On the economic effects of allowing a WACC above the midpoint

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I. Introduction

(1) Oxera's report in this proceeding (Oxera, 2014) clearly shows the difficulties involved in empirically estimating the costs and benefits of setting the allowed WACC at a percentage above the 50th percentile of the estimated WACC distribution. In its empirical part the Oxera report concentrates almost exclusively on reliability investments in electricity networks. The difficulties incurred by Oxera are magnified if one includes all types of investment and all types of investment effects on welfare. In particular, Oxera's analysis shows that there are some empirical relationships, which can be crucial but which we know very little about. This concerns, for example, the relationship between any underestimation of the WACC (the ΔWACC) and the resulting change in investment (the ΔI) and between the ΔI and the change in reliability (the ΔR). There is some knowledge about the ΔR and the change in welfare (the ΔW), i.e., about the social costs of outages. Thus, in order to relate ΔWACC to ΔW one has to take several steps, about two of which we have very little knowledge. One can argue that similar problems arise if one were to relate ΔWACC to the change in innovation and then the change in innovation to ΔW. The same holds for other potentially beneficial effects of investment. For example, reliability investments in transmission grids often take the form of redundant lines or higher-capacity lines that in addition to increasing reliability reduce congestion, reduce power losses and allow for more competition between generators over these lines. Capturing all these joint benefits and their interaction magnifies the complexity of the empirical task and shows that concentrating on only one effect, such as increased reliability, will likely underestimate the investment benefits. Any attempt at empirical investigation will therefore produce highly uncertain results that may suggest more precision than attainable. The question therefore is if approaches exist that allow one to circumvent such detailed estimations and produce more satisfactory results.

(2) In the following Section II we first derive some simple consequences of starting with the assumption that at the higher allowed WACC investment occur at the socially optimal level for consumer welfare. This then implies that only under certain conditions will a move from the midpoint WACC to such a higher WACC be justified. These conditions include (a) very large effects of the change in WACC on the amount of investment, (b) very strong welfare effects of the changed investments, and (c) the possibility that even at the elevated WACC investment remains sub-optimal. The last possibility in particular points to the necessity of other policies than an increased allowed WACC for reaching optimal investment outcomes. The paper then in Section III looks at simple cases, for which an increased allowed WACC may be justified or not. Together with the presumed heterogeneity of investment types and of the industries covered these cases in Section IV lead to a discussion of the advantages and disadvantages of a general versus a case-by-case approach towards the allowed WACC. So far the conclusions are based on a consumer welfare approach. The next short section V deals with potential consequences of moving to a

total surplus approach. A further short section VI deals with the empirical issues of the particular case of electricity grid investments in reliability. These issues are viewed as daunting. An international benchmarking approach is suggested as a possible solution for New Zealand. The last section VII concludes with conjectures about policy consequences.

II. Consequences of deviating from welfare-optimal investment

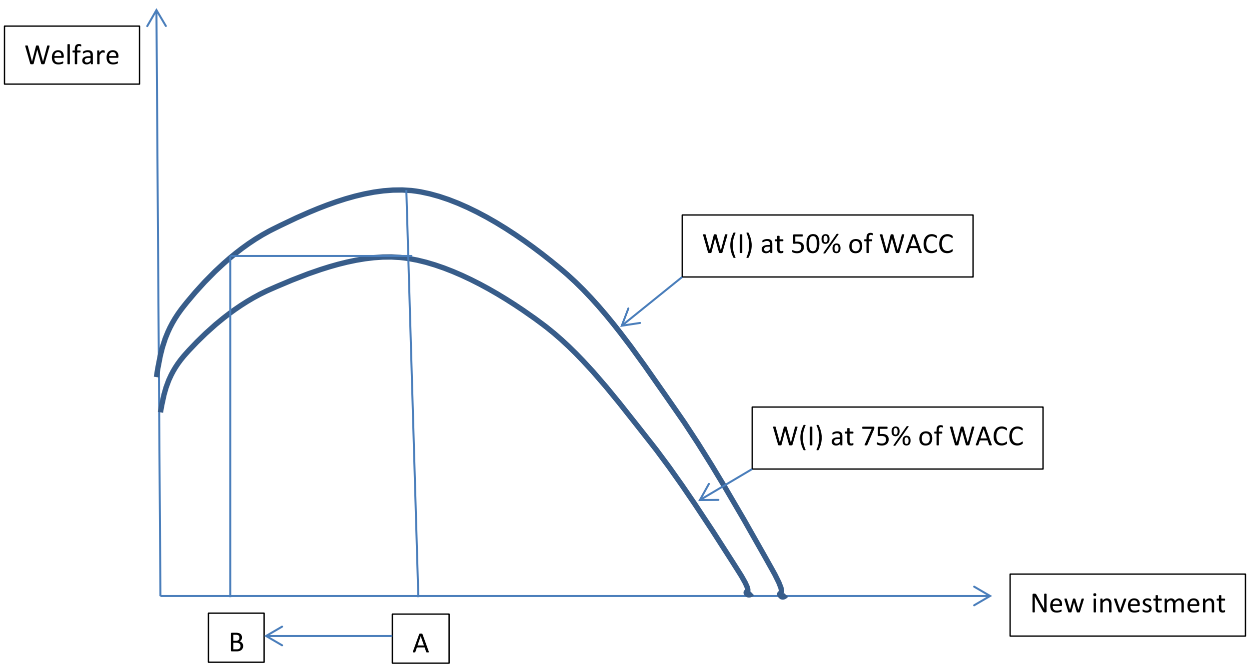
(3) Without having done detailed research for all the industries in question I conjecture that the investment issue differs substantially for different industries, such as electricity distribution and airports, and for different types of investments within industries, such as investments for reliability or for adding new customers or for smart grid innovations that are, for example, dealing with distributed generation. Some of these investments help produce private goods (e.g., connecting new customers), while others help produce public goods (e.g., reliability). Thus, for some of these investments we would expect markets to work quite well (although possibly distorted by market power or by regulation), whereas for other investments markets would not work. The question then is if the allowed WACC shall be used as an instrument to correct market failures or if the correction of such market failures should be left to other regulations (as second instruments). If on the one hand the allowed WACC were used as the only tool then it would, for example, have to correct for underinvestment due to market failure, suggesting the desirability of a positive ΔWACC in order to generate some kind of Averch-Johnson effect.[1] But since the market failures vary from industry to industry and from type of investment to type of investment, the ΔWACC would have to be differentiated on a case-by-case basis. If on the other hand the correction of market failures were left to other regulations then the starting point for an analysis of the allowed WACC would naturally be the welfare-optimal investment.

(4) In order to make that point the simple graph in Figure 1 captures the relationship between investment and consumer welfare (as the stipulated regulatory objective). In Figure 1 the upper graph depicts the relationship between new investment and consumer welfare under the midpoint WACC. The welfare includes consumer surplus from the resulting end-user prices and is based on all capital costs for the investment, where the return on assets is taken to be the midpoint WACC. Assuming that the investment is actually undertaken, the optimum investment is at point A. The lower curve depicts the new investment/welfare relationship for the 75th percentile WACC, assuming that this higher WACC is applied to all old investment only. This therefore leads to a parallel downward shift of the curve, yielding the same optimum investment at A. The downward shift of the welfare curve results from the effect of the higher price on consumer welfare that would result from the increase in the allowed WACC.[2]

[1] For the case of network reliability an Averch-Johnson effect could also mean that efficient maintenance (such as tree-trimming) is replaced by expensive investments that do not necessarily increase reliability by more.

[2] Something not considered in the following arguments is the stochastic nature of the investments because of the stochastic relationship between the chosen WACC and the investment. Here it could be important that the welfare function is concave. As a result, basing the assessment on expected investments is going to overestimate welfare, because W(E(I)) > E(W(I)), where E is the expectations operator.

Figure 1: Effect of different levels of WACC on consumer welfare, considering only old investment



(5) As an admittedly extreme case let us assume that under the 75th percentile WACC the firm actually invests the optimal amount A. This means that other policies than increasing the allowed WACC assure optimal investment and that there is no Averch-Johnson effect from the allowed WACC exceeding the actual WACC. It can then be seen that staying at the midpoint WACC is better for consumer welfare than moving to the 75th WACC percentile, as long as investment under the midpoint WACC would not be reduced drastically, meaning below point B.[3] This argument makes use of the property that at the investment optimum the derivative of welfare w.r.t. investment is zero. This is highly intuitive, because at the optimum the costs of additional investments just have to equal the additional benefits. Thus, if the additional benefits are large so are the additional costs. This means that small reductions in investment have a second-order effect on welfare, while, because of its price effect on the whole output an increase of the allowed WACC has a first-order effect on consumer welfare. This can turn the often perceived asymmetry between static and dynamic welfare on its head. It means that the argument of overwhelming dynamic over static efficiency effects implicitly assumes that the firm will strongly under-invest, for example, because it cannot capture all the beneficial dynamic effects of investment.[4] Thus, any argument that a reduction in investment yields large welfare reductions, while the associated price reductions have only small effects is suspect, as long as (a) one starts in the neighborhood of optimal

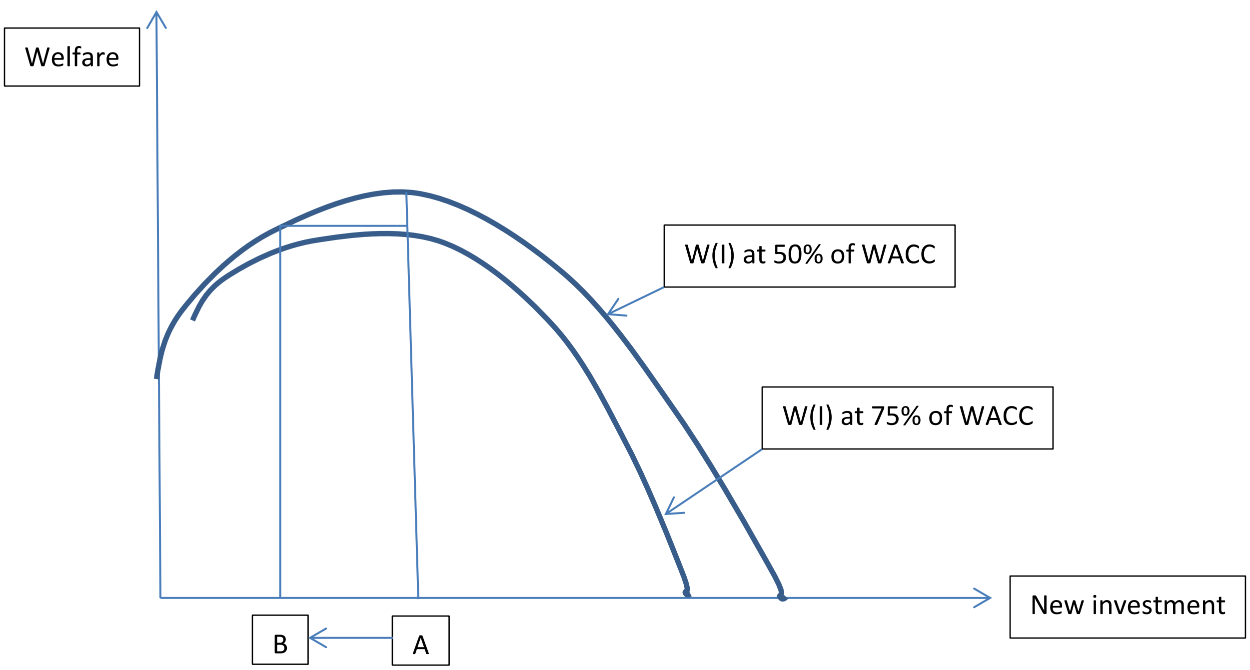
[3] The Dobbs (2011) model represents such a case, where investment goes to zero if the allowed WACC is below the firm's actual cost of capital. In addition Dobbs assumes that welfare is zero in that case also.

[4] If the constraint on the allowed WACC is binding the firm is not at its profit maximum. The literature on the Averch-Johnson effect, however, shows that in that case the firm may over-invest. So, the innovation argument must come from a different perspective than simply the one on investing.

investment, or (b) there are no particularly large investment effects on welfare, or (c) one uses a consumer welfare approach.

(6) Now, if one applies the full capital costs and the cost difference only to the new investment, one gets a downward shift from a higher allowed WACC that is increasing in the amount of investment.[5] This is shown in Figure 2. This effect by itself is smaller, because it applies only to the new investment, but if there are both old and new investments covered by the increased WACC it would be an additional effect.[6] A further effect not quite visible in the graph is that the optimum points for both cases may diverge. For example, at a lower WACC the optimal reliability investment should be higher than for higher WACC.

Figure 2: Effect of different levels of WACC on consumer welfare, considering only new investment



Interim conclusions

(7) Applying these arguments to the reliability example that is treated so extensively in the Oxera (2014) report yields the following insights. If reliability investment is currently optimal it means that the marginal cost of additional investment is just balanced by the marginal benefits of a reliability increase. Thus, there is no great net gain from additional investment right now, because the investment costs (in

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[5] An aspect not considered in these remarks is that a firm's cost of capital may actually increase in the amount of the investment. Thus, if a firm undertakes a large, lumpy investment this may not only have a large effect on benefits but may also require a larger WACC than a smaller investment.

[6] If old investments are deemed large relative to new investments this could provide a case for a two-tiered approach.

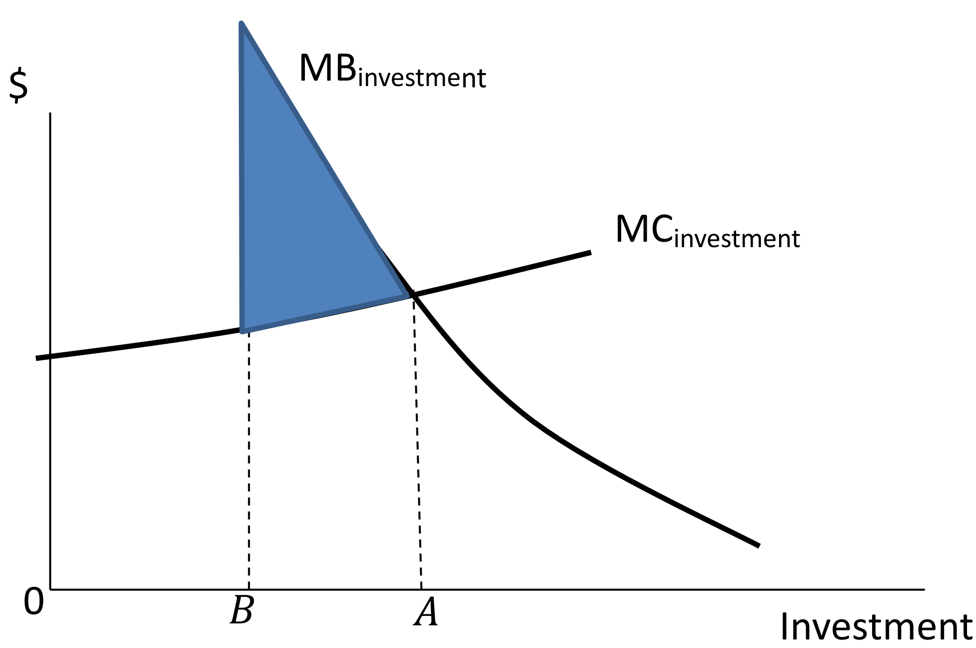
terms of consumer price increase) are just as high as the benefits of a reduction in the outage probabilities.

Thus, any argument for using an increase in the allowed WACC in order to boost investment has to be based either on a large investment effect (beyond the distance between points A and B in the above figures) or on some inherent deviations of investments from the welfare optimum. W.r.t. reliability investments such a case for sub-optimal investment can be made in the absence of specific reliability policies, because the regulated network is normally not financially responsible for all the damages caused by outages.[7] The network only bears the revenue reductions from lost sales and its own repair costs, which can be a small fraction of the total. One can then argue that a higher than the midpoint allowed WACC can avoid any further disincentives or could even lead to investment increases beyond the ordinary profit maximum (an Averch-Johnson effect). But in doing so one has to also keep in mind other regulatory policies specifically aimed at keeping reliability investments at some optimal level.

III. Specific simple cases

(8) In order to get a better feel we now consider specific cases, using a marginal approach, based on the (social) benefits and costs of investment. First, assume that a higher than allowed WACC leads to optimal investment at point A in Figure 3, while investment is reduced to point B without the higher WACC. Optimality is characterized by marginal benefits (MB) equaling marginal cost (MC) of investment. Because the MB curve is steep the welfare effect is quite large relative to the case of flat MB and MC curves shown in Figure 5.

Figure 3: Marginal cost and marginal benefit of investment, when marginal benefit is steep



[7] In previous work I have therefore suggested that electric utilities provide customers with insurance against outages (Vogelsang, 1982; Fumagalli et al., 2004), but this involves public-goods problems.

Figure 3 suggests that a higher allowed WACC may be justified in case of steep MB curves, meaning that the benefits are very sensitive to small changes in investment. This could represent the case of innovative investments.

(9) Figure 4 shows the case of a steep MC curve of investment. Again, like in the case of a steep MB curve, there is a significant welfare effect from reducing investment, starting from the optimum. This suggests that a higher allowed WACC may be justified in case of steep MC curves, something that could represent lumpy investments at capacity constraints.

Figure 4: Marginal cost and marginal benefit of investment, when marginal cost is steep

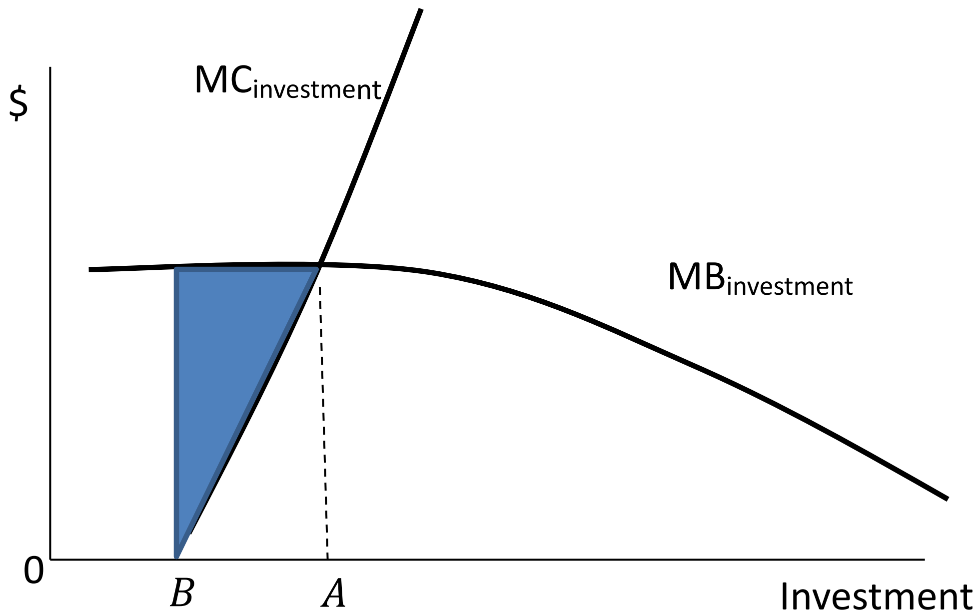
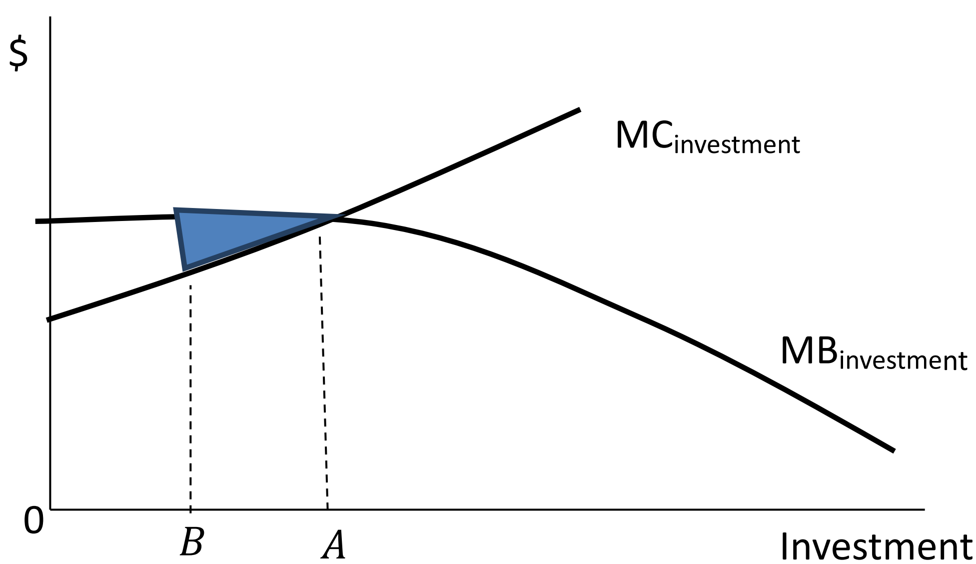


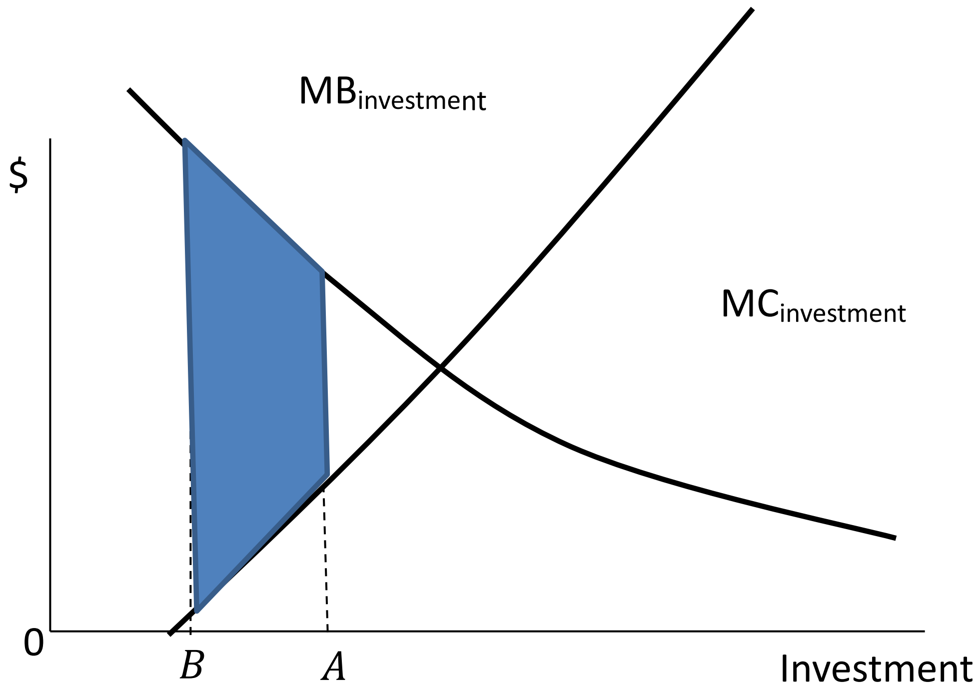
Figure 5: Flat marginal cost and marginal benefit curves



(10) Figure 5 represents the case where both the MB curve and the MC curve are flat. In this case even fairly large deviations from optimal investments do not matter too much. This could hold for a number of investments that fall into the RAB but do not have a great effect on the firm's performance, such as the type of car driven by the CEO.

(11) Figure 6 differs from Figures 3-5 by the property that in spite of ΔWACC the firm remains below optimal investment. In this case the welfare loss from not granting ΔWACC can be sizeable even if the MB curve and the MC are not steep. The reason is that one moves from welfare triangles to welfare rectangles. This means that in case optimal investment cannot be assured through other policies nor through a higher WACC then allowing a higher WACC may nevertheless be advisable. This case could hold for innovations if not all marginal benefits can be captured by the innovating firm.

Figure 6: Starting at sub-optimal investment



IV. General versus case-by-case approach

(12) Even if there is no market failure w.r.t. investment or if other policies are effectively correcting for such failure it is not clear whether a general or a case-by-case policy w.r.t. a higher WACC should be applied. There may be different ΔI associated with a given allowed WACC for different industries or for different types of investment. Or there may be different slopes of the welfare function left of the welfare maximum for different types of investment. However, if individual empirical analyses of these cases are deemed infeasible, because they either cannot be done or because they are too time-consuming or too expensive, then a common WACC percentage level should be chosen. Since this would be a compromise between different situations, it should represent some average. In my view, the result would have to be above the 50th percentile of the WACC distribution but probably below the 75th

percentile deemed correct for reliability investments in electricity distribution networks. In any case, a general policy w.r.t. the WACC percentage level for all regulated investments presupposes that other policies as second instruments deal with all the specific differences between industries and between types of investments.[8] For example, if the WACC percentage is set high there may be an additional reliability policy that penalizes the regulated firm for outages beyond some pre-specified limit. Conversely, if the WACC percentage is set low then a reliability policy may financially reward the regulated firm for outages below some pre-specified limit.[9]

V. Consumer welfare versus total surplus as welfare measures

(13) We have so far assumed that the relevant welfare measure is the long-term benefit of consumers. The firm's profits therefore do not explicitly count in the above welfare functions. However, profits are not totally neglected, because firms are assumed to curtail investments if they do not expect to receive a competitive return on their investments. Using total surplus as the relevant welfare function would change Figures 1 and 2, because the end-user price increase from WACC set above the midpoint would not lead to a large shift but only to a miniscule shift generated by the resulting DWL.[10] A further issue is that of externalities not captured by consumers, such as environmental benefits. These should, in my view, be the subject of policies other than allowing a higher WACC percentage and should therefore not affect the relevant surplus measure.

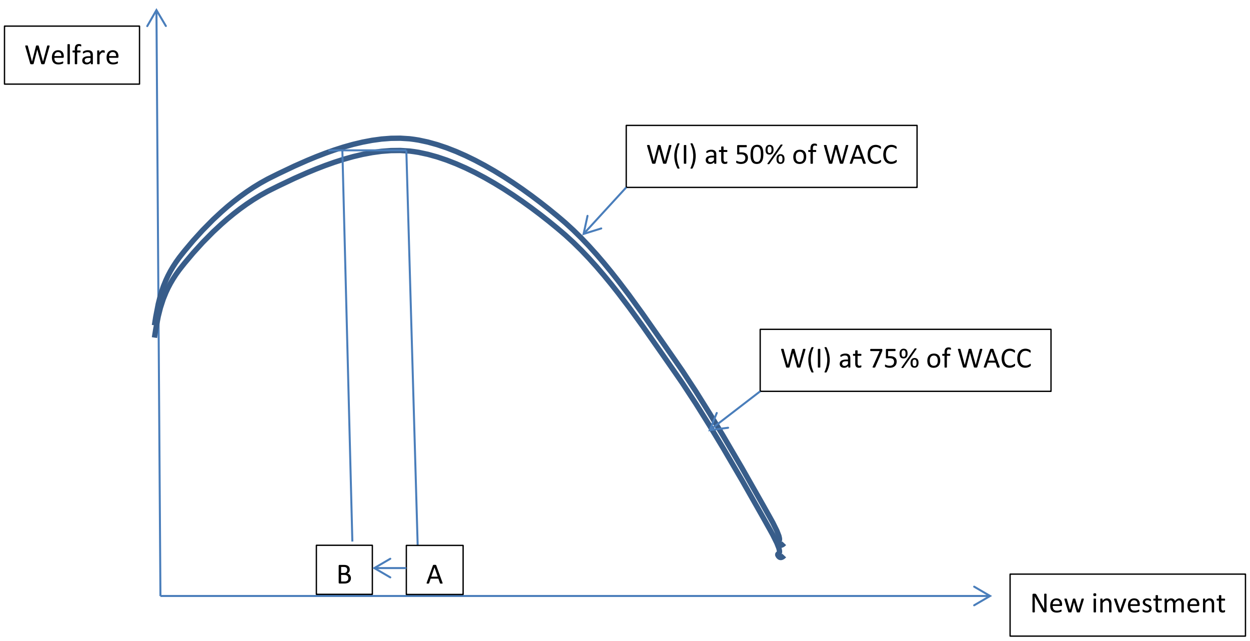
Figure 7 shows that, compared to Figure 1, a reduction of the difference between the two welfare curves reduces the range for which it is optimal not to allow a ΔWACC. In fact, the difference between DWL and the change in consumer welfare may be much larger than depicted by the difference between Figures 1 and 7. Nevertheless, the investment range shrinks by less than the difference between DWL and the change in consumer surplus.

[8] In spite of a general allowed WACC percentage the actual allowed WACC will differ between industries because of different β values.

[9] Such penalties or rewards may themselves affect the true WACC faced by the regulated firm and may therefore be relevant for the decision about the WACC percentage level. Another complicating issue is that electricity outages can be caused by failures at the generation, distribution and/or transmission levels. Thus, assignment of responsibility may not be easy. Also, natural events, such as earthquakes, may be primarily responsible, although firms may be able to take precautions that help cope better. Furthermore, reliability investment may interact with capacity investment and therefore affect different policy objectives at the same time. For example, network capacity affects the level of competition and the amount of congestion.

[10] This DWL would depend on the actual WACC and the allowed WACC and would therefore be an expected value.

Figure 7: Effect of different levels of WACC on total surplus, considering only old investment



VI. Restricted empirical analysis

(14) We have argued above that a full-fledged empirical analysis of the welfare effects of setting a specific WACC percentage point would not be feasible. Would it be feasible if one restricted the analysis to the effects of a change in the allowed WACC percentage on the reliability of electricity distribution (or transmission) networks? Part of this is what Oxera (2014) already has done. In addition, one would have to establish (a) how investments in reliability will be affected by the choice of the allowed WACC, (b) how this change in investment is going to change the reliability, and (c) how current reliability in New Zealand relates to optimal reliability. In order to do tasks (a) and (b) one would have to know what investments are involved and how current planning procedures are w.r.t. such investments. For telecommunications networks analytical cost models exist that would help identify the relevant investments and their costs. I doubt that such models exist for electricity networks. Even if they did, the cost models do not give us the required behavioral implications (although profit-maximizing decisions could be derived). The same information as for task (b) plus good information on the social costs of outages would be needed for task (c). However, here some information could be gained from knowledge about current outage statistics in New Zealand compared to other countries in the world. I do not know to what extent other countries have optimized their outage rates, but there are some countries that have put substantial effort into reliability policies and into setting incentives (that relate to expected costs of outages). My conjecture is that the countries with the highest reliability may actually have too reliable networks. However, the next tier may be quite close to the optimum. Comparing the New Zealand data to these countries may at least provide for a good feel about where New Zealand stands. Corrections to such international benchmarking may have to be made for

geography, including for weather and earthquakes. Overall, the benchmark approach to task (c) appears to me to be more feasible than satisfactorily solving tasks (a) and (b).

VII. Conclusions

(15) Without a formal or detailed analysis the overall conclusions take the form of the following conjectures:

(1) Any attempt at empirical investigation of the effects of setting the allowed WACC at specific percentage points will produce highly uncertain results that may suggest more precision than attainable. The question therefore is if approaches exist that allow one to circumvent such detailed estimations and produce more satisfactory results.

(2) This paper is based on an approach that looks at the investment effects of changing the allowed WACC percentage point in the neighborhood of welfare-optimal investment. This way of thinking has so far been absent from the discussion in this proceeding but it could have strong implications.

(3) If, for example, reliability investment is currently optimal it means that the marginal cost of additional investment is just balanced by the marginal benefits of a reliability increase. Thus, there is no great net gain from additional investment right now, because the investment costs (in terms of consumer price increase) are just as high as the benefits of a reduction in the outage probabilities.

(4) Thus, any argument for using the allowed WACC percentage point as a major tool to increase investment has to be based either on a large investment effect or on some inherent deviations of investments from the welfare optimum. In particular, any argument that a reduction in investment yields large welfare reductions, while the associated price reductions have only small effects is suspect, as long as (a) one starts in the neighborhood of optimal investment, or (b) there are no particularly large investment effects on welfare, or (c) one uses a consumer welfare approach.

(5) In case of sub-optimal investment one can argue that an increase of the allowed WACC beyond the firm's actual cost of capital can avoid any further disincentives or could even lead to investment increases beyond the ordinary profit maximum (an Averch-Johnson effect). But in doing so one has to also keep in mind regulatory policies specifically aimed at keeping investments for specific purposes, such as reliability, at some optimal level.

(6) The question then is if the allowed WACC shall be used as an instrument to correct market failures or if the correction of such market failures should be left to other regulations (as second instruments).

(7) Since the market failures vary from industry to industry and from type of investment to type of investment, the allowed WACC would have to be differentiated on a case-by-case basis in order to correct for market failures.

(8) Besides in case of deviations from optimal investment due to uncorrected market failure we have identified several other reasons for allowing a WACC above the midpoint level. They include steep marginal benefits and/or steep marginal cost curves for investment.

(9) However, if individual empirical analyses of the WACC implications for these cases are deemed infeasible, because they either cannot be done or because they are too time-consuming or too expensive, then a common WACC percentile should be chosen. Since this would be a compromise between different situations, it should represent some average. In my view, this would have to be above the 50th percentile of the WACC distribution but probably below the 75th percentile deemed correct for reliability investments in electricity distribution networks.

(10) In any case, a general policy on the allowed WACC percentile for all regulated investments presupposes that other policies as second instruments deal with specific differences between industries and between types of investments.

(11) The case for allowing a WACC above the 50th percentile may be much weaker than the conventional arguments state and may be restricted to specific types of investment, such as those for innovations or for reliability or to particularly lumpy investments. However, a switch from consumer welfare to total surplus as the welfare criterion would strengthen the case for going up potentially to the 75th percentile.

(12) An international benchmark approach could be used to check for approximate optimality of the current reliability of New Zealand electricity networks.

(13) Industries differ by types of investments and by types of second instruments besides the allowed WACC percentage point. Unless other instruments are used to prevent or correct market failure, the arguments for a case-by-case approach rather than for a one-size-fits-it-all approach appear stronger under this approach than under the conventional one. The case for a general WACC percentage point rather than one that varies case by case rests on a lack of information of the regulator.

VIII. References

Dobbs, I.M. (2011), "Modeling welfare loss asymmetries arising from uncertainty in the regulatory cost of finance", *Journal of Regulatory Economics* 39, pp. 1-28.

Fumagalli, E., Black, J., Ilic, M., and I. Vogelsang (2004), "Quality of Service Provision in Electric Power Distribution Systems Through Reliability Insurance," *IEEE Transactions on Power Systems* 19, pp. 1286-1293.

Oxera (2014), „Input methodologies – Review of the ‚75th percentile' approach", prepared for the New Zealand Commerce Commission.

Vogelsang, I. (1982), *Anreizmechanismen zur Regulierung der Elektrizitätswirtschaft - Eine Fallstudie zur ökonomischen Theorie der Institutionen*, [Incentive Mechanisms to Regulate Electric Utilities - A Case Study in Institutional Economic Theory], Tübingen: J.C.B. Mohr (Paul Siebeck).