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Valuing the future. Time horizon and discount rates

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Summary

When performing a cost-benefit analysis of investment projects, it is necessary to compare and evaluate the consequences that occur at different points in time. The normal procedure is to transform estimated future values to present values by using a discount rate. The discount rate is interpreted as the required rate of return reflecting what could obtained if the capital was put to the best alternative use. Traditionally, a constant risk-adjusted rate of return has been used, independent of the project's time horizon (exponential discounting). This implies that costs and benefits that occur far into the future will have little impact today. For example, environmental efforts and railway infrastructure projects that involve large costs up-front and for which benefits only occur in the long run, will inevitably experience difficulties in achieving a positive net present value. This has been seen as problematic, both from an ethical point of view, bearing in mind future generations, and from an investment point of view, based on considerations of how such risks actually develop.

In this study we examine different theoretical models that explain the optimal time profile for the discount rate, and especially we look at factors that may lead to a decreasing discount rate. The optimal level of the discount rate is influenced by the following factors:

- The macroeconomic development over time and uncertainty related to it
- Uncertainty about the project's own contribution to future wealth
- Decision-makers' preferences.

We focus primarily on uncertainty related to future macroeconomic development, factors that are independent of the project's own risk profile. The use of a constant rate of return rests on the assumption that growth in welfare (consumption per capita) remains at the same rate, implying that consumption and population increase at the same rate. An expectation of steady *growth* in consumption per capita over time should imply that the discount rate increases over time, given that there is little need to save for future generations because each generation will be richer. If, on the other hand, there is reason to believe that *the growth in wealth will decrease*, for example due to resource limitations relative to population growth, the discount rate should decrease over time.

An investment can either be financed by postponing consumption or by renouncing other investment alternatives. In the former case, the discount rate is determined by the consumer's required rate of return, while in the latter case it is determined by the alternative rate of return in the financial market. We show that in both approaches,

increasing uncertainty (with respect to future consumption or the market's rate of return) leads to a decreasing optimal discount rate over time. The classical Ramsey model assumes that investment is financed by postponing consumption. Consumers will claim compensation for postponed consumption. It can be deduced that increasing uncertainty with respect to future consumption growth implies a decreasing discount rate. This may be interpreted as precautionary saving. Other models explain the discount rate by the alternative rate of return in the financial market. In these models as well, a decreasing time profile for the discount rate may be derived when future rates of return in the market are uncertain and there is some serial correlation over time. This outcome will hold even when the project's own rate of return is certain.

Towards the end of the report we also discuss another possible explanation for decreasing discount rates, namely when *decision-makers have time-dependent (hyperbolic) preferences*. This means that their time preferences change over time and that postponing benefits is worse in the short run than in the long run. For example, people may prefer to have one apple today rather than two apples tomorrow, but they still prefer two apples in ten days' time to one apple in nine days' time. The problem with hyperbolic preferences is that they may lead to investment decisions that are inconsistent over time. This may explain why good intentions in the long run often do not materialize as concrete efforts in the short run. This can be shown by another example taken from everyday life: 'I will stop smoking one day, but not today'.

Decreasing discount rates over time is often seen as a symptom of hyperbolic preferences. An important aim of this study, however, is to show that decreasing discount rates may also be explained by factors related to macroeconomic development and that this does not necessarily lead to inconsistent decisions.

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Forskningsprogrammet Concept skal utvikle kunnskap som sikrer bedre ressursutnytting og effekt av store, statlige investeringer. Programmet driver følgeforskning knyttet til de største statlige investeringsprosjektene over en rekke år. En skal trekke erfaringer fra disse som kan bedre utformingen og kvalitetssikringen av nye investeringsprosjekter før de settes i gang.

Concept er lokalisert ved Norges teknisk- naturvitenskapelige universitet i Trondheim (NTNU), ved Fakultet for ingeniørvitenskap og teknologi. Programmet samarbeider med ledende norske og internasjonale fagmiljøer og universiteter, og er finansiert av Finansdepartementet.

The Concept research program aims to develop know-how to help make more efficient use of resources and improve the effect of major public investments. The Program is designed to follow up on the largest public projects over a period of several years, and help improve design and quality assurance of future public projects before they are formally approved.

The program is based at The Norwegian University of Science and Technology (NTNU), Faculty of Engineering Science and Technology. It cooperates with key Norwegian and international professional institutions and universities, and is financed by the Norwegian Ministry of Finance.

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