Charging for utilities and energy infrastructure

How taking a cohort perspective strengthens the case against current cost charging.

Jim Cuthbert, December 2013

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Summary

Since the great privatisations of the Thatcher era, the method used by regulators for reimbursing investment in UK utilities has been based on current cost pricing. That is, the regulator works out in constant price terms how much the utility should be allowed to charge in order to earn a target real rate of return on capital invested: and then this allowable charge is uprated to current prices by the actual rate of inflation.

This current cost pricing approach was the subject of an earlier Jimmy Reid Foundation paper, (J.R. Cuthbert, August 2012): that paper looked at the application of current cost pricing in the privatised water industry in England and Wales, and showed that there were extensive mistakes, both in the application of the technique by OFWAT, and in the conceptual basis of the approach itself. This resulted in the observed excess profits and overcharging in the water industry. Because the conceptual problems with the approach are not restricted to the water industry, the findings were also of general relevance to all UK utilities.

What was lacking in that earlier paper, however, was a coherent critique of current cost pricing from the point of view of the consumer. The consumers' viewpoint is vitally important because it is, of course, consumers who ultimately fund capital investment through the charges they pay for the utility. But how a consumer will view a particular charging method appears to depend critically on the discount rate which describes the consumer's time preference for money: that is, the extent to which the consumer would rather have a pound today, rather than a pound next year. And since consumer discount rates are unknown, and will vary greatly between different individuals, it has in the past seemed difficult to draw unambiguous conclusions about consumer preferences.

What this paper shows is that this ambiguity in fact resolves if two further features of the real world are taken into account: (a) that investment programmes contain a large element which is stable from year to year and (b) and that consumers in effect form cohorts, who enter the system, pay charges for a number of years, and then exit.

When these features are taken into account, the paper demonstrates that, for most cohorts of consumers, current cost pricing will appear very expensive relative to another standard approach, historic cost pricing. And this conclusion is largely independent of whatever discount rate actually represents consumers' time preferences. The paper therefore represents very strong additional evidence against current cost pricing: and it adds considerable weight to the call made in the earlier paper for a thorough review of current cost pricing as applied in UK utilities.

The relevance of this paper goes beyond utilities, and also extends to the energy sector – since a version of current cost pricing is also used in setting strike prices for renewable and nuclear energy projects.

Foreword.

This paper is concerned with analysing some of the properties of current cost charging: this is the method applied by regulators in all UK utilities to determine how much utility operators should be allowed to charge to cover the cost of capital investment. A variant of the method is also applied in setting prices for much energy investment.

That there are flaws in the current cost approach is now very much evident. Circumstantial evidence for this is provided by the extremely high profits earned in many privatised utilities – and the resulting high customer charges. An earlier Reid Foundation paper by the present author, (Cuthbert, 2012), took the water industry in England and Wales as an example, and identified both mistakes in the application of the current cost approach by OFWAT, and flaws in the current cost methodology itself, which accounted for such excess profits.

This paper does not repeat that earlier work, but complements it, by taking a different perspective, that of the consumer. If we are thinking of how a capital pricing method looks from the point of view of a particular consumer, a natural thing to consider is the net present value of the stream of charges resulting from a specific investment, calculated at a discount rate which represents that consumer's time preference for money.

However, if this approach is applied to a comparison between current cost charging, and one standard alternative, historic cost charging, then the results are ambiguous – because we do not know what the correct discount rate is to represent consumers' preferences: and because quite different inferences would be drawn at different discount rates.

What this paper shows is that this ambiguity resolves if two additional features of the real world are taken into account. Firstly, that there is a large element of real world investment programmes which is stable from year to year: and secondly, that consumers form natural cohorts, which enter the charge paying system, remain there for a number of years, and then leave the system.

Once these two factors are taken into account, then very clear and unambiguous conclusions emerge. Independent of the specific discount rate taken to represent consumers' time preferences for money, most cohorts of consumers will find current cost pricing a very expensive way of paying for capital expenditure.

The results of this paper therefore complement the earlier critique of current cost charging in (Cuthbert, 2012), and provide an additional very strong argument in favour of a radical and immediate review of utility pricing.

1. Introduction

1. Following the widespread privatisation of utilities in the Thatcher era, utility regulators had the problem of how they should set that element of the regulated price which reimburses utility companies for the cost of capital invested. The solution, applied first of all in the privatised water industry in England and Wales, and now applied in all UK utilities, was a method based upon current cost pricing. The utility regulator sets an allowable real return on capital invested: and each year over the life of the relevant asset, the utility company is allowed to incorporate into its customer charges an amount equal to real depreciation on the capital invested, plus the specified real return on outstanding capital, with both quantities then being uprated to current prices by the rate of inflation.

2. If inflation is running at a constant rate per annum, then what the utility operator receives by way of reimbursement through this current cost pricing mechanism represents a nominal return on the original capital sum invested equal to the specified real rate of return, plus the rate of inflation. (Strictly, if the real rate of return is r, expressed as a fraction, and the rate of inflation is i, then the operator receives a return of $r + i + ri$.) In other words, if the net present value of the stream of reimbursements is calculated, at a discount rate equal to the real rate of return uprated for inflation, then the resulting net present value is exactly equal to the original capital sum invested. This situation is often described by saying that the current cost charging method satisfies the net present value criterion for investment. (This is a standard property, but a proof can be found in Cuthbert, 2012, annex 1).

3. It is important to remember that, for any given rate of interest, there are an infinite number of different ways of reimbursing capital investment which satisfy the net present value criterion: so the fact that the current cost pricing scheme satisfies the net present value criterion cannot in itself be taken as the ultimate justification for choosing this scheme over other possibilities. Hence, in deciding between different possible ways of reimbursing utility companies for the cost of investment, it is important to look at other factors as well as the net present value criterion. And given that, ultimately, it is the consumer who pays the cost of capital investment, through the charges they pay for the utility, one very important factor which must be considered is the way different reimbursement schemes appear from the point of view of the consumer.

4. A natural way of looking at this issue from the consumer's perspective is to calculate the net present value of the stream of reimbursements resulting from a given investment, where the discount rate used in calculating this net present value is the appropriate discount rate to reflect the consumer's time preference for money.

5. Suppose this approach is applied to the comparison between current cost pricing, and one commonly considered alternative – namely, historic cost charging. Under historic cost charging, for a given nominal interest rate, the operator would receive as reimbursement each year an allowance for depreciation equal to the original sum invested divided by the length of asset life: and an allowance for interest equal to the specified nominal interest rate applied to the capital sum outstanding.

6. Let us imagine we are comparing the reimbursement profiles arising from current cost and historic cost charging, when the same nominal interest rate applies in both schemes (that is, when the nominal interest rate in the historic cost scheme is equal to the real interest rate in the current cost scheme uprated for inflation). Under historic cost charging, what consumers actually pay each year starts off higher than under current cost charging – but ends up lower. Since both the current cost and historic cost approaches satisfy the net present value criterion, the net present value of both current cost and historic cost charges, discounted at the originally specified nominal interest rate, is equal to the original capital value. So if this interest rate was the appropriate discount rate to represent a particular consumer's time preference for money, this consumer would have no basis for preferring current cost over historic cost, or vice versa, if he was paying charges over the whole life of this particular capital asset.

7. The situation is very different, however, if the discount rate representing the consumer's time preference for money is different from the originally specified interest rate. For consumer discount rates less than the original interest rate, the net present value of current cost charges is higher than the net present value of historic cost charges. And conversely, for consumer discount rates higher than the original interest rate, the net present value of current cost charges is lower than the net present value of historic cost charges.

8. What the appropriate discount rate is to represent the consumer's time preference for money thus appears to be a critical factor in determining which of current cost or historic cost charging would be preferred by consumers. Unfortunately, what the appropriate discount rate should be is not known: even worse, it is very unlikely that any single discount rate is going to adequately represent the time preferences of all consumers. In current circumstances, when real interest rates on savings are very low – indeed probably negative – cash rich consumers are likely to have a very low time preference rate: for such a consumer, who would probably be happy if they could invest their savings at a rate of return equal to inflation, a discount rate at or below inflation is likely to be appropriate. On the other hand, for consumers who are cash poor, a £ in the hand now will be worth much more than a £ tomorrow – so a time preference discount rate significantly higher than the rate of inflation is likely to be appropriate.

9. Given this uncertainty about the appropriate discount rates to represent consumers' time preferences, it might therefore appear difficult to draw any hard and fast conclusions about the relative attractiveness to consumers of current cost versus historic cost charging. What this paper argues, however, is that the situation described so far neglects two crucial aspects of the situation in the real world: and that once these aspects are taken into account, very clear conclusions do actually emerge.

10. The two aspects of the real world which is important to allow for are the facts that:

    a) it is unrealistic just to consider the problem of paying for a single capital investment. In the aggregate (that is, at the level of an industry, or a major utility company) there is a substantial amount of gross new capital investment which is stable from year to year.

    b) Secondly, an individual consumer does not pay for capital investment over the whole life of a single asset. A better model of the way consumers are exposed to utility charges is that each year a new cohort of consumers starts paying charges, will pay charges for a number of years, and will then exit the system.

11. What will be shown in this paper is that, once these two factors are allowed for, a very unambiguous picture of consumer preferences emerges. If we consider the net present value of the charges paid by a given cohort of consumers over their charge paying life, then for most cohorts that net present value will be significantly lower for historic cost as compared with current cost charging – and this is true whatever the discount rate which describes consumer time preferences.

12. The structure of this paper is as follows:

    Section 2 gives historic data on capital investment in the water industry, to illustrate the fact that there is indeed a large, stable element to investment programmes.

    Section 3 introduces the relevant formulae for current cost and historic cost charging: illustrates the comparative payment profiles that result, and also illustrates the net present values of these payment profiles calculated at different discount rates.

    Section 4 introduces the concept of cohorts of consumers, and calculates the net present value of the charges paid by successive cohorts, under both current cost and historic cost charging, in the case when a constant amount of gross real investment takes place each year. The implications are considered of varying the relevant parameters which determine this model – namely, length of period for which each cohort pays charges, the rate of inflation, the length of asset life, and the assumed real rate of return for the current cost approach. The clear conclusion emerges, which is the main conclusion of this paper: namely that, irrespective of the discount rate chosen to represent consumers' time preferences for money, most cohorts will find current cost charging significantly more expensive than historic cost charging.

Section 5 considers a special variant of utility pricing applied by the Office of Rail Regulation in charging for rail infrastructure assets. It is shown that the effects are even more marked for this variant than for the standard application of current cost charging as used in other utilities. The implications extend beyond the rail sector, because the way in which strike prices are set for investment in renewable and nuclear energy in effect involves a similar charging approach as that adopted in rail.

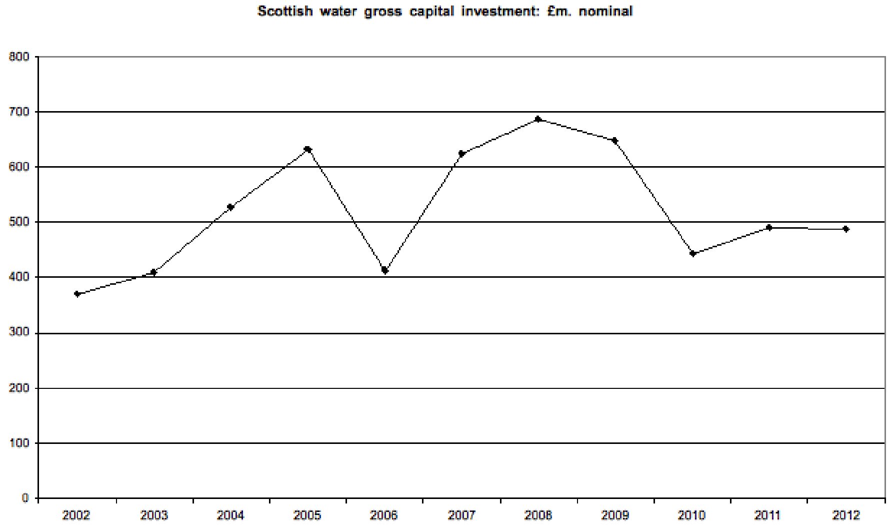
Section 6 broadens the analysis to look beyond the simple comparison between historic cost and current cost pricing. While it is convenient to restrict the analysis in most of this paper to this simple comparison, it would be wrong to imply that these are the only possible options. This section illustrates some of the implications of what would in the long run be a much cheaper alternative approach for funding the stable element of the capital investment programme: namely, funding capital expenditure direct from revenue.

Section 7 sets the analysis in this paper in the context of the earlier critique of current cost charging in (Cuthbert, 2012), and then draws conclusions.

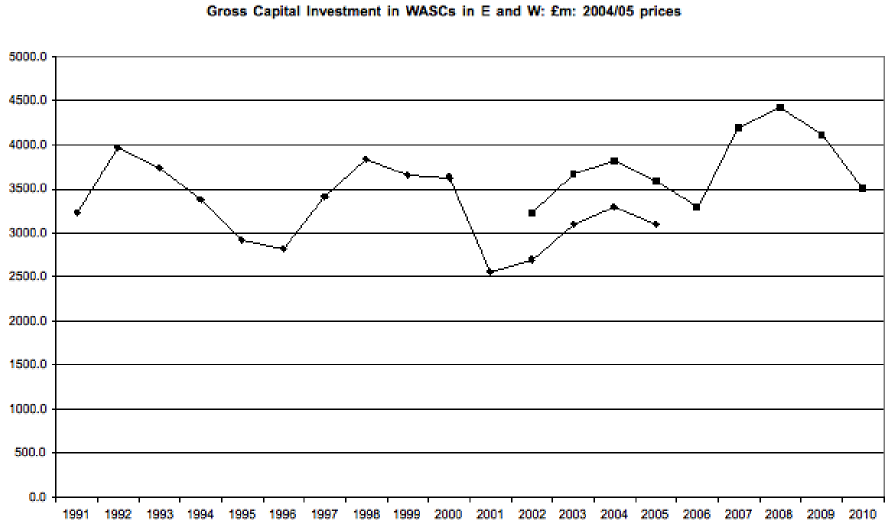
2. Aggregate investment programmes have a large stable element,

1. The fundamental thing about capital investment is that it is lumpy: and the basic problem is how to translate the discrete capital expenditure associated with a given project, which will be incurred in a very small number of years, into a smooth series of payments to be made by consumers over the lifetime of the project.

2. The lumpiness of individual capital investment projects, however, sometimes obscures another important fact about real world capital expenditure: namely that, at the level of a large utility company, or at the level of a whole industry, aggregation of individual projects results in an overall capital investment programme where there is a substantial element which is stable from year to year. Two illustrations of this fact are given here. The following chart shows gross capital investment for a large single utility company, namely Scottish Water, since its formation in 2002.



The next chart shows gross real capital investment for the water and sewerage companies in England and Wales from 1991 to 2010. (The discontinuity in this chart arises because of the way in which infrastructure renewal expenditure is handled in the figures published by OFWAT: the latter part of the series includes infrastructure renewal, the former part excludes it).



3. What is clear is that, for both these examples, there is in effect a substantial fixed element to the overall capital investment programme. For example, for the water and sewerage companies in England and Wales, aggregate capital investment has never dropped below £2.5 billion in any year: on top of this there has been a fluctuating element which has varied between zero and £2 billion.

4. In fact, it also appears likely that the fluctuations observed in both examples are to a certain extent artificial constructs, and are related to the timing of the periodic pricing reviews undertaken by the relevant regulators. In Scotland, the Water Industry Commission for Scotland, and its predecessor body, conducted five yearly pricing reviews which covered, successively, the periods 2002-06, 2006-10, and 2010-15: and in England and Wales, OFWAT conducted reviews covering successive five year periods, starting with 1995-2000. There is a plausible association between the pattern of capital investment in the above charts, and the timing of these reviews. So it is quite possible that, under another form of regulatory

regime, the already large stable elements in these capital investment programmes might be even larger.

3. The mechanics of current cost and historic cost charging.

1. The description of current cost pricing in this section is based on the approach used by OFWAT in the privatised water and sewerage industry in England and Wales: but the same method is now used by all the regulators of utilities in the UK (apart from the Office of Rail Regulation, where a variant approach is used, as described in Section 5). The basic approach is as follows:

   a) First of all, the regulator determines how much capital investment is required – this is the amount of capital investment which will be reimbursed by the pricing system.

   b) The regulator also determines a target real rate of return, at which capital investment will be reimbursed. (See OFWAT's regular final determinations on setting prices for further details: OFWAT 1994, 1999, 2004: there are further technical details on the OFWAT model in OFWAT's financial model rule book, OFWAT 2006.)

2. When a utility operator invests in a capital asset which has been approved at stage (a) above, then this results in consumers being charged each year, through the life of the asset, an amount which in real terms is equal to

   (i) a depreciation charge, equal to the capital cost of the asset, divided by the life (in years) of the asset: plus,

   (ii) an interest charge, equal to the rate of return at (b) above, applied to that portion of the original capital value which has not been paid off through the annual payments at (i).

   The depreciation and interest charges at (i) and (ii) are in real terms: what is actually included in prices are these amounts after being uprated to current prices by cumulative inflation since the original investment was made.

3. In algebraic terms,

   if n is the length of asset life, (in years),

   if r represents the target real rate of return, expressed as a fraction, (so a real rate of return of 3% would correspond to $r = 0.03$),

   if i is the annual rate of inflation, (expressed as a fraction),

   and if a utility invests in year 0 in an approved capital asset of cost K,

   then in year j it will receive through the pricing mechanism an amount equal to

$$\frac{K}{n}\,[1+r(n-j+1)](1+i)^j, \qquad j=1,\ldots n$$

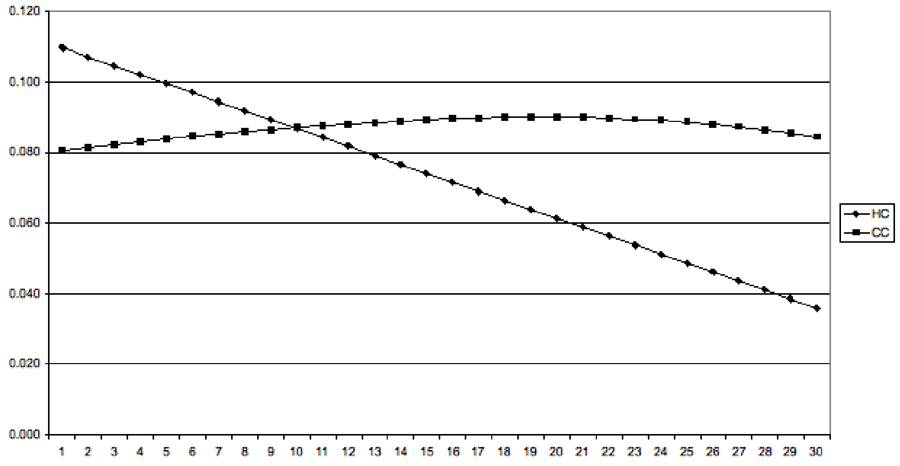
4. Much of this paper is concerned with comparing the properties of current cost pricing with another possible approach, which will be called historic cost pricing. Historic cost pricing would involve charging consumers each year the cost which the utility would have incurred by taking out a fixed interest loan, which it paid back over the life of the relevant asset, and also paid interest each year on the outstanding debt. In algebraic terms, if, as before, K represents the initial sum invested, and **n** is asset life, and if **y** (as a fraction) is the nominal interest rate on the loan, then under historic cost pricing the utility would receive each year an amount equal to

$$\frac{K}{n}\,[1+y(n-j+1)], \qquad\qquad j=1,\ldots\, n$$

The fact that historic cost pricing is used in this paper as a useful model to compare with current cost pricing should not be taken to imply that it is the only possible alternative to the current cost approach: or indeed, that historic cost pricing is the author's preferred alternative. But historic cost pricing is nevertheless an instructive alternative to focus on, for a number of reasons. First of all, because it represents a viable alternative, which used to be applied, (or something like it), in funding municipal utilities. And secondly, because utilities today tend to fund a significant part of their capital expenditure by historic cost borrowing: so that the contrast between the reimbursement flowing into a utility (determined by current cost charging) and the funding costs flowing out (a significant portion of which will be on historic cost terms) turns out to be important.

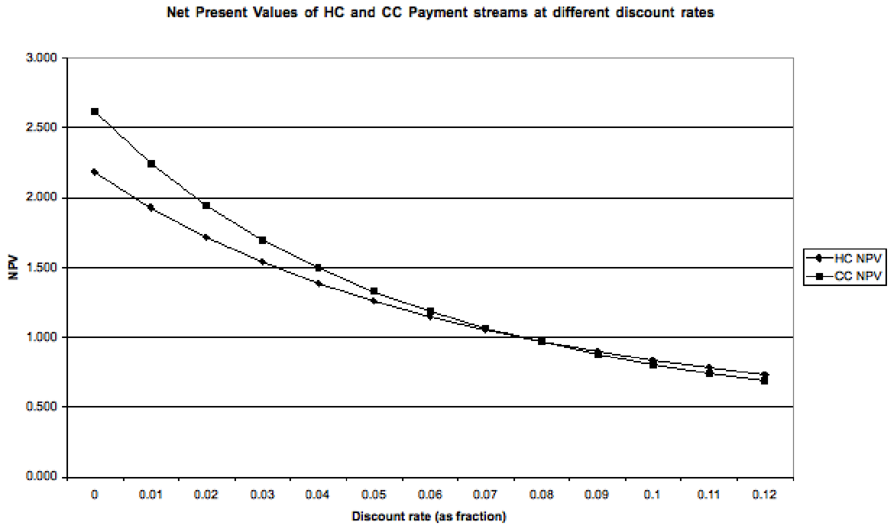
5. If inflation is running at a constant rate (say *i*) per annum, then current cost charging with a real rate of return **r** yields a nominal return on the original investment of (***i*** + ***r*** +***ir***): (see Cuthbert, 2012, annex 1 for a proof of this standard result). It follows that if, in a historic cost charging scheme, the nominal rate of interest **y** is chosen such that **y** = ***i*** + ***r*** + ***ir***, then both the historic cost and the current cost schemes will give the same return on the capital invested. However, the profiles of the payments under the two schemes are quite different. This is illustrated in the following chart, in the case of ***r*** = 0.045, ***i*** =0.03, and assuming an asset life of 30 years, (giving a nominal return under both schemes of 7.635%). For the purposes of this chart, the initial investment is taken as 1.

Current cost and historic cost payment profiles resulting from a unit investment in year 0: asset life =30, real return 4.5%, inflation 3%



Note how in the early years of the asset's life, historic cost charges are much higher than current cost, but the reverse is true for the later years.

6. In this paper, what is of particular concern is the perspective of consumers who pay, via their utility bills, for the charges relating to capital investment. For a consumer who is paying charges over the whole life of an individual capital asset, what is relevant is the net present value of the associated stream of capital payments, calculated at the discount rate which represents that consumer's time preference for money. (See Annex 1 for the definition of net present value.) The following chart shows the net present values of the current cost and historic cost payment schemes as a function of discount rate, for the same example as considered in the previous chart.



As expected, since both pricing schemes yield the same return of 7.635% on the original investment, the net present values of both current cost and historic cost charges at this discount rate are equal to the amount originally invested. However, the net present value of the current cost payment stream is higher than that of the historic cost stream for discount rates below 7.635%: and vice versa for discount rates higher than this value.

7. As noted in the introduction, no single discount rate is likely to express the time preference for money of all consumers. Cash rich consumers are likely to have a fairly low time preference rate, possibly around the rate of inflation. Cash poor consumers are likely to have much higher time preference rates. This makes it difficult, if not impossible, to draw any conclusions from the kind of material examined so far in this paper, as to how consumers as a whole are likely to regard current cost as compared to historic cost charging. As will be seen in the next section, however, this situation changes when additional features of the real world are taken into account.

4. The implications of looking at charging schemes from the point of view of cohorts of consumers.

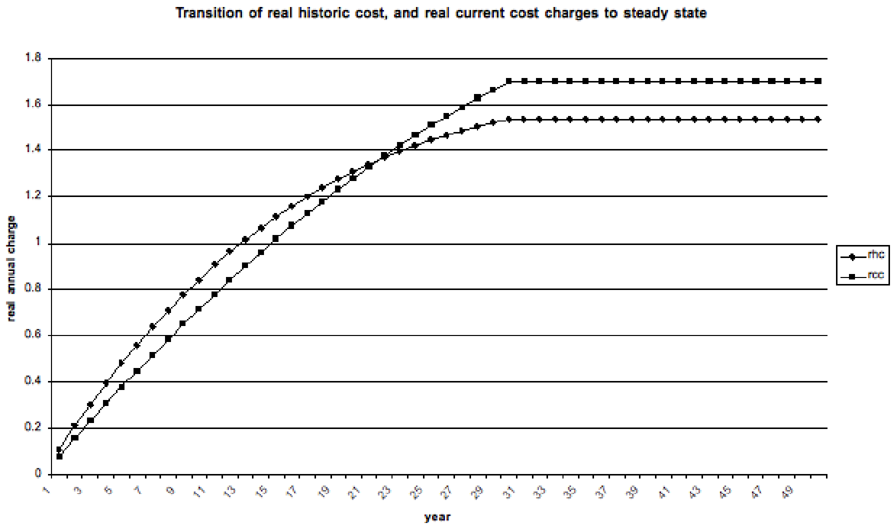
1. The situation considered in the previous section is that of a single capital investment, and a consumer paying charges over the whole life of this investment. Both of these features are unrealistic in the real world. As has been seen in section 2, there is a large ongoing element of investment which is stable from year to year: and a consumer will typically enter the charge paying system, pay charges for a number of years, and then leave the system.

2. To allow for the first of these features, what is considered from now on in this paper is a steady state model of investment, where the same real amount of gross investment is undertaken every year. More specifically, it is assumed that an initial investment of 1 is made in year 0, and that there is then gross real investment of 1 in each year thereafter (to avoid minor complications with infinite payment streams, it is assumed that this stream of investments does eventually terminate, but only after a very large number of years).

   The parameters ***n***, ***r***, ***i***, and ***y*** have the same meanings as assumed previously: that is, they represent, respectively, asset life, the real rate of return assumed for current cost charging, the rate of inflation, and the nominal interest rate assumed for historic cost charging.

   As before, it is also assumed that ***y*** is chosen so that $y = i + r + ir$. For convenience, this value is referred to as the “cost of capital”.

3. Under this steady state model for investment, both current cost and historic cost charges will eventually settle down to a constant amount per annum in real terms. This is illustrated in the following chart, again for the parameters $n = 30$, $r = 0.045$, and $i = 0.03$. (Note that the real charges in this chart are expressed at year 0 prices.)



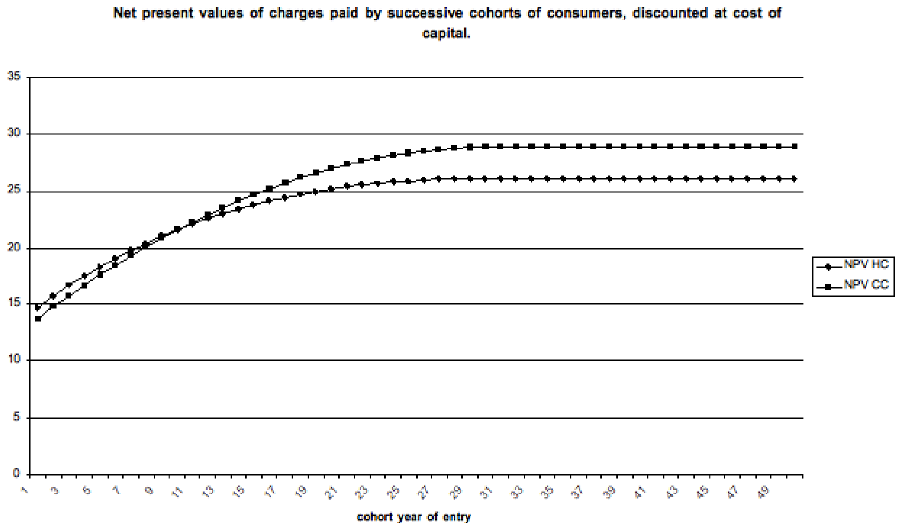
   Initially, real historic cost charges are higher than current cost charges, as would be expected. From year 21 on, however, current cost is more expensive than historic cost. Real annual charges become constant as from year 30 (which is, of course, the length of asset life assumed in this particular example). From then on, the annual current cost charge is 1.698, as compared with 1.536 for historic cost charges: that is, in the long run current cost is 10.5% more expensive each year than historic cost.

4. In net present value terms, however, if net present values are calculated using the cost of capital as discount rate (in this case, the cost of capital is 7.635%) then the net present value of the stream of current cost payments is exactly the same as the net present value of the stream of historic cost payments. So in net present value terms, if the cost of capital is taken as a reasonable description of consumers’ time preference for money, there is still no grounds for differentiating, in terms of consumer preferences, between the current cost and historic cost streams of charges.

5. This situation changes, however, when a cohort perspective is brought in. A cohort is defined as a group of consumers, entering the charge paying system in a given year, and, it is assumed, paying charges for a continuous number of years thereafter. Looking at things

from a cohort perspective therefore involves bringing another parameter into the model – namely, the number of years for which it is assumed each cohort pays charges.

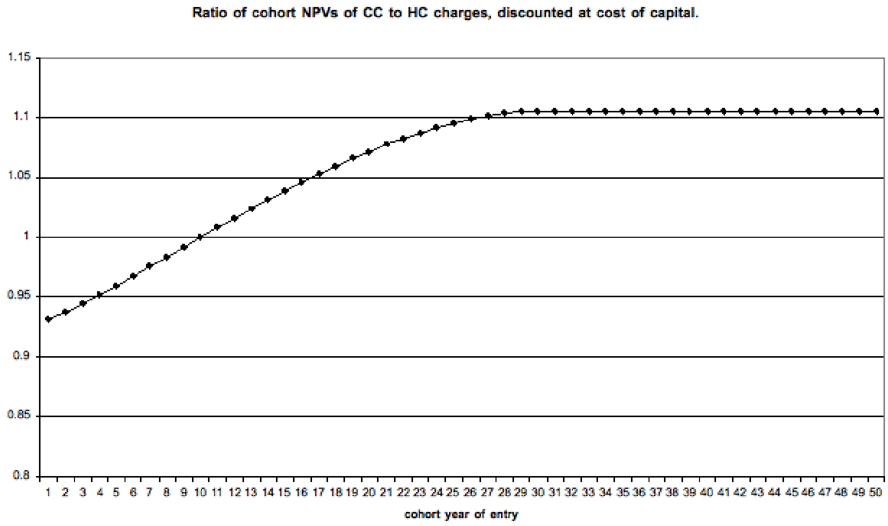
6. Continuing with the same example as illustrated in the previous chart, but now taking a cohort perspective (where it is assumed each cohort pays charges for 30 years) the following chart shows the resulting cohort net present values. The chart illustrates the net present values, calculated at a discount rate equal to the cost of capital, of the charges paid by each successive entry cohort, under both current cost and historic cost charging. (Technically, these net present values have been expressed in real terms: that is, the net present values for each cohort have been worked out at the prices of the entry year for that cohort: and then expressed in real year zero prices, so that different cohorts can be compared).



For the first nine cohorts to enter the system, the net present value of historic cost charges is greater than the net present value of current cost charges: that is, these cohorts would find historic cost charging more expensive. (The difference, however, is not very large: the first year entry cohort experiences the greatest differential, and would regard historic cost as 7.3% more expensive than current cost). From year 10 on, however, all cohorts would perceive current cost as being more expensive than historic cost. And from year 30 on (when the system reaches its steady state) all cohorts would feel current cost 10.5% more expensive than historic cost.

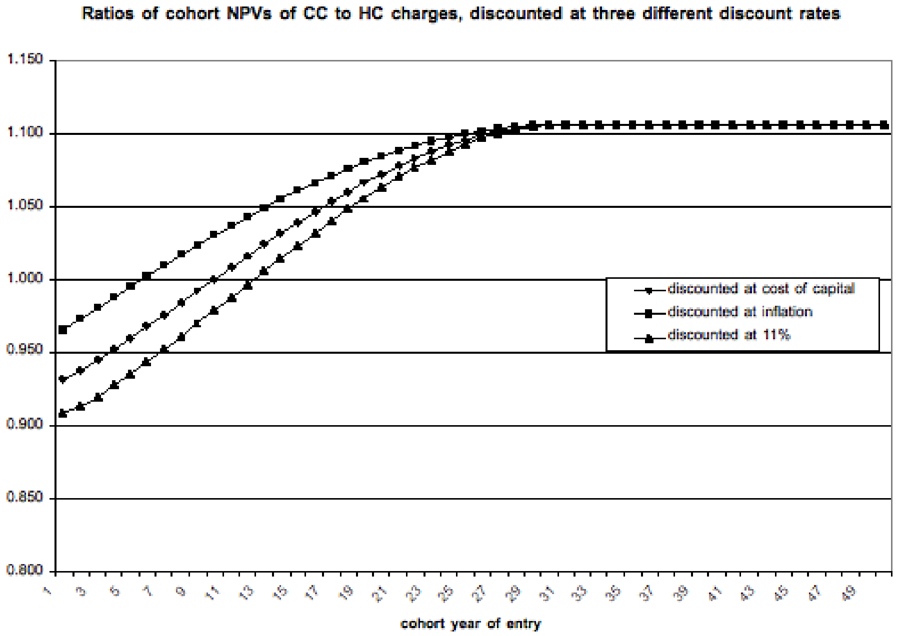
7. This is a striking result. If we do not take a cohort perspective then, discounting at the cost of capital, the equality of the net present values of the streams of current cost and historic cost payments might lead us to conclude that there was no difference from a consumers' perspective between current cost and historic cost charging (if the cost of capital is taken as an adequate proxy for consumer time preferences). However, taking a cohort viewpoint, and using the same discount rate, it nevertheless follows that all but a small number of initial cohorts will have a strong preference for historic cost over current cost.

8. Another way of looking at the key information in the previous chart is to consider the ratio of the net present values of current cost to historic cost charges for each cohort. This is shown in the following chart.



Since this is just another way of summarising the information in the previous chart, this chart tells exactly the same story. For the first nine entry cohorts current cost appears cheaper than historic cost: but thereafter current cost is more expensive than historic cost, reaching the steady state differential of 10.5% by year 30.

9. The advantage of the particular presentation adopted in the preceding chart is that it enables us to see very clearly what happens if, instead of discounting at the cost of capital, net present values are calculated at either a significantly lower discount rate, or at a significantly higher discount rate. As an illustrative lower discount rate, the rate of inflation if 3% considered in this example has been chosen: and as an illustrative high discount rate, 11% has been arbitrarily chosen. The following chart repeats the presentation of the chart in the preceding paragraph, but this time showing the ratios of the net present values of current cost to historic cost for all three of these alternative discount rates.



As would be expected, at the low discount rate the initial cost advantage of current cost is reduced (the initial entry cohort would find historic cost pricing only 3.6% more expensive than current cost). At the low discount rate it also very quickly becomes the case that entry cohorts find current cost more expensive than current cost: this happens from entry cohort 6 onwards. Conversely, at the high discount rate, current cost initially has a higher cost advantage (the initial entry cohort would find historic cost 10% more expensive than current cost). And at this discount rate it takes longer for current cost to become more expensive: it is not until entry cohort 13 that this happens.

10. What is really significant about this chart, however, is the way that it illustrates how, no matter what discount rate is taken to represent the time preference of consumers, the net present value of current cost settles down to the same relativity to that of historic cost, with current cost being 10.5% more expensive than historic cost. This illustrates a fundamental and very important fact: when taking a cohort perspective, the long run cost differential between current cost and historic cost pricing is independent of the discount rate used to express consumers' time preferences.

11. So far, we have been looking at just one specific example: so it is important to consider what happens when the different parameters in the model are varied. Annex 2 gives tables showing the resulting effects on two important features: namely

    a) the length of time until the crossover point: that is that point after which all entry cohorts find current cost more expensive than historic cost.

    b) the long run differential in perceived costs between current cost and historic cost.

    (Note that, when individual parameters are changed, the condition that $y = i + r + ir$ is always maintained: in other words, comparisons are always being made between current cost and historic cost schemes which have the same cost of capital.)

    The detail in Annex 2 points to the following general conclusions:

    Effect of length of time for which a cohort pays charges

    As cohort length increases, then the crossover point becomes earlier. But cohort length has no effect on the ultimate perceived relativity between current cost and historic cost.

    Effect of assumed real rate of return

    Increasing the assumed rate of return has the effect of making the crossover point earlier. Increasing the assumed real rate of return also has the effect of increasing the extent to which current cost is perceived as being more expensive than historic cost.

    Effect of inflation

    Increasing the rate of inflation makes the crossover point earlier (but not by much). But increasing the rate of inflation has a big effect on increasing the extent to which current cost is perceived as being more expensive than historic cost.

    Effect of length of asset life

    The longer the asset life, the later the crossover point after which current cost appears relatively more expensive than historic cost. But the longer the asset life the greater the extent to which current cost is perceived as being more expensive than historic cost.

12. Overall, probably the two most important facts are that the long run perceived cost disadvantage of current cost pricing relative to historic cost pricing from a cohort perspective is independent both of

    a) the discount rate used to represent consumers' time preference: and

    b) the length of the period for which a cohort pays charges.

    This means that the fundamental conclusions about the long run cost disadvantage of current cost pricing relative to historic cost pricing are very general.

13. It is also important to note how the long run cost disadvantage of current cost relative to historic cost increases with the assumed real rate of return, with the rate of inflation, and with the length of asset life.

14. But it is not just the long run which is important. It is also relevant, in policy terms, that current cost is relatively quickly perceived to be more expensive than historic cost: (that is, by relatively early entry cohorts), particularly when cohort length is long, and when the real rate of return is high.

5. The Office of Rail Regulation variant of current cost charging.

1. As mentioned in the introduction, the Office of Rail regulation, (ORR), uses a variant of the current cost charging methodology, when it sets allowable charges for rail infrastructure investment.

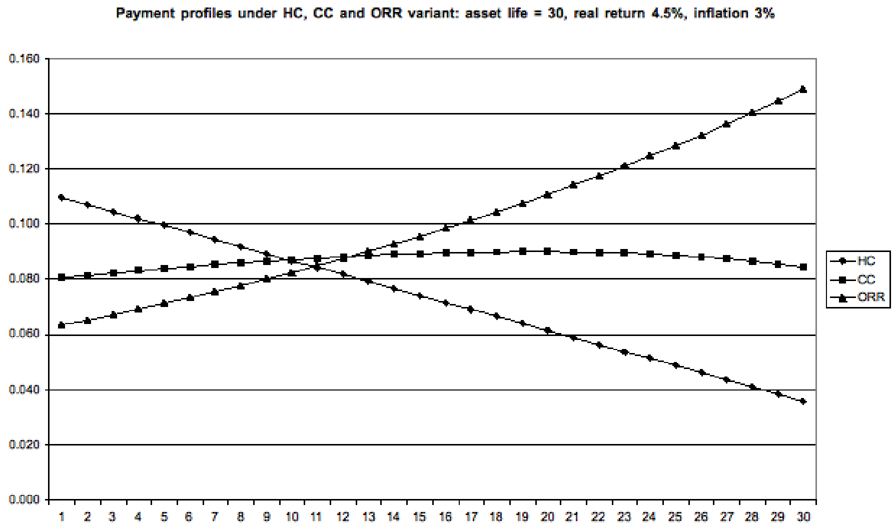
2. The ORR variant uses the same parameters as the standard current cost approach, but is based upon a form of real terms mortgage. That is, for a given asset life, n, and assumed real rate of return, r, the first step is to work out what constant real rate payment each year would repay the original investment, and give the required real rate of return, r. This constant real annual charge is then uprated to cash terms by the rate of inflation.

3. Algebraically, if i is the rate of inflation, then for an investment of K in year 0, the following annual charge would be levied in year j under the ORR approach:-

    $$Kr(1+i)^j/[1-(1+r)^{-n}], \qquad j=1,\ldots n$$

    The ORR approach yields the same nominal rate of return on the original investment as conventional current cost charging: namely ($r+i+ri$): (for a proof of this, see Cuthbert 2012, Annex 6).

4. Charges under the ORR variant are more heavily weighted towards the end of the asset life than for conventional current cost charging. This is illustrated in the following chart:


Payment profiles under HC, CC and ORR variant: asset life = 30, real return 4.5%, inflation 3%

5. In terms of the cohort perspective considered in this paper, the effect of the ORR variant of current cost charging is to increase the long run cost disadvantage relative to historic cost: but also to make the crossover point somewhat later. The effect on the long run cost differential is actually very marked. For example, for the case considered in the above chart (that is, asset life 30 years, real rate of return 4.5%, and inflation 3%) then in the long run cohorts will perceive ORR current cost as being 19.9% more costly than historic cost, as compared with conventional current cost being 10.5% more expensive than historic cost.

6. The ORR variant of current cost charging is not just a curiosity whose importance is limited to the rail sector. The practice adopted in renewable energy, and in negotiations on the Hinckley Point nuclear power station, which involves setting a real strike price for electricity which is then fully uprated for inflation, means that essentially the same model as the ORR approach is being applied in these sectors. This is likely to have profound consequences for consumers' perceptions of electricity charges, given the long asset lives and relatively high real rates of return typically assumed in the energy sector.

6. The importance of not losing sight of potentially radically different approaches to charging

1. This paper has concentrated on a comparison between current cost and historic cost charging. This is a useful comparison to make since historic cost is a well understood and conventional approach, which could be implemented within the present institutional structure for the utility industries in the UK. It would be wrong, however, to let our concentration on this comparison blind us to the fact that there are more radical alternatives to current cost pricing which could be considered.

2. For example, for that element of the capital investment programme which is stable in real terms from year to year, the cheapest possible approach in the long run for consumers would be to fund investment directly from customer charges – without any funding being provided by borrowing, (or equity). Such an approach would, however, have a number of radical implications, which could well mean a profound rethink of the way utilities are structured and owned. Among the implications which would need to be considered are the following:

a) Since consumers would now be paying for failed capital investment, and not just successful capital investment, there may have to be an addition to charges to allow for some element of risk being transferred back to the consumer.

b) Since interest charges are paid before tax, funding capital direct from revenue would involve a loss of this tax advantage – which again would have to come into the calculation.

c) To ensure that there was indeed a significant element of the capital programme which was stable from year to year, the approach would only be feasible for large utilities – or at a whole industry level. This might require rethinking the current structure of utility companies.

d) And, of course, there are likely to be severe transitional effects: special measures might have to be taken to mitigate high levels of consumer charges during the transitional period from conventional financing to funding capital direct from revenue.

3. Nevertheless, in the long run there could be a substantial cost benefit to consumers of funding direct from revenue that element of the capital programme which is stable from year to year. As an illustration, consider the example we have looked at before, of annual real gross investment of 1, where asset life is 30 years, real rate of return 4.5%, and annual inflation 3%: assume also that there is a corporate tax rate of 20% on profits, and that, if capital were being funded direct from revenue, consumer charges would have to be uprated by a further factor of 5% to allow for risk of failed investment otherwise carried by the utility company. Then in the long run, the real annual charge paid by the consumer if investment was funded direct from customer charges would be 1.149 (after allowing for risk transfer, and the fact that investment beyond annual steady state depreciation would have to be funded out of after-tax revenue). This compares with an annual real consumer charge of 1.698 under current cost charging and 1.536 under historic cost. In other words, in this example current cost charging is 47.7% more expensive for consumers in the long run than funding capital direct from revenue: and historic cost charging is 33.6% more expensive.

4. The potential long run cost savings to the consumer of moving to this alternative approach to funding the long run stable element of capital programmes are so large that they should not be ignored. Serious consideration is certainly merited of how it might be possible to overcome the transitional problems of moving to such a system: and of what the implications might be for the structure and ownership of utilities to enable such a funding system to be implemented.

7. Conclusions

1. Before drawing conclusions on the findings of this paper, it is appropriate to set this paper in the context of an earlier paper by the current author (Cuthbert, 2012) which presented a detailed critique of the current cost charging method.

2. That earlier paper was illustrated with particular reference to the way current cost charging had been applied by OFWAT to the privatised water industry in England and Wales. What that paper showed was that there were extensive flaws, both in the assumptions made by OFWAT in applying the methodology, and, more basically, in the current cost methodology itself. These flaws accounted for the extremely high levels of profit being earned in the privatised

water industry: levels of profit which had actually been concealed, to a considerable extent, by a further OFWAT mistake of using a flawed metric to assess the return on equity capital.

3. That earlier paper, therefore, in itself represents a strong argument against the use of the current cost charging method. That paper did not, however, give a full account of how the impact of current cost charging would be perceived from the important perspective of the consumer. The earlier paper did note that, for a consumer with a time preference for money expressed by a discount rate significantly less than the discount rate of capital, and who was paying charges relating to the whole lifetime of a single capital asset, then, in net present value terms, that consumer would perceive current cost charging as being expensive compared to, for example, historic cost charging. But, as pointed out in the introduction to this paper, this in itself does not allow strong conclusions to be drawn, since a consumer with a time preference equal to the cost of capital would appear to be indifferent between current cost and historic cost: and a consumer with a higher time preference rate would appear to prefer current cost.

4. What the present paper does is to resolve this ambiguity: it shows how, once allowance is made for the fact that consumers form natural cohorts, then strong conclusions can be drawn. Most cohorts of consumers, whatever the time preference for money, will indeed have a strong perception that current cost charging is more expensive that historic cost. The findings in this paper therefore complement, and extend, the critique of current cost charging in the earlier paper.

5. More specifically, the detailed conclusions to be drawn from the current paper are as follows:

   I. It is important, when considering choice of utility pricing model, to consider the implications of the real world facts that (a) investment programmes contain a large element which is stable from year to year: (b) and that consumers in effect form cohorts, who enter the system, pay charges for a number of years, and then exit.

   Once these effects are allowed for then, irrespective of the discount rate which represents consumers' time preference for money, most consumer cohorts will find current cost charging relatively expensive compared to, for example, historic cost charging.

   II. The perceived higher long run cost to consumers of current cost charging increases the longer the length of life of the relevant asset, the higher the real rate of return assumed, and the higher the rate of inflation. So locking in current cost charging for assets with long lives is costly for consumers, particularly if there is a danger of inflation increasing within the life of the asset.

   III. The specific variant of current cost charging used in the rail industry, and in much energy infrastructure, exhibits even more marked long run cost disadvantages than conventional current cost pricing. Because of the long asset lives and high real rates of return assumed in investment decisions like the recent Hinckley Point nuclear facility, this calls into particular question the wisdom of using this approach in these cases.

   IV. Despite the emphasis in this paper on the simple comparison between current cost and historic cost pricing, it would be wrong to regard historic cost as being the only alternative to current cost. In particular, active consideration should be given to the possibility of moving to a position where a significant part of capital expenditure is funded direct from consumer charges: such an approach would have very significant cost benefits. This would inevitably raise the question of whether such a radical approach would be possible within the current structure of privatised utilities.

V. Overall, it would be wrong to shy away from debate and consideration of different possible pricing strategies for utility and energy infrastructure. It would have been better to have had this debate before our utilities were privatised in the first place: but the fact that privatisation was a rushed job, and that current cost charging was introduced without proper consideration of all its implications, should not prevent us now from having a proper debate about different pricing systems and their implications. Until a proper review of pricing systems is undertaken, we will continue to suffer the needlessly high utility and energy costs implied by current cost charging.

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Annexe 1: Definition of Net Present Value

1. Let $\mathbf{a} = (a_0, a_1, ...a_n)$ be a sequence of payments, where the individual terms may be positive or negative.

Then the Net Present Value, (NPV), of the payment stream, calculated at discount rate $\sigma, (\sigma > -1)$, and with year zero reference date, is defined as

$$\text{NPV}(\mathbf{a}, \sigma) = \sum_{j=0}^{n} a_j (1+\sigma)^{-j} \qquad (1)$$

The NPV can be taken as representing the value at time zero of the payment stream **a**, to an agent whose time preference for money is expressed by the discount rate σ.

Annexe 2: Effect of varying assumptions

Table 1. Effect of cohort length.

Assumptions: asset life = 30
real rate of return = 0.045
inflation = 0.03

	Year when CC becomes more expensive than HC			Final NPV ratio CC to HC
Cohort length	Discounted at cost of capital		Discounted at inf.	
10	18		17	1.105
20	13		12	1.105
30	10		6	1.105
40	8		1	1.105

Table 2. Effect of varying inflation.

Assumptions: asset life = 30
real rate of return = 0.045
inflation = 0.06

	Year when CC becomes more expensive than HC			Final NPV ratio CC to HC
Cohort length	Discounted at cost of capital		Discounted at inf.	
10	17		17	1.187
20	13		11	1.187
30	10		6	1.187
40	8		1	1.187

Table 3. Effect of varying asset life.

Assumptions: asset life = 20
real rate of return = 0.045
inflation = 0.03

	Year when CC becomes more expensive than HC			Final NPV ratio CC to HC
Cohort length	Discounted at cost of capital		Discounted at inf.	
10	13		12	1.055
20	9		8	1.055
30	7		3	1.055
40	6		1	1.055

Table 4. Effect of varying real rate of return.

Assumptions: asset life = 30
real rate of return = 0.09
inflation = 0.03

	Year when CC becomes more expensive than HC			Final NPV ratio CC to HC
Cohort length	Discounted at cost of capital		Discounted at inf.	
10	12		11	1.156
20	8		5	1.156
30	6		1	1.156
40	4		1	1.156