would reduce the periodicity of incentives arising from the fact that, under the previous methodology, the benefit of an efficiency improvement would be retained by companies for the remainder of the control period only, making the incentives for efficient management stronger near the beginning of the control period than near its end.
 - (b) It would improve the consistency of incentives between operating and capital expenditures, and thereby encourage companies to make efficient decisions based on life-time costs of different solutions; under the previous methodology, marginal expenditure treated as capital would earn a return from the beginning of the next control period whereas marginal operating expenditure would be lost for the company.
- 2.2 Both types of distortions could have led to inefficient behaviour as well as encouraged distortions in the reporting of data, particularly with regards to capitalisation policies. Thus, if effective, Ofwat's scheme would bring two benefits:
- (a) stronger and more consistent efficiency incentives; and
 - (b) an increase in the quality of accounting data reported by companies.
- 2.3 Ofwat's scheme is generally considered successful and Ofwat has proposed to continue with substantially unchanged arrangements.

Summary of Ofwat's Methodology

- 2.4 Our understanding of Ofwat's 1999 scheme for out-performance of regulatory assumptions in the 1995-2000 control period is as follows.
- 2.5 For operating expenditure, companies were allowed to recover in each future year an amount equivalent to the difference in out-performance between the period five years earlier and the year used as the base year in the review (1998-1999). The intuition for the scheme is as follows. In order for a company to face a similar reward for out-performance in years two, three, four and five of a price control period as it does in year one, it is appropriate to roll through the returns from out-performance in these latter years into the subsequent price control period. Specifically, in each of the first four years of the subsequent price control period, additional allowances are provided for any out-performance realised exactly five years earlier. The additional allowance in each of these years is calculated as the out-performance achieved at the end of the price control period (i.e. the base year) less any out-performance that had already been achieved five years earlier (this second component is deducted to maintain the policy of allowing out-performance to be rewarded for a period of five years only). Thus, for example, the



incentive allowance for 2002-2003 was calculated as out-performance in 1998-1999 less out-performance in 1997-1998.

- 2.6 For capital expenditure, companies were allowed the normal rate of return on the basis of projected capital expenditure for the first five years, and on the basis of actual capital expenditure, if lower, thereafter. Ofwat states that depreciation allowances were adjusted to reflect differences in capital expenditure, but not for changes in accounting or current cost valuation policy, and that a notional asset life was used for that purpose. Our interpretation is that, if for example there was a £1,000 capital under-spend in 1997-1998, and if the notional asset life was 20 years, then the regulatory capital value would be reduced by £750 in 2002-2003 (calculated as £1,000 less £250 of accumulated depreciation over five years), and depreciation allowances would be reduced by £50 a year for the following 15 years. (However, the published documentation leaves a degree of doubt as to the exact treatment of depreciation, and a possible alternative interpretation would differ from the above description by assuming that the lagged deduction from the regulatory capital value is equal to the full amount of capital expenditure under-spend, without any adjustment for a notional amount of depreciation.)
- 2.7 Further adjustments were made to remove the effect of deviations in expenditure attributable to logged-up schemes (i.e. expenditure projected to be required to meet new outputs or obligations that had not been reflected in the determination of price limits).

Incentive Effects and Revenue Profiles

- 2.8 From our understanding of Ofwat's methodology, capital expenditure lower than the regulatory assumption by an amount X would result in a decrease in the regulatory capital value by $X \cdot (1 - p/NAL)$ after a lag of p years, where NAL is the notional asset life (in years) used to calculate the depreciation adjustment in the rolling scheme. This adjustment equalises regulatory capital value and the book value of the asset if the deemed asset life used in the rolling scheme corresponds to the accounting life of the asset.
- 2.9 For operating expenditure, by contrast, a marginal deviation of X between assumed and actual expenditures would be reflected in revenues in full after a lag of p years.
- 2.10 Assuming an allowed cost of capital of 6.5 per cent, a notional depreciation period of 20 years, and a rolling lag of five years, the implied proportion of any out-performance recovered in each future year would be as shown in Table 2.1. (The proportion of a capital expenditure deviation passed-through is determined as the sum of a depreciation effect of 5 per cent and a "return on regulatory capital value" effect which varies between approximately 0 and 5 per cent over the period.)

**Table 2.1: Implied sharing ratios in Ofwat's rolling scheme**

Lag	Proportion passed-through (capital expenditure)	Proportion passed-through (operating expenditure)
After 1 years	0.00%	0.00%
After 2 years	0.00%	0.00%
After 3 years	0.00%	0.00%
After 4 years	0.00%	0.00%
After 5 years	10.20%	100.00%
After 6 years	9.88%	0.00%
After 7 years	9.55%	0.00%
After 8 years	9.23%	0.00%
After 9 years	8.90%	0.00%
After 10 years	8.58%	0.00%
After 11 years	8.25%	0.00%
After 12 years	7.93%	0.00%
After 13 years	7.60%	0.00%
After 14 years	7.28%	0.00%
After 15 years	6.95%	0.00%
After 16 years	6.63%	0.00%
After 17 years	6.30%	0.00%
After 18 years	5.98%	0.00%
After 19 years	5.65%	0.00%
After 20 years	5.33%	0.00%
Total recovered	124.20%	100.00%
Weighted average lag	11.6 years	5 years
NPV incentive at 3% (*)	14%	16%
NPV incentive at 6% (*)	38%	30%
NPV incentive at 9% (*)	55%	40%

(*) Illustrative real discount rates of 3 per cent, 6 per cent and 9 per cent have been used to calculate net present values.

Source: Europe Economics calculations.

- 2.11 The figures labelled as “NPV incentive” in Table 2.1 indicate the proportion of the net present value of any expenditure deviation that is retained by the company. Illustrative figures are shown for different possible discount rates; the appropriate discount rate to be applied would depend on the company’s perception of regulatory risk. (This discount rate is not closely related to the allowed cost of capital used in calculating revenues; the latter reflects the costs of financing the wide variety of risks, including engineering and input price risks, and is not the same as the time value of money that is only exposed to regulatory risk.)
- 2.12 Table 2.1 demonstrates that Ofwat’s scheme cannot be expected to give rise to consistency of incentives between operating and capital expenditures, except if by



coincidence the net present values of cashflows profiled according to the two sets of weights were to be the same.

- 2.13 The direction of the bias between incentives on operating and capital expenditures depends upon the discount rate implicit in companies' choices between different profiles of future revenue limits. Based on the estimates in Table 2.1, incentives are stronger on capital expenditure efficiency than on operating expenditure efficiency, unless the relevant discount rate is very low (approximately 3.5 per cent real, which implies low regulatory risk).
- 2.14 The potential alternative interpretation of Ofwat's scheme mentioned above, under which the regulatory capital value would be adjusted at the end of the lag period without making a corresponding adjustment to a notional amount of accumulated depreciation, would give rise to the pass-through of a greater percentage of capital expenditure deviations (174.75 per cent instead of 124.20 per cent in Table 2.1), but with a longer average lag (14.9 years instead of 11.6). Again, the direction and scale of distortions cannot be determined with certainty without further analysis, but it is clear that this alternative scheme would not provide structural consistency of incentives either.

Impact of Asymmetries

- 2.15 Ofwat's policy to date has been to adjust revenues to reflect capital expenditure out-performance (compared to regulatory projections), but not to allow companies to receive a return on capital over-spends even after five years have elapsed, unless the over-spends are justified by logging-up or by reference to discretionary output improvements that can be demonstrated do be valued by customers. The marginal rate of pass-through is zero if the company is in an unjustified over-spending state over the course of the control period.
- 2.16 Thus, if a company is over-spending on capital expenditure without a justification in terms of outputs, perhaps because it has discovered unexpected opportunities for efficient capital substitution, then the marginal incentive to control capital expenditure becomes much stronger than that for operating expenditure. This places artificial restrictions on the scope for capital substitution by companies, and can lead to distortions between operating and capital expenditures, and consequently to inefficiency.
- 2.17 It seems plausible that this asymmetry was introduced by Ofwat to limit the risk of excessive capital expenditure, given *inter alia* the possibility that the scheme as currently specified does not provide consistent incentives for operating and capital expenditures.
- 2.18 An alternative, and more effective, way of controlling this risk would be to ensure consistency of incentives between operating and capital expenditures, so that it would not be in companies' interests to invest beyond what is efficient.

Impact of Assumed Efficiency Improvements

- 2.19 Finally, there appears to be a technical distortion in Ofwat's scheme for the calculation of rolling allowances for operating expenditure, as the treatment of deviations in a base year



for a price control review is not exactly the same as that implied by Table 2.1 for operating expenditure in other years.

- 2.20 The reason for this discrepancy is that the operating expenditure rolling allowance in each year is calculated as the difference between under-spend five years before and under-spend in the year used as reference for the price control review. No adjustment is made to account for the decrease in costs that has been assumed in calculating expenditure assumptions as a result of projected efficiency improvements.
- 2.21 Thus, a saving of £100,000 in the reference year would lead to an increase of £100,000 in the rolling allowance in each year of the next control period, whereas in fact the regulatory assumption for operating expenditure would be smaller as a result of assumed efficiency improvement. For example, if an efficiency improvement of 5 per cent had been assumed between the base year and the first year of the control period, then the company would gain a net income of £5,000 in that year. As a result, the profile of pass-through is different for out-performance in a base year and out-performance in any other year, introducing a further distortion in incentives.

Summary of Problems with Ofwat's Scheme

- 2.22 In summary, we have found that Ofwat's scheme cannot be expected to meet the objectives of addressing periodicity of incentives and trade-offs between operating and capital expenditures, for three reasons:
- (a) The time profile of pass-through is different for operating and capital expenditures.
 - (b) The time profile of pass-through is different for operating expenditure in a base year and in any other year.
 - (c) There is an asymmetry of treatment between deviations in different directions.



3 OUTLINE OF PROPOSED SCHEME

- 3.1 This section considers how the problems of Ofwat's scheme highlighted in Section 2 may be addressed, and the constraints that apply to the design of a consistent efficiency incentive regime for the regulation of long-lived monopoly infrastructures.

Possible Adaptation of Ofwat's Methodology

- 3.2 A simple rolling scheme based on Ofwat's approach but which achieves the objective of equalising incentives across time and across expenditure categories is one under which any over- or under-spending would, at the margin, lead to a corresponding one-off addition or deduction from revenues after a fixed lag.
- 3.3 This result can be achieved by using Ofwat's rolling methodology for operating expenditure, corrected by an adjustment for assumed efficiency improvements, and applying it to both operating and capital expenditures. (If a variable rate of efficiency improvement is assumed for different future years then there will be some marginal differences in incentives between years, but no significant distortion of incentives.)
- 3.4 For example, with a five-year lag, an unexpected saving of X in 2002/2003, whether on operating or capital expenditure, would lead to a reduction of X, scaled down to reflect the assumed rate of efficiency improvement over time, in 2007/2008 revenue limits (compared to what these limits would have been without the earlier under-spend).
- 3.5 Under such a scheme, the regulatory capital value would not be adjusted to reflect actual capital expenditure, as the pass-through of capital expenditure deviations would be achieved directly through revenues at the end of the lag period. This feature may explain why Ofwat does not appear to have considered the scheme outlined here, given that Ofwat historically started from the concept of a rolling regulatory capital value and only subsequently developed the concept of a rolling allowance for operating expenditure.
- 3.6 Furthermore, whilst this adapted scheme would provide consistency of incentives across time and between operating and capital expenditures, it does not satisfy the other objectives set out in Section 1. In particular, it is likely to lead to an undue roller-coaster of prices if the time profile of a major capital expenditure programme differs significantly from what had been assumed in setting price controls.

Constraints on Incentives for Recurring Expenditure

- 3.7 To address the remaining objectives set out in Section 1, we first analyse the way in which the economic nature of long-lived monopoly infrastructures constrains the form of incentives that can be applied with respect to the recurring expenditures necessary to continue delivering services to customers.



- 3.8 The starting point for such an analysis is the theoretical concept of pure yardstick regulation, under which each company's revenues would be set only on the basis of external benchmarks, without reference to its own costs. In effect, this would bring the treatment of expenditure assumptions in line with that of the allowed cost of capital, which, in principle, is estimated by reference to the terms on which companies can raise finance in (competitive) capital markets, disregarding each company's past returns on capital. Such a yardstick approach would provide strong and consistent efficiency incentives, as any efficiency improvement would have no impact on future revenues under pure yardstick regulation.
- 3.9 But pure yardstick regulation is not sustainable for monopoly infrastructure businesses. Potential differences in operating environment make it impossible to determine a benchmark for expenditure levels that can be trusted in the long run to enable each company to earn a reasonable return on capital (and no more) if it is reasonably efficient. In other words, pure yardstick regulation could lead to excess profits for some companies and bankruptcy for others, and cannot, therefore, meet regulatory objectives.
- 3.10 To avoid this problem, a hybrid approach is required, under which any sustained deviation between actual expenditure and benchmark expenditure is resolved in favour of using actual expenditure, but only with a time lag so as to maintain cost control incentives. This leads to a regime under which regulatory expenditure assumptions in each year are determined in part by reference to expenditure of the same company in previous years.
- 3.11 Such a regime should apply to all expenditures comprising "recurring expenditure", i.e. expenditures for which past expenditure levels are used as the basis for projections of future expenditure, adjusted for assumed efficiency improvements. In the case of water and sewerage, this concept of "recurring expenditure" could therefore be identified with total base service expenditure. But other concepts of "recurring expenditure" may also be acceptable, depending on the economics of each industry and on the overall regulatory approach to setting expenditure projections.
- 3.12 Comparisons of costs and efficiency have a key role to play under this hybrid approach, as the potential for efficiency improvement assumed in rolling forward past expenditure into future expenditure assumptions may be set on the basis of comparisons with other industries combined with the results of comparative efficiency analysis within the relevant regulated sector.
- 3.13 The extent of risk and benefit sharing between companies and customers can be adjusted by altering the balance given to older or more recent past expenditure levels when setting revenues. A longer time lag leads to more powerful incentives, whilst a short time lag is closer to cost-of-service regulation and thus provides lower risks and weaker incentives.



Outline Design of Schemes for Recurring Expenditure

- 3.14 A general form of regulatory incentive regime would entail setting revenues for each year on the basis of a weighted average of expenditure in a range of preceding years, in each case with an efficiency/growth adjustment applied when rolling forward the expenditure from past years. For revenues to reflect overall costs, a set of weights for each lag adding up to 100 per cent must be used. Once determined, the weights should remain the same over time (at least for the foreseeable future) in order to ensure consistency of incentives.
- 3.15 To implement this principle in the context of a medium-term price control review framework, and to ensure that there is no accidental claw-back of efficiency improvement through changes “in hindsight” of assumed rates of efficiency improvement, we suggest a separate determination of two components of revenue allowances (see Section 4):
- (a) a basic expenditure projection set at each price control review by applying projected efficiency improvements to expenditure in a base year (being the last year for which data are available at the time of the review); and
 - (b) a rolling allowance calculated on the basis the combination of a weighted average of past deviations between actual expenditure and regulatory expenditure projections.
- 3.16 In that way, the basic expenditure projections can be set at each price control review on the basis of a best forecast of future efficiency improvements, applied to actual recurring expenditure in the base year (the last year for which expenditure data are available), without a need to be concerned about the ratchet effect. This is because the rolling allowance, calculated in a mechanistic manner along the lines of Ofwat’s scheme for operating expenditure (but taking account of projected efficiency gains and allowing negative values), provides a compensatory term that ensures that base year expenditure, even though it feeds into expenditure projections, does not affect revenue limits in the years immediately after a price control review.
- 3.17 The algebra to achieve these results is provided in Section 4. It includes the concept of a regulatory reserve, which may be positive or negative, and which “stores” amounts owed to or from the company between the time of a deviation in expenditure and the time at which the effect of the deviation is passed-through to customers. Thus, for example:
- (a) Lower than expected total expenditure in a year that is not a base year for any price control review reduces the regulatory reserve, as the company will return the benefit of that saving to customers after the rolling period (i.e. there is a debt to customers).
 - (b) Lower than expected recurring expenditure in a year used as base year for a price control review increases the regulatory reserve, to “fund” positive rolling allowances that raise revenues up to what they would have been without the base year under-spend (which led to lower expenditure projections) until the end of the rolling period.
 - (c) A positive rolling allowance (which increases revenues) reduces the reserve (it uses it up). A negative rolling allowance (revenue reduction) increases the reserve.



Incentives for Forward-looking Expenditure

- 3.18 The above discussion was concerned with recurring expenditures, i.e. the operating and capital expenditures necessary to maintain services to customers. Different issues arise for the remainder of total expenditure, which we term “forward-looking expenditure” as it is linked to the provision of new or changed outputs set on a forward-looking basis at the time of the review.
- 3.19 The constraints discussed above would not apply to the treatment of forward-looking expenditure if it could be considered separately. In fact, for a one-off project, all that is needed for a satisfactory incentive structure is an absolute expenditure benchmark determined at the outset, and there would seem to be no problem with sharing out- or under-performance between companies and customers according to any agreed rule.
- 3.20 However, doing so in parallel with a rolling scheme for recurring expenditure could introduce distortions in incentives. This is because the difference in incentives could distort behaviour, for example choices relating to the quality of the assets to be purchased (in the light of the impact of asset failure on operating expenditure), or the allocation of expenditures between different categories.
- 3.21 To avoid such distortions and inefficiencies and ensure that different options are assessed on a whole-life basis, it is therefore necessary to apply the same weighted-average lagged pass-through to deviations on forward-looking expenditures as for recurring expenditure. This is achieved in the algebra provided in Section 4 by adjusting the regulatory reserve to reflect capital expenditure under-spends (which reduce the reserve) or over-spends (which increase it). Amounts put in reserve in that way are then passed through to revenues over the range of lags defined by the chosen weights profile, which must be the same for all categories of expenditure.
- 3.22 It is important to note that, given these arrangements, the regulatory capital value should not be adjusted to reflect any under- or over-spend, as this would constitute double counting. Thus, for example, a lower than expected capital expenditure is captured in a negative regulatory reserve, which is then passed through to customers over time; it should not simultaneously lead to a reduction in the regulatory capital value (or in any regulatory depreciation allowances), even after a lag.
- 3.23 Thus, under our proposed scheme, the “regulatory capital” of each company is made up of two components, each with a distinct role:
- (a) The regulatory capital value reflects regulatory assessments of capital expenditure requirements (as well as the associated regulatory depreciation allowances, and the historic regulatory value of companies), unadjusted for any differences between projected and actual expenditures.
 - (b) The regulatory reserve captures the effect of all deviations between actual and projected expenditures across all expenditure categories, and passes them through to customers after a lag or lags (defined by the chosen weights profile).



Profiling of Revenues and Strength of Incentives

- 3.24 The profile of weights used to pass expenditure deviations through to customers is in some way similar to a depreciation profile, as out- or under-performance “earned” in the past is “drip-fed” in revenues through rolling allowances until 100 per cent of it has been recovered (subject to scaling down for projected efficiency improvements).
- 3.25 The choice of weights profile should be informed by a number of criteria, including the desired strength of incentives and the time profile of future revenues.
- 3.26 The shape of time profile is particularly important to avoid an artificial roller-coaster for prices. For example, if there is substantial capital expenditure under-spending in a single year, then it would be unhelpful for the totality of such an under-spend to be recovered after a single fixed lag of p years, as this would lead to a potentially large one-year dip in prices, followed by a similarly large rise. It might be possible to address this issue through ad hoc smoothing of revenues within the relevant control period, but even then problems could still arise if there was a period of substantial under- or over-spending, requiring smoothing of revenues between control periods, which raises significant issues of regulatory commitment.
- 3.27 A natural way of designing a weight profile that would avoid such problems is to use the profile generated by Ofwat’s rolling regulatory capital value scheme (as set out in Section 2), which appears unlikely to lead to an undue roller-coaster. However, as noted above, the pass-through ratios shown in Table 2.1 cannot be used directly as weights, as they do not add up to 100 per cent.
- 3.28 Furthermore, the scheme is significantly simpler if the minimum lag is set to six years rather than five. This is because (given a system of five-yearly price control reviews) prices need to be set in year t for years $t + 1$ to $t + 5$, at a time where expenditure data for year t cannot be available (as year t is not finished when the review has to conclude). Ofwat makes ad hoc adjustments to take account of these issues, which lead to additional complexity and potential distortions to incentives, and it seems preferable to avoid the problem altogether by using a minimum lag of six years. (If expenditure data for 2003/2004 cannot be used in setting price limits from April 2005 then a seven-year lag may be preferable.)
- 3.29 We have therefore determined our preferred weight profile by normalising the weights derived from an Ofwat-like rolling regulatory capital value regime with a six-year lag and a deemed depreciation period of 20 years. Using 6.5 per cent for the allowed return of capital, this leads to the profile shown in Table 3.1.

**Table 3.1: Proposed weight profile**

Lag	Weight
After 1 years	0.00%
After 2 years	0.00%
After 3 years	0.00%
After 4 years	0.00%
After 5 years	0.00%
After 6 years	8.66%
After 7 years	8.38%
After 8 years	8.09%
After 9 years	7.81%
After 10 years	7.52%
After 11 years	7.24%
After 12 years	6.95%
After 13 years	6.67%
After 14 years	6.38%
After 15 years	6.10%
After 16 years	5.81%
After 17 years	5.53%
After 18 years	5.24%
After 19 years	4.96%
After 20 years	4.67%
Total recovered	100.00%
Weighted average lag	12.2 years
NPV incentive at 4% (*)	40%
NPV incentive at 8% (*)	62%
NPV incentive at 12% (*)	75%

(*) The pseudo-discount rates shown for these NPV calculations reflect the combination of a real discount rate and an efficiency improvement assumption.

Source: Europe Economics calculations.

- 3.30 The illustrative pseudo-discount rates used in Table 3.1 to estimate the strength of incentives in NPV terms are higher than the illustrative rates shown in Table 2.1. This reflects the fact that, under our proposed scheme, expenditure deviations are scaled down by the effect of projected efficiency improvements before being passed-through to customers with a lag. Thus, for example, a pseudo-discount rate of 8 per cent could represent the combined effect of (approximately) a 6 per cent assumed real discount rate and a 2 per cent assumed annual expenditure reduction.



4 PROPOSED SCHEME RULES

4.1 This section provides an algebraic specification of the scheme outlined in Section 3.

Notations

4.2 We use the following notations:

t refers to a financial year ($t + 1$ is the following financial year, etc)

TE_t is total expenditure in year t (including all operating and capital expenditures, whether of a recurring nature or not)

RE_t is recurring expenditure in year t (whether operating or capital expenditures)

REA_t is the recurring expenditure assumption in year t

FEA_t is the forward-looking expenditure assumption in year t

DA_t is the regulatory depreciation allowance in year t

RA_t is the rolling allowance in year t

RCV_t is the closing regulatory capital value (also known as RAB) in year t

RR_t is the closing regulatory reserve in year t

r_t is the pre-tax allowed cost of capital in year t

e_t is the efficiency improvement assumption for year t

w_p is the weight in the selected weight profile for a lag of p years (with $\sum_p w_p = 1$)

RL_t is the revenue limit in year t

4.3 In the following equations all values are expressed in constant prices; in practice there would need to be additional factors in some equations to take account of changes in the RPI.

4.4 A year is said to be a base year if it is the last year for which expenditure data are available at the time of finalising the outcome of a price control review. For example, the financial year ending March 2004 is taken to be the base year for setting expenditure projections for the period from April 2005 to March 2010. (It may be that only data for the year ending 2003 would be available in practice, in which case some amendments are needed to the algebra presented here.)



Expenditure Assumptions

- 4.5 The recurring expenditure assumption in year t of the forthcoming control period is determined by reference to the relevant base year t_0 for the review as follows:

$$REA_t = (1 - e_t)(1 - e_{t-1}) \dots (1 - e_{t_0+1}) RE_{t_0}$$

- 4.6 This formula rolls forward the base year recurring expenditure by applying an annual efficiency assumption.
- 4.7 The efficiency improvement assumption e_t has a slightly different meaning in the first year of each control period. If t_0 is a base year, $t_0 + 2$ is the first year of the following control period, then the combined effect of e_{t_0+1} and e_{t_0+2} should reflect the expected efficiency improvement, assessed in t_0 , between t_0 and $t_0 + 1$. Given that e_{t_0+1} had to be set at the previous review (in $t_0 - 5$) there may therefore be a difference between e_{t_0+2} and the actual efficiency improvement expected between $t_0 + 1$ and $t_0 + 2$.
- 4.8 The forward-looking expenditure assumptions FEA_t are determined on the basis of a regulatory assessment of the expenditure required to meet new obligations and output requirements (beyond any changes that are rolled into the services covered by recurring expenditures and taken into account in setting efficiency improvement assumptions), without reference to the company's own past expenditure in any category.

Regulatory Capital Value and Depreciation Allowances

- 4.9 The depreciation allowance DA_t attributable to each component of the forward-looking expenditure assumption in each previous year on the basis of the projected life and depreciation profile for the relevant asset class or expenditure category:

$$DA_t = \sum_p DAE_t(p)$$

where each depreciation allowance element $DAE_t(p)$ is given by

$$DAE_t(p) = \sum_c d_p(c) FEAE_{t-p}(c), \text{ where}$$

c refers to an asset class or expenditure category

$d_p(c)$ is the depreciation rate (expressed as a percentage of gross expenditure) for asset class or expenditure category c in year p of its life (use an "instant depreciation" profile for the operating expenditure components of forward-looking expenditures)

$FEAE_t(c)$ is the enhancement expenditure assumption attributable to asset class or expenditure category c in year t

- 4.10 The closing regulatory capital value in year t is given by:

$$RCV_t = RCV_{t-1} + FEA_t - DA_t$$



Regulatory Reserve and Rolling Allowances

4.11 The rolling allowance in year t is calculated as follows:

$$RA_t = \sum_p w_p RAE_t(p)$$

where each rolling allowance element $RAE_t(p)$ is given by

$$RAE_t(p) = (1 - e_t) \dots (1 - e_{t-p+1})(TE_{t-p} - REA_{t-p} - FEA_{t-p}) + \\ + \sum_{t_0} (1 - e_t) \dots (1 - e_{t_0+1})(REA_{t-p} - RE_{t-p})$$

where the sum extends to all base years t_0 comprised between $t-p-1$ and $t-2$ inclusive.

4.12 The closing regulatory reserve in year t is:¹

$$RR_t = (1 - e_t)RR_{t-1} - RA_t + (TE_t - REA_t - FEA_t) + WAL (REA_t - RE_t) \text{ if } t \text{ is a base year}$$

$$RR_t = (1 - e_t)RR_{t-1} - RA_t + (TE_t - REA_t - FEA_t) \text{ otherwise}$$

where

$$WAL = \sum_p w_p p \text{ is the weighted average lag.}$$

4.13 A key feature of the regulatory reserve is that it reverts to zero as the effect of past out- or under-performance is passed-through to customers according to the rules of the rolling scheme. Thus, for example, a positive regulatory reserve is a credit that the company will be entitled to recover through positive rolling allowances in the future.

Determination of Revenue Limits

4.14 In each year the revenue limit (before adjustment for any past over- or under-recovery) is calculated as:

$$RL_t = REA_t + DA_t + RA_t + r_t RCV_{t-1}$$

¹ September 2003 correction; this formula had been erroneously stated in the original version of the paper.