

## A critical assessment of discounting policies for transport Cost-Benefit Analysis in five European practices

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Cost-Benefit Analysis (CBA) has a long tradition as a broadly-used instrument for assessing transport infrastructure investments. In a CBA, the discount rate often determines whether a project passes the benefit-cost test. One concern is that literature on the subject offers widely differing recommendations regarding which discount rate should be used. What has not yet been studied is the way practitioners translate these (inconclusive) recommendations into the discounting policies applied to transport CBA. This paper aims to bridge this gap by analyzing how the rationales and arguments for underpinning discounting policies provided in literature are translated into five practices: the Netherlands, the United Kingdom, Norway, Sweden and Denmark. It does so by studying the countries' transport appraisal guidelines and interviewing experts. This study observes that the five practices attempt to fully substantiate the discount rate in empirical results from (academic) studies. However, apart from empirical evidence, discounting policies in the five countries are based on practical arguments, political-administrative arguments and judgmental arguments. In some cases these judgments are inevitable because the empirical evidence is inconclusive, but in other cases discretionary decisions are made without any references to empirical evidence. The most important conclusion of this study is that both the political-administrative arguments and judgmental arguments are not - or are poorly - communicated in the guidelines of the five countries. This makes it difficult for the user of the CBA to decide whether s/he agrees with the reasonableness of the judgments. Finally, this study discusses solutions to improve the transparency of discounting policies.

*Keywords:* Cost-Benefit Analysis; Infrastructure Project Appraisal; Discount Rate; Transport Appraisal; Guidelines.

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### 1. Introduction

Cost-Benefit Analysis (CBA) has a long tradition as a widely-used instrument, providing information to decision makers about the societal costs and benefits of carrying out transport infrastructure investments (e.g., Asplund and Eliasson, 2016; Naess, 2006; Sager, 2013; Welde and Odeck, 2011). Basically, a CBA is an overview of all the positive effects (benefits) and negative effects (costs) of a project or policy option (e.g., van Wee, 2012). These costs and benefits are quantified as far as possible and expressed in monetary terms using the notion of households' willingness to pay for these effects (e.g., Boadway, 2006). Finally, government projects are typically intertemporal in nature, so the benefits and costs occur over a number of periods (e.g., Boadway, 2006). To deal with this, they are presented as so-called present values, implying that - even after a correction for inflation - it is better to have one euro or dollar now than in ten years'

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time, for example (van Wee, 2012). The discount rate is used to express this valuation. Often, present values are aggregated to yield an indicator of the project's net impact on social welfare.

In a CBA the discount rate often determines whether a project passes the benefit-cost test (e.g., Arrow et al., 2014; Gollier 2012a).<sup>2</sup> Hence, the choice of the discount rate can have an important impact on the decision-making process in practices which use CBA to provide information for decision-making about the extent to which funding is approved for a specific transport project (examples are Chile, the United Kingdom and the Netherlands, see Gomez-Lobo, 2012; DfT, 2014, 2015; Mouter et al., 2013). The choice of the discount rate might matter less in practices in which CBA is used to rank large numbers of transport investments against each other because, over time, projects with similar cost and benefit profiles are affected by the discount rate in the same way (examples are Sweden and Norway, see Eliasson et al., 2015). However, for two reasons, discounting policies might also have a major influence in practices in which CBA is formally applied as a ranking tool: 1) When projects do not have similar cost and benefit profiles the discount rate can substantially affect the ranking of projects. It is conceivable that projects do not have similar profiles. For instance, a new high-speed rail line might have a different profile than a modest road expansion; 2) literature indicates that in reality CBA is used to inform go/no go decisions about transport investments in practices in which CBA is formally institutionalized as a ranking tool. Eliasson and Lundberg (2012) concluded that in Sweden planners primarily use CBA as a screening tool to avoid investments with negative net benefits – even though formally, CBA should be used to rank project proposals against each other. Moreover, Nyborg (1998) observed that Norwegian politicians tend to use CBA as a screening device to identify projects with a very negative benefit-cost ratio.

One concern that has been put forward in existing literature is that scholars provide widely differing recommendations regarding the appropriate discount rate that practitioners should use (e.g., Harrison, 2010). However, the way practitioners translate these (inconclusive) recommendations into applied discounting policies for transport CBA is not studied in the literature. This paper aims to bridge this gap by analyzing how the rationales and arguments for underpinning discounting policies provided by the literature are translated into five practices: the Netherlands, the United Kingdom, Norway, Sweden and Denmark. Based on this in-depth assessment it is possible to establish the extent to which practices struggle with similar problems regarding the translation of prescriptions from the literature into applied discounting policies. The identification of (generic) problems allows us to provide recommendations for improving discounting practices.

A secondary goal of this study is to examine the differences between the five practices in terms of the underpinning of discounting policies. Various studies establish that countries around the world use very different discount rates, but these studies do not provide (potential) explanations for these differences (e.g., Boardman et al., 2013; Mackie and Worsley, 2013; Naess, 2006; Olsson et al., 2012). We identify potential explanations through studying the countries' transport appraisal guidelines and interviewing experts.

This study might inspire academics who aim to conduct research which better enables practitioners to design discounting policies in the face of varying prescriptions from literature. The societal contribution of our study is that practitioners can adopt the recommendations for improving discounting policies addressed in this study. Moreover, practitioners from the five countries included in this study can learn from each other's practices where rationales for discounting policies differ. When practitioners learn that the rationale used in another practice is 'better', improvements can be made by 'transplanting' the rationale. However, when

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<sup>2</sup> For instance, the discount rate is extremely important in the evaluation of the optimal level of climate policy (e.g., Nordhaus, 1994; Stern, 2008).

practitioners conclude that rationales employed in their own practice are superior, the result of the confrontation is that the rationale for the domestic practice is underpinned in a better way, which can also be considered as a learning effect. Practitioners that are charged with (re)designing discounting policies in other countries which apply CBA (e.g., France, New Zealand, Australia, United States, Chile and Japan) can also benefit from this study by examining the rationales that are employed in their practice and comparing them with the rationales of the five countries analyzed in this study. Also, a review of the rationales used in mature practices can be informative for practitioners from countries that aspire to institutionalize CBA in their practice, such as Serbia (Designing and Development Public Enterprise Roads of Serbia, 2010).

The remainder of the paper is organized as follows: Section 2 discusses the methodology. Section 3 provides an overview of (theoretical) arguments for underpinning discounting policies that are prevailing in scientific literature. Section 4 discusses the discounting policies of the five countries. Section 5 provides a critical assessment of the discounting policies. Section 6 provides conclusions and a discussion.

## 2. Methodology

As it would be almost impossible to analyze and compare the discounting policies of all of the countries worldwide that apply CBA within a reasonable period of time, the discounting policies of five countries (the Netherlands, the United Kingdom, Norway, Sweden and Denmark) have been selected and are analyzed in this study. These countries were selected because they are regarded by several scholars as countries with serious (and well-documented) CBA track records (e.g., Mackie and Worsley, 2013; Odgaard et al. 2005), which enhances the feasibility of meeting this study's research goals.<sup>3</sup> To survey the five discounting policies, transport appraisal guidelines were examined and 38 CBA experts were interviewed. The 38 experts interviewed for this study<sup>4</sup> were academics, consultants and policy makers who have experience with transport CBAs. Table 1 classifies the respondents in relation to their profession and country.

**Table 1: Respondent classified in relation to their profession and country**

	Academic	Consultant	Policy maker	Total
The Netherlands	2	1	1	4
United Kingdom	5	2	2	9
Norway	6	1	2	9
Sweden	5	0	2	7
Denmark	4	2	3	9

The interviews were semi-structured and consisted of three parts. Firstly, when the country's discounting policy was not communicated in an English language publication, the interviews were used to reveal the policy. Secondly, respondents were asked about the underpinning of the discounting policy applied and about the process of deciding upon the discounting policy. This was the most important part of the interviews, considering the aim of this study to analyze how the rationales and arguments for underpinning discounting policies provided by existing literature are translated into the five practices. Thirdly, respondents were asked to reflect on the policy's merits and, when applicable, they were asked to reflect on the observations of other

<sup>3</sup> The scope of the study is the discounting policies of the five practices chosen. It cannot be claimed that the results of this study are, by definition, representative for all countries worldwide that apply CBA for their transport projects as, before carrying out this study, it proved to be very difficult to identify the extent to which the discounting policies of these five countries are a representative sample.

<sup>4</sup> Respondents were approached by email. 35 interviews were telephone interviews. Three Danish respondents preferred to answer questions and follow up questions via e-mail.

respondents.<sup>5</sup> When applicable, the interview guide was updated. For instance, because the first interview with a Swedish respondent revealed that the discount rate had recently been decreased from 4% to 3.5%, the following question was added to the interview guide for Swedish respondents: *"I heard that the discount rate for transport projects in Sweden recently dropped from 4% to 3.5%. My question is: what was the argument for this decrease?"* We used an inductive and grounded approach to analyze our data because we did not have strong a priori expectations regarding respondents' answers to the three categories of questions (Bryman, 2008). This means that the data analysis was conducted without formulating hypotheses in advance.

The respondents were recruited in two rounds. In the first round, one clear CBA proponent, one clear CBA antagonist and one policy maker were interviewed. The rationale was that the CBA proponent and antagonist could provide different perspectives on their practice and the policy maker would be able to provide detailed information with respect to procedures. These respondents were identified by consulting fellow academics. For instance, in the case of Sweden several academics were asked to provide suggestions for a CBA antagonist and policy maker who were able to provide reflections concerning the Swedish discounting policy.<sup>6</sup>

The respondents were also asked who else needed to be interviewed in order to obtain a complete picture of their practice. In the second round, the people put forward by the first round respondents were interviewed. Because the meticulousness of the guidelines and the awareness of respondents in terms of underpinning discounting policies differed between the practices, the number of respondents interviewed varied per country. For instance, it was necessary to interview nine Norwegian, Danish and British respondents to obtain a comprehensive picture of the underpinnings for each country's discounting policy and only four Dutch respondents needed to be interviewed for the same purpose, because the Dutch Discount Rate Working Group (2015) recently published a very extensive report regarding its discounting policy.

### 3. Literature Review: Rationales for underpinning discounting policies

Because this study aims to analyze how rationales and arguments for underpinning discounting policies provided by existing literature are translated into five practices, it is firstly important to provide a review of arguments for underpinning discounting policies that are prevailing in scientific literature.

#### 3.1. Rationales for underpinning the risk-free social discount rate

Approaches to choosing social discount rates (discount rates applied to public projects) can generally be placed into two categories: the descriptive approach and the prescriptive approach (e.g., Arrow et al., 1995; Baum, 2009; Howard, 2013). The descriptive approach selects discount rates that reflect the real-world market behavior of people today. It implicitly assumes that the 'individual discount rate' that households apply to personal benefits and costs equals the 'social discount rate' that individuals would apply to social benefits and costs (Howard, 2013). When performing a CBA for a government project, the descriptive approach sets the social discount rate equal to the rate of return money would receive had it not been used in the project. It is generally assumed that money not used in a government project would stay in the hands of private citizens and be invested (Howard, 2013). As such, it is common practice to set the risk-free discount rate to be equal to some measure of the real rate of return on investment in the private sector. Hence,

<sup>5</sup> In such cases the names of these other respondents were not revealed.

<sup>6</sup> Contrary to our expectations we did not find interesting diverging perspectives among proponents and antagonists regarding the main goal of our study. Hence, we do not use this distinction in the remainder of the paper.

this approach is also coined as the 'opportunity cost of capital approach' (Nordhaus, 2007). Descriptivists, such as Nordhaus (1994, 2007), argue that social discount rates should be inferred from individual discount rates because there is no (ethical) justification for choosing a discount rate which is not fully grounded in actual behavior. Moreover, Azar (2007) asserts that using the same discount rate for public and private investments ensures that they are treated equally, since they use up similar financial resources that should be valued using the same opportunity cost of funds.

The prescriptive approach to discounting derives social discount rates from fundamental ethical views, even if the resulting rates do not match market rates (e.g., Dasgupta, 2008; Stern, 2008). A first argument employed by prescriptivists to criticize the descriptive approach is that standing is only granted to contemporary humans who participate in financial markets (Baum, 2009). In the descriptive approach, people today may value the stakes of the next generation, but it is also plausible that individuals may only optimize consumption over one's own lifetime and not consider future generations in their market behavior. Prescriptivists therefore conclude that the social discount rate for government projects affecting future generations can only be established based on ethical considerations about the way future project effects should (ethically) be valued compared to present project effects. Obviously standing issues are relevant when establishing discount rates for policies which will affect future generations (e.g., climate change policies). However, it can be argued that this prescriptivist critique is only relevant for the assessment of specific types of transport projects, these being projects with intergenerational impacts (e.g., high-speed rail lines and long-term subsidizing of electric vehicles).

Although standing issues may not pertain to transport projects with short-term impacts, Baum (2009) establishes that for these projects too, it holds true that analysts cannot avoid injecting their value judgments into the selection of the discount rate. First of all, the existence of multiple market rates implies that analysts cannot consider any one single market rate to describe how society discounts. In choosing one of these rates (whichever they choose), descriptivists impose their values upon society (Baum, 2009). Moreover, authors such as Stern (2008) and Sagoff (1988) argue that the social discount rate should be grounded in public discount rates instead of private discount rates, because individuals may not discount impacts that accumulate for themselves in the same fashion as impacts that accrue for others, or society as a whole. Stern (2008) asserts that in imperfect economies (suffering from, amongst others, externalities and missing markets), the social value of a unit of private consumption/investment may be different from the social value of a unit of public investment. According to Stern, it is a serious mistake to argue that the social discount rate should be anchored by importing one of the many private rates of return on the markets. Ackerman and Heinzerling (2004, p. 191) make a similar claim, arguing that using private market behavior as a standard for public policy overlooks the possibility that people will have different preferences when they take on different roles: *"the future seems to matter more to American citizens than to American consumers, even though they are, of course, the same people. For example, Americans are notoriously bad at saving money on their own, apparently expressing a disinterest in the future. But Social Security is arguably the most popular entitlement program in the United States. The tension between Americans' personal saving habits and their enthusiasm for Social Security implies a sharp divergence between the temporal preferences of people as consumers and citizens"*. Howard (2013) finds empirical evidence for the claim that individuals do indeed discount personal impacts differently than social impacts. He concludes that individuals discount social payments at a lower rate than personal payments, based on a comparison of individuals' discount rates for monetary payments that accrue to the individual with monetary payments that benefit society more generally. The distinction between public discount rates and personal discount rates might be particularly relevant for the evaluation of transport projects, as recent research projects indicate that individuals evaluate impacts of transport projects differently in their roles as consumer and citizen (e.g., Mouter et al., 2017).

In case the discount rate is not selected based on market rates ('opportunity cost of capital approach'), analysts aim to establish the rate at which individuals are willing to trade future consumption with consumption today, also known as the 'consumption behavior approach'. Present wealth can either be spent on present consumption or invested, thereby increasing future consumption. In this case, the discount rate can be expressed through the so-called Ramsey model which was designed to assess tradeoffs between present and future consumptions:

$$d = p + L + \mu g \quad (1)$$

When the parameters are set based on empirical observations,  $d$  denotes the discount rate,  $p$  is the rate of pure time preference<sup>7</sup> (also coined as the rate of impatience),  $L$  reflects the possibility that, because of a future exogenous calamity (for example, an asteroid hitting the earth), some future generations might not ever arrive (Goulder and Williams, 2012),  $g$  is relative consumption growth per capita and  $\mu$  describes how fast the marginal utility of consumption declines as consumption increases. Subsequently, the discount rate can be determined by estimating the parameters in the Ramsey equation.

If there were no distortions (e.g., capital income taxes), externalities associated with saving or inefficiencies in markets (e.g., restrictions on the ability of households to borrow or lend), the 'consumption behavior approach' and the 'opportunity cost of capital approach' would compute the same risk-free discount rate (e.g., Arrow et al., 2013; Boadway, 2006; Gollier, 2012a). That is, market interest rates may not reflect true consumption discount rates (Boadway, 2006). Given that distortions exist in any economy, it would be extremely surprising if the two rates were the same (Baumol, 1986). Hence, there is the apparent problem of choosing between them (Pearce and Ulph, 1999). In existing literature, both approaches are often discussed as justifiable frameworks (e.g., Arrow et al., 2013). However, the 'consumption behavior approach' is often mentioned as the preferred theoretical framework (e.g., Gollier, 2012a; Groom et al., 2005), since, as a result of market distortions, capital markets do not reflect consumer preferences very well. A practical issue concerning the use of the 'opportunity cost of capital' approach for evaluating projects with long time horizons is that bonds with maturities longer than thirty or fifty years do not exist in any significant quantity in sufficiently liquid markets, which makes it difficult to infer a risk-free discount rate for such projects (Gollier, 2012a). Despite these downsides, leading scholars in the field believe that the risk-free discount rate, computed using the 'opportunity cost of capital' approach, can provide a 'reality check' on the risk-free discount rate computed using the 'consumption behavior approach' (Arrow et al., 2012).

Prescriptivists claim that the parameters  $p$  and  $\mu$  should be based on value judgments instead of empirical observations (e.g., Stern, 2008). In their view, determining the pure rate of time preference ( $p$ ) is a normative rather than an empirical question: 'how much should future well-being count, relative to current well-being, in the social welfare function?' According to Stern (2008) such questions can be answered through thought experiments. Various scholars argue from a normative perspective that the pure rate of time preference should be zero because a positive value for  $p$  means that – all other things being equal – the further into the future we go, the less worth we attach to the well-being of people living there (e.g., Broome, 1992; Gollier, 2012a; Solow, 1974; Ramsey, 1928). For instance, Ramsey (1928) states that: "*it is assumed that we do not discount later enjoyments in comparison with earlier ones, a practice which is ethically indefensible and arises merely from the weakness of the imagination*". Ramsey viewed discounting as unethical for the social planner because when horizons are long and one discounts, the future agent that the social planner serves disappears (Shively, 2002). From a normative point of view, the variable  $\mu$  in the Ramsey equation can be interpreted as a measure of society's relative aversion to

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<sup>7</sup> The rate of pure time preference reflects individuals' preference for consumption now, rather than later, with an unchanging level of consumption per capita over time.

intertemporal inequality (e.g., Gollier, 2012a; Goulder and Williams, 2012). The more weight society gives to equality between generations, the higher the value of the parameter (Arrow et al., 1995).

Another ethical argument put forward by John Rawls is that the whole idea of calculating a 'correct' or 'efficient' discount rate is a mistake (van Liederkerke, 2004). From a Rawlsian perspective, one should first answer the question of what a just and fair distribution of savings between generations could be, and then continue to look for the discount rate which meets this aim. People who are charged with setting the discount rate should forget the mathematical frame and ask themselves what justice between generations entails and then do the math (van Liederkerke, 2004). Shively (2002, p.5) also suggests to 'do the ethics before the math': "*If discounting provides a result to which we object later on ethical grounds, we might conclude that discounting was an inappropriate tool for use*". Various authors argue from a normative perspective that countries ought not to use a (high) discount rate, since this results in 'a dictatorship of the present over the future' (Chichilnisky, 1997), an unsustainable future (e.g., Gowdy, 2010; Pigou, 1932), it breaches principles of intergenerational justice (e.g., Davidson, 2006) and requires a world view that neglects issues of fairness and equity, especially across generations (Shively, 2002).

Various descriptive scholars argue that selecting a social discount rate that is (substantially) lower than the market interest rate would leave future generations worse off, because a low rate diverts financial resources from better use, creating an inefficient allocation of funds (Azar, 2007; Nordhaus, 2007). Moreover, descriptivists criticize prescriptive approach supporters, charging them of elitism (e.g., Anthoff et al., 2009). They argue that prescriptivists impose their discounting views on society, even if society does not agree with these views (Baum, 2009). Conversely, the descriptive approach is often justified on grounds that it uses a description of how society discounts instead of having analysts impose their own discounting views on society (Baum, 2009). Baum (2009) notes, however, that while the descriptive approach to discounting can claim to discount according to a description of how society discounts, the approach cannot claim to have avoided injecting its values into the analysis. As discussed, analysts need to make a value judgment when choosing whether public discount rates or private discount rates are relevant when determining the social discount rate. When analysts choose for the latter option, they need to choose from the various market rates that are available.

### 3.2 *The implications of risk and uncertainty*

As well as determining the starting percentage rate for the risk-free discount rate (i.e. the risk-free discount rate in year 1), the term structure of the discount rate<sup>8</sup> also needs to be determined. Among a significant number of scholars in the field there is strong consensus that the risk-free discount rate should decline over time (e.g., Atkinson and Mourato, 2008; Arrow et al., 2014; Boardman et al., 2013). The most prominent rationale for a declining risk-free discount rate is that the large uncertainty associated with aggregate consumption in the distant future (parameter 'g' in the Ramsey equation) should induce the prudent representative agent to use lower rates to discount more distant cash flows (Gollier, 2012b). It is often suggested in existing literature that economic agents are time inconsistent if the term structure of the discount rate is decreasing. According to Gollier (2012a) this is not the case, as long as the consumer's rate of time preference (p) is constant. Arrow et al. (2014) argue that time inconsistency can be eliminated when estimates of the discount rate are regularly updated.

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<sup>8</sup> The term structure of the discount rate can be defined as the curvature of the discount rate. When the discount rate diminishes over time, the term structure is decreasing, and the term structure of the discount rate is flat when the discount rate does not change over time.

Once the decision about the risk-free discount rate has been made, practices then have to decide whether they would prefer to discount risky projects using a higher discount rate or discount these projects using the risk-free discount rate, and then communicate the project's risks to the decision-maker in another way. The argument in existing literature (e.g., Damodaram, 2008; Gollier, 2012a) for discounting risky project effects with a higher discount rate is grounded in the observation that people are risk averse and therefore prefer certain, rather than uncertain, future effects. In existing literature, there is a consensus that only non-diversifiable risks should be considered in the discounting policy of Cost-Benefit Analyses (e.g., Arrow and Lind, 1970; Damodaram, 2008; Gollier, 2012a). Non-diversifiable risk is the risk of the project that cannot be diversified away, since it correlates with the aggregate risk (also coined as the macro-economic risk) of the government portfolio. Risks that can be fully diversified away in the government portfolio are not relevant for establishing the discounting policy, since adding the risk to the portfolio does not increase its riskiness (Arrow and Lind, 1970). Moreover, there is a consensus in current literature that a project's non-diversifiable risks can correlate with the aggregate risk, in both a positive and a negative way. In the case of positive correlation, the risk premium is positive and in the case of a negative correlation, implementing the project reduces the aggregate risk. It therefore has an insurance value, which takes the form of a negative risk premium (Gollier, 2012a).

In addition, scholars agree that risks should not be double counted in discounting policies. However, according to Damodaram (2008) it is all too common for public or private actors to double - or even triple - count risk in simulations and base decisions upon the wrong type of risk. Moreover, Damodaram (2008) states that it is important that risk is not double counted, since it is patently unfair to risky investments to discount their cash flows back at a risk-adjusted rate and to then reject them because the variability in value is high.

One aspect of discounting policies on which leading scholars disagree is the term structure of the risk premium in the discount rate. Gollier (2012b) argues that the same arguments proposed in scientific literature to justify a decreasing term structure for the risk-free discount rate - parametric uncertainty of consumption growth (parameter  $g$ ) - also justify an increasing term structure for the risk premium. In contrast, Weitzman (2012) argues that the risk premium should be declining, reflecting the increasing relative value of having insurance against the increasingly likely possibility over time of disastrous outcomes. Finally, the Capital Asset Pricing Model - which is heavily criticized in existing literature (e.g., Gollier, 2012b; Hagen et al., 2012) - assumes that the term structure of the risk premium is flat.

### 3.3 *The process of selecting discount rates*

The way discount rates are actually established is rarely discussed in existing literature. However, there are two noticeable exceptions. Firstly, Henderson and Bateman's paper (1995, p. 415), which concludes that: *"the discount rate for a given project or project sector has never been a question determined through a rigorous calculus, but rather it has been an issue played out within and between branches of government, occasionally surfacing as an explicit political decision."* Henderson and Bateman discuss various examples of processes in which the discounting policies are the result of political bargaining, discretionary judgment and narrow interest group manipulation. Secondly, Groom and Hepburn (2017) analyze the conditions under which one particular advance in the theory of discounting (declining discount rates) found its way into policy. They conclude that three factors affect the successful implementation of declining discount rates in countries such as the United Kingdom and France: 1) the presence of economic ideas of high quality. Government "gatekeepers" must find the ideas "persuasive enough" so that policy makers can feel confident that the academic work is "sound". Here, the perceived reputation/quality of academics is as important as the quality of their work; 2) there must be strong (political) demand for the ideas. That is, the implementation of the high quality ideas must be lucrative for influential policy makers; 3) key personalities (policy brokers) are needed who help to overcome political,

intellectual, and even administrative barriers that can prevent implementation of this scientific innovation.

#### **4. Results: the discounting policies of five countries**

This section describes the discounting policies of the five countries selected, including the rationales and arguments that are used to underpin the discounting policies. The description of the Dutch, British, Norwegian and Swedish discounting policies are largely based on the country's appraisal guidelines and related documents. Interviews were primarily used to generate complementary insights into the underpinning of the discounting policies in these countries. The description of the Danish practice is fully based on statements made by respondents in the interviews, since no English language document describing the Danish discounting policy was available. The absence of such a document clarifies why the Danish country description is relatively short.

##### *4.1 The Netherlands*

The Dutch Discount Rate Working Group (2015) recommends a risk-free discount rate of 0% and a general risk-adjusted discount rate for the appraisal of government projects of 3%. The Working Group recommends a higher risk-adjusted discount rate of 4.5% for physical public investment projects with substantial fixed costs (e.g., transport infrastructure projects).

The Working Group adopts 'the opportunity cost of capital' approach as the key theoretical framework to establish the discount rate. The main rationale for the risk-free discount rate of 0% is that long-term interest rates had fallen to approximately 0% at the time when the Working Group drafted their recommendation. Moreover, the general risk-adjusted discount rate of 3% was estimated on the basis of the required returns on a broad portfolio of investments in the economy. Although the Working Group adopts 'the opportunity cost of capital' approach as the key theoretical framework, it argues that the recommended general risk-adjusted discount rate of 3% can also be defended from a 'social rate of time preference' point of view ('consumption behavior approach'). The Working Group observes that using the Ramsey equation, discount rates ranging between 1% and 6% can be defended, as a result of uncertainty concerning the parameters of the Ramsey equation. For instance, the Working Group identifies empirical arguments in current literature for a 2% rate of pure time preference, and ethical arguments for a 0% rate of pure time preference. Moreover, the Working Group establishes that the analysis of the ranges of discount rates that can be defended using the Ramsey equation provides additional support for the general discount rate of 3%, inferred by the opportunity cost of capital approach, because the 3% is right in the middle of the bandwidth of discount rates that can be defended using the Ramsey equation. Respondents confirmed that ethical arguments were discussed within the Working Group, but in the end the discount rate was underpinned using empirical arguments. One respondent argued that the Working Group's decision was grounded in empirical arguments because they aspired to make a value-neutral choice regarding the discount rate. According to this interviewee it is up to politicians, and not academics, to make ethical decisions. A second respondent argued that ethical considerations only matter when establishing discount rates for the evaluation of government policies which clearly affect future generations (e.g., decisions concerning the size of the national debt and climate change policies). In this respondent's view, one can safely use an empirically-based discount rate for the evaluation of transport projects that do not significantly affect future generations.

The Working Group explains the higher discount rate for transport projects (4.5%) through arguing that the fixed costs make the net benefits of a project more sensitive to fluctuations in usage and they are therefore riskier in economic terms than an average government project. However, why a discount rate of 4.5% for transport projects was selected – instead of a discount

rate of 3.5% or 5.5%, for instance – was not clarified in the recommendation. Interviews with members of the Working Group confirmed that a thorough foundation for the use of a 4.5% discount rate is currently lacking. One respondent stated that the main cause of this was time pressure. Because fundamental discussions regarding discounting policies required a lot of time, concrete decisions regarding the level of the discount rate were made in the face of tight deadlines. A second respondent argued that the selection of the 4.5% discount rate was a pragmatic decision. From a theoretical point of view it would have been better to discount the benefits of transport projects with an even higher discount rate and discount the costs with the standard premium of 3%. Two respondents argued that 4.5% was considered to be a reasonable number, which needs to be investigated in future research.

The Working Group acknowledges that they have taken note of the scientific debate on the question as to whether the term structure of the discount rate should be downward sloping. However, the Working Group recommends a flat term structure, giving four reasons: 1) Gollier (2012b) argues that the same arguments proposed in scientific literature to justify a decreasing term structure for the risk-free discount rate – parametric uncertainty of consumption growth (parameter  $g$ ) – also justifies an increasing term structure for the risk premium. Hence, the risk-adjusted discount rate may be constant; 2) the risk-free discount rate is already very low (0%) and lower than what is considered to be appropriate for long maturities in the climate discussion; 3) a flat discount rate is easier to apply in practice; 4) the issue of a declining discount rate is particularly relevant for climate projects and the Working Group has chosen to incorporate uncertainty concerning climate costs and benefits in CBAs through scenario analysis.

Another feature of the Dutch discounting policy is that macro-economic risk is not only handled via the discount rate, but also through estimating a project's costs and benefits for at least two future macro-economic scenarios. The key argument for handling macro-economic risk through both the discount rate and scenario-analysis is that scenarios are useful to identify uncertainty. Interestingly, a previous CBA guideline (Dutch Ministry of Finance and CPB, 2003) concluded that CBA analysts should either estimate the effects of a project using scenarios that differ in macro-economic growth, or adjust the discount rate for macro-economic risk, to avoid double counting. The directive to choose for either incorporating macro-economic risk via a risk premium in the discount rate, or to capture it via scenario analysis was endorsed by de Zeeuw et al. (2008). Respondents confirmed that the combination of scenario analysis and a risk-adjusted discount rate is still an unresolved, precarious issue. According to two respondents, there are good arguments to adopt a risk-adjusted discount rate and omit scenario analysis, but conducting scenario analysis is a valued tradition in the Dutch practice of policy analysis which cannot be easily overruled. Scenario analysis is prescribed in various CBA Guidelines (Eijgenraam et al., 2000; Koopmans, 2004; Romijn and Renes, 2013) and the importance of conducting scenario analysis is emphasized in various evaluations of the Dutch CBA practice (Annema et al., 2007; Beukers et al., 2012; Mouter et al., 2015).

#### *4.2 United Kingdom*

In UK practice, the Green Book (Treasury of the United Kingdom, 2003) establishes that the costs and benefits are discounted using a declining discount rate (3.5% for the period of 0-30 years, 3% for the period of 31-75 years and 2.5% for the period of 76-125 years). The Green Book discusses how the 'consumption behavior approach', expressed through the Ramsey rule, is used as a framework to derive the 3.5% discount rate for the period of 0-30 years. According to the Green Book, evidence suggests a pure rate of time preference ( $p$ ) of around 1.5%, an annual growth in per capita consumption of around 2% and elasticity of marginal utility of consumption at around 1. The elasticity of marginal utility of consumption is derived from Pearce and Ulph (1999), amongst others, estimating a range from 0.7 - 1.5 and Oxera (2002), estimating a range from 0.8 to 1.1. The key references used to underpin the rationale for declining discount rates are discussed in the Oxera (2002) report.

In the past, the British discount rate included a risk premium. However, it was concluded during the revision that it was a better solution to address relevant risk specifically for each project through various risk analysis methods, such as quantified risk analysis (Hagen et al., 2012). The Green Book assumes that, given the size of national income relative to the scale of most individual projects, the cost of variability of individual projects is usually negligible (Treasury United Kingdom, 2003). Hagen et al. (2012) observe that this claim is not underpinned with specific reasons or references. Two British respondents state that this is a serious issue. One respondent states that the treatment of risk in the UK practice is 'very unsatisfactorily' and 'not really sophisticated'. Another respondent (an academic) thinks that macro-economic risk should be considered in appraisal and that academics should push for more sophisticated analysis.

#### 4.3 Norway

The Hagen et al. (2012) committee recommends a risk-free discount rate of 2.5% for the first 40 years and a risk-free discount rate of 2% after 40 years. To determine the discount rate, leading scholars on this topic were invited to discuss the state-of-the-art literature with the Hagen et al. (2012) committee. The committee concluded – referring to Gollier (2008) and Weitzman (1998), for instance – that a strong argument has been put forward in existing literature for applying a declining risk-free discount rate. Moreover, Hagen et al. (2012, p.61) concluded that existing literature did not give a firm answer to the question as to what the risk-free discount rate should be: *“Different estimates and assumptions as to the parameter values included in the Ramsey condition may produce very different estimates as to the required rate of return. Harrison (2010) shows that different sources arrive at required rates of return that range from 1.4 percent to 8 percent.... This illustrates that there is no straightforward answer to what is an appropriate discount rate when using this simple approach.”* Hence, it was decided to use 'opportunity cost of capital' as the theoretical framework to decide upon the discount rate (Hagen et al., 2012, p.77): *“There is no one correct way of providing specific estimates for the risk-free market interest rate, the risk premium and the time profile of interest rate developments. However, a reasonable approach may be to assume that it will, under normal market conditions, be possible to secure a risk-free real interest rate of 2.5 percent within a time span of 40 years through investments in the international financial market.”* One respondent endorsed that the risk-free discount rate was (partly) based on judgment: *“We did have some clues about what the level approximately should be. But the theory did not give us clear answers regarding the level of the discount rate. Partly it came out of thin air.”*

Hagen et al. (2012, p.68) recommended that projects should be discounted using a standard risk-adjusted discount rate, since the outcome of the former regime – estimating the specific risk-adjustment for individual projects – was only followed in a small number of cases, resulting in major projects being discounted at the risk-free discount rate, which was evaluated as undesirable. Moreover, the committee concluded that for determining the risk premium in the discount rate, the CAPM was no longer useful, arguing, amongst other things, that the model assumes that all assets are tradable and have a market price, whilst large parts of national wealth are not tradable and that the model failed to predict how investors act and how financial markets work. Since it was decided not to use the CAPM for determining the risk premium, the Hagen et al. (2012, p.70) committee searched through existing literature for an alternative solution and established a declining term structure of the risk premium, sustaining their argument in a discussion paper by Weitzman (2012). Hagen et al. (2012) assume that a transportation measure has a risk profile that is somewhat closer to a government bond than to an average project funded via the stock exchange and conclude that a risk-adjusted real required rate of return on government bonds of 4% is reasonable. Consequently, the committee recommended a discount rate of 4% for the first 40 years (2.5% risk-free and 1.5% risk premium), a discount rate of 3% for years 41 – 75 (2% risk-free and 1% risk premium) and after 75 years a risk-free discount rate of 2% should be used.

#### 4.4 Sweden

In the 2012 revision of the Swedish ASEK Guidelines (Swedish Transport Administration, 2012),<sup>9</sup> the advisory group of scientific experts recommended that the discount rate should remain at 4%, but the Director General of the National Transport Administration decided to reduce it to 3.5% (Hultkrantz et al., 2014). Consequently, the Guidelines (Swedish Transport Administration, 2012, p. 9) recommend using a social discount rate of 3.5%, arguing that although there are many different views on what the size of the social rate of discount should be, there is a consensus that the Ramsey model should be used as a starting point for determining the discount rate. Subsequently, the discount rate can be determined by estimating the parameters in the Ramsey equation. The ASEK Guidelines state that it is reasonable to make the same assumptions for the consumer's rate of time preference and the numerical value of the elasticity of marginal utility of consumption as those shown the British Green Book (Treasury United Kingdom, 2003) and the European HEATCO recommendations (HEATCO, 2006). The third parameter in the Ramsey equation – the relative consumption growth per capita – was estimated using the projected annual growth in GNP per capita (about 1.8% until 2050). Based on the Ramsey model, a discount rate of 3.28% was estimated (Hagen et al., 2012).

The ASEK Guidelines outline that, although there are scientific arguments for using a declining social discount rate (e.g., Weitzman, 2001 and Gollier, 2002), Sweden works with a constant discount rate, since using a declining discount rate leads to practical complications, as the modelling tools used for CBA are not designed to handle variable discount rates. Moreover, the Guidelines state that macro-economic risk may be an argument for a higher discount rate, compared to the rate determined by the Ramsey equation. Based on the estimation using the Ramsey equation, as well as discussions about risks and declining discount rates, a flat discount rate of 3.5% was established (Swedish Transport Administration, 2012). Because it is not clear to which extent arguments prevailing in scientific literature concerning the inclusion of macro-economic risk and a declining risk-free rate affected the selection of the discount rate, it can be concluded that these arguments were not explicitly considered in the Swedish discounting policy. However, because these arguments were part of the discussions which preceded the selection of the discount rate, it can be established that the Swedish discounting policy implicitly incorporates arguments in the literature concerning the inclusion of macro-economic risk and a declining risk-free discount rate. Finally, interviews revealed that another argument for using a flat discount rate in CBAs for transport projects is that the time horizon of CBAs for Swedish transport projects is 40 years (Olsson et al., 2012), and a declining risk-free discount rate will not, or will only marginally, affect the economic evaluation of projects with such horizons.

#### 4.5 Denmark

The discount rate is determined by the Minister of Finance. Quite recently the discount rate was reduced to 4% (3% risk-free and 1% risk premium). Also, it was decided that the discount rate should decline after 35 years and 70 years. After 35 years, costs and benefits should be discounted at a rate of 3% (2.5% risk-free and 0.5% risk premium), and after 70 years costs and benefits should be discounted with a risk-free rate of 2%. The decision to adopt a declining discount rate was influenced by the recommendations of the Hagen committee. The arguments and rationales used by this committee were 'transplanted' into the Danish practice (see section 4.3 for a discussion of the arguments).

#### 4.6 Respondents' reflections on the process of selecting discounting policies

Apart from obtaining complementary insights into rationales and arguments for discounting policies, respondents were also asked to reflect on the process of deciding upon the discounting policy in their country, as well as its merits. Interviews with Swedish and Danish respondents, in

<sup>9</sup> The ASEK Guidelines were revised in 2018 (Swedish Transport Administration, 2018). These Guidelines provide the same recommendations.

particular, provided new perspectives, since they observed that the applied discount rate in their country is predominantly an outcome of a political-administrative process and not of an impartial scientific exercise. Below, these observations are discussed in more detail.

Three respondents stated that in Sweden the discount rate is not centrally determined by the Ministry of Finance. After a discussion with other Administrations (such as the Environmental Administration), at the end of the day it was the Director General of the Transport Administration who decided on the discount rate which should be used in CBAs for the transport sector. According to the respondents, the Director General selected the lowest possible discount rate that he could reasonably justify, since he realized that the CBA results for infrastructure projects are enhanced when a low discount rate is used. One Swedish respondent stated the following: *“my concern is that the decision about the parameters is taken by the Director General of the Transport Administration. I don't question him as an individual but the fact that the decisions on the parameters are actually taken by people with interests in the results of CBA studies is not very good, I think”*.

Four Danish respondents emphasized the political character of the decision about the discount rate in their practice. The Minister of Finance decided upon the rate, after tough negotiations. According to one respondent, the Ministry of Finance was reluctant to reduce the discount rate (which used to be 6%), since from their point of view, money is best kept in the Treasury and a low discount rate potentially enhances the CBA scores of many projects, which gives project proponents an argument to fund the project. However, in the media, people argued that discount rates should be lowered for three reasons. Firstly, the real interest rate was lower than zero. Secondly, as a result of the high discount rate, no projects aimed at mitigating climate change (e.g., subsidizing electric vehicles) were viable. Thirdly, the Great Belt Company had government secured loans and had borrowed money at 1.5-2% for many years. One respondent stated that in the coalition agreement between the three government parties, it was stated that they should take a look at the discount rate, and there was huge pressure on the Ministry of Finance to lower the rate.

In conclusion, both Danish and Swedish respondents emphasized the fact that political-administrative bargaining processes play a vital role in the establishment of the applied discount rate in their practice. Discounting policies were established after negotiations between actors preferring a low discount rate (e.g., the Swedish Transport Administration) – since this results in their projects performing better in CBAs – and the Ministry of Finance, which favors a high discount rate – since this will lead to low CBA scores and, accordingly, a better argument to keep money in the Treasury. Moreover, respondents discussed the fact that political-administrative negotiations are both fueled and restricted by empirical observations. Danish respondents argued that the discussion about the discount rate catalyzed after it was discovered that the real interest rate was significantly lower than the existing risk-free discount rate. Hence, a situation in which the results from empirical observations or (academic) studies dispute the soundness of the existing discount rate, is perfect soil for a reopening of a bargaining process to adjust the discount rate. Besides fueling debate on the discount rate, empirical observations also set the boundaries for the ‘discounting policy bargaining process’. For instance, from the analysis of the Swedish practice it can be seen that the Director General of the Transport Administration selected the lowest possible discount rate that he could reasonably justify. The observation that bargaining processes may influence discounting policies is covered in the literature (Henderson and Bateman, 1995), but the fact that these processes can be restricted by empirical observations is a new insight. The observation that bargaining processes are not only fueled by academic advances, but also by empirical observations complements the results of Groom and Hepburn (2017).

The Dutch respondents established that the discounting policy was not – or was only to a limited extent – affected by political-administrative mechanisms. The discussion in the Working Group particularly focused on discussions regarding contrasting insights within academic literature. One respondent stated that an additional meeting was planned to discuss arguments which underpin the higher discount rate for transport projects, because affiliates from the Ministry of Transport were not amused by this. However, respondents perceived that, even at this meeting, the discussion focused on arguments conveyed in existing scientific literature.

## 5. Assessment of the five practices

This section provides a critical assessment, through analyzing the rationales and arguments that are used for underpinning the discounting policies in the five practices. Section 5.1 discusses the differences between the discounting policies of the five countries. Section 5.2 analyzes the arguments and rationales used for underpinning the discounting policies in the five practices, for instance, by addressing the way rationales offered in existing literature (see section 3) are translated into the practices.

### 5.1 Differences between discounting policies

To begin with, Table 2 provides an overview of the characteristics of the discounting policies. The second and the third row show the risk-free discount rate and the way macro-economic risk is handled in the discounting policies of the five practices. The discount rate schedule is presented in the fourth row. To provide an indication of what the differences in discounting policies mean for CBA results, the final rows present the net present value and the benefit-cost ratio of a hypothetical transport project with 1.4 billion of construction costs and net yearly benefits of 70 million. These final indicators are calculated for a time horizon of 40 years (the shortest time horizon of the five countries - Sweden) and 100 years (the longest time horizon of the five countries - the Netherlands).

**Table 2: Characteristics of discounting policies for the five practices**

	Netherlands	United Kingdom	Norway	Sweden	Denmark
<b>What is the (declining or constant) risk-free discount rate?</b>	Constant risk-free discount rate of 0%	Declining risk-free discount rate: 3.5%: years 0-30 3%: years 31-75 2.5%: years 76+	Declining risk-free discount rate 2.5%: years 0-40 2%: years 41+	Constant risk-free discount rate of 3.5%. However, arguments for a declining discount rate are implicitly considered	Declining risk-free discount rate 3%: years 0-35 2.5%: years 36-70 2%: years 71+
<b>Is macro-economic risk incorporated in the discount rate?</b>	Constant standard risk premium of 4.5%, also macro-economic risk is handled via scenarios	Macro-economic risk is not handled through the discount rate	Declining standard risk premium is incorporated in the discount rate 1.5%: years 0-40 1%: years 41-75	Macro-economic risk is not explicitly handled through the discount rate but is implicitly considered in the discounting policy	Declining standard risk premium is incorporated in the discount rate 1%: years 0-35 0.5%: years 36-70
<b>What is the</b>	4.5% for the full	3.5%: years 0-30	4%: years 0-40	3.5% for the full	4%: years 0-35

<b>discount rate schedule?</b>	time horizon	3%: years 31-75 2.5%: years 76+	3%: years 41-75 2%: years 76+	time horizon	3%: years 36-70 2%: years 71+
<b>NPV/BCR for a project with costs of 1.4 billion and yearly benefits of 70 million (40 years)</b>	NPV: -42 million  BCR: 0.97	NPV: +166 million  BCR: 1.19	NPV: + 55 million  BCR: 1.04	NPV: +164 million  BCR: 1.18	NPV: +56 million  BCR: 1.04
<b>NPV/BCR for a project with costs of 1.4 billion and yearly benefits of 70 million (100 years)</b>	NPV: +206 million  BCR: 1.15	NPV: +678 million  BCR: 1.48	NPV: +456 million  BCR: 1.33	NPV: +606 million  BCR: 1.43	NPV: +505 million  BCR: 1.36

Table 2 shows that the resulting discount rate schedules (fourth row) for the Scandinavian countries and the United Kingdom appear to be rather similar. However, based on the calculation of the net present value of the fictive project (final rows), it is possible to conclude that the (relatively small) differences in discount rate schedules substantially affect net present values. Moreover, it can be concluded that the discount rate schedule applied in the Netherlands deviates from the other countries, which has a substantial effect on net present values.

Table 2 also shows that the discounting policies vary substantially between the countries. These are the three most significant differences: Firstly, the discounting policies differ with respect to incorporating macro-economic risk into the discount rate. In the United Kingdom risk is not handled through the discount rate, in Sweden risk is only handled implicitly, and both Norway and Denmark apply a declining risk premium, which commences at a rate of 1.5% (Norway) or 1% (Denmark), whereas in the Netherlands risk is handled through a risk-adjusted discount rate of 4.5%. The second component where discounting policies significantly differ is the starting percentage of the risk-free discount rate (the risk-free discount rate in year 1). The discount rate schedules in the United Kingdom and Sweden start with a higher risk-free discount rate than in the other countries. Thirdly, the United Kingdom, Denmark and Norway apply a declining risk-free discount rate, whereas Sweden considers the arguments for a declining discount rate only implicitly in their discounting policy, and the Netherlands does not apply a declining risk-free discount rate.

### *5.2 Assessment of arguments and rationales used for underpinning discounting policies*

Because the key aim of this paper is to analyze how the rationales and arguments for underpinning discounting policies provided in existing literature are translated in five practices, Table 3 outlines the prevailing arguments in the literature for underpinning specific components of discounting policies, as well as the arguments that are used in the five practices. Four types of arguments are distinguished: 1) empirical arguments; 2) judgments based on inconclusive empirical evidence: when empirical evidence does not provide a definite answer, one needs to make a discretionary choice, based on the inconclusive empirical evidence; 3) unspecified judgments: a discretionary decision is made without any specific references to empirical evidence and/or ethical considerations; 4) practical arguments.

**Table 3: Arguments for discounting policies, distinguished by their nature**

<p><b>Arguments underpinning the starting percentage of the risk-free discount rate</b></p>	<p><b>Literature:</b> -Both the ‘consumption behavior’ and ‘opportunity cost of capital’ approaches are justifiable theoretical frameworks for determining a risk-free discount rate, but the former is prevalent (e.g., Arrow et al., 2013).</p> <p><b>Netherlands (0%):</b> -Opportunity cost of capital approach. The real interest rate observed in financial markets is used as a starting point (empirical)</p> <p><b>United Kingdom (3.5%):</b> -Consumption behavior approach. Risk-free discount rate is based on the results of (academic) studies, which provide ranges for the parameters of the Ramsey equation (judgment based on inconclusive empirical evidence)</p> <p><b>Norway (2.5%):</b> Opportunity cost of capital approach. No one correct way of providing specific estimates for the risk-free market interest rate. A reasonable approach seems to be to assume a 2.5% risk-free discount rate, based on the return in international markets (judgment based on inconclusive empirical evidence)</p> <p><b>Sweden (3.5%):</b> -Consumption behavior approach. Reasonable to make the same assumptions as UK and HEATCO for estimating two parameters in the Ramsey equation (<math>p</math> and <math>\mu</math>) (judgment based on inconclusive empirical evidence) -Relative consumption growth, based on projected annual GDP growth (empirical)</p> <p><b>Denmark (3%):</b> -Opportunity cost of capital approach. The recommendations of the Norwegian Hagen committee were ‘transplanted’ into Danish practice. These recommendations resulted from judgment based on inconclusive empirical evidence. (judgment based on inconclusive empirical evidence)</p>
<p><b>Arguments underpinning the decision to use a constant or declining risk-free discount rate.</b></p>	<p><b>Literature:</b> -Consensus that the risk-free discount rate should decline over time (e.g., Atkinson and Mourato, 2008; Arrow et al., 2014; Boardman et al., 2013).</p> <p><b>Netherlands (constant):</b> -Constant risk-adjusted discount rate, underpinned with academic literature. Arguments in the literature for a declining risk-free discount rate justify an increasing term structure for the risk premium (Gollier, 2012b). Hence, the prescription in the scientific literature to use a declining risk-free discount rate can result in a prescription of a constant risk-adjusted discount rate (empirical) -A constant discount rate is easier to apply in practice (practical)</p> <p><b>United Kingdom (declining):</b> Declining discount rate, underpinned with academic literature (empirical)</p> <p><b>Norway (declining):</b> Declining discount rate, underpinned with academic literature (empirical)</p> <p><b>Sweden (constant):</b> -Modelling tools used for CBA are not designed to handle variable discount rates (practical) -Discount rate was determined, based on discussions about risks and a declining discount rate (unspecified judgment) -It doesn’t matter (much) if the discount rate is flat or declining (much), for the economic evaluation of projects with a time horizon of 40 years (practical)</p> <p><b>Denmark (declining):</b> -The recommendations of the Norwegian Hagen committee were ‘transplanted’ into Danish practice. These recommendations were based on empirical evidence. (empirical)</p>
<p><b>Arguments underpinning the decision to incorporate a premium for macro-economic risk in the discount rate (or not)</b></p>	<p><b>Literature:</b> -Only non-diversifiable risks should be considered in discounting policies (e.g., Arrow and Lind, 1970; Damodaram, 2008; Gollier, 2012a). -Risks should not be double counted (e.g., Damodaram, 2008) -Leading scholars disagree on whether the term structure of the risk premium should be increasing or decreasing (Gollier, 2012b; Weitzman, 2012).</p> <p><b>Netherlands (4.5%):</b> -General risk-adjusted discount rate of 3%, based on the required returns of a broad portfolio of investments in the economy (empirical)</p>

	<p>-Transport projects discounted by 4.5% because the net benefits of transport projects are more sensitive to fluctuations in usage. But it is not clear why 4.5% was used (unspecified judgment)</p> <p>-Aggregate risk is handled within the Dutch discounting policy through both a 'risk-adjusted discount rate' and 'macro-economic scenario analysis' (unspecified judgment)</p> <p><b>United Kingdom (0%):</b></p> <p>-Given the size of the national income, the contribution of an individual project to the macro-economic risk seems to be negligible (unspecified judgment)</p> <p><b>Norway (1.5% years 0-40, 1% year 41-75):</b></p> <p>-Risk premium based on academic literature (empirical)</p> <p><b>Sweden:</b></p> <p>-The discount rate was determined, based on discussions about risks and a declining discount rate (unspecified judgment)</p> <p><b>Denmark (1% years 0-35, 0.5% years 36-70):</b></p> <p>-The recommendations of the Norwegian Hagen committee were 'transplanted' into Danish practice. These recommendations were based on empirical evidence. (empirical)</p>
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To begin with, Table 3 shows that all practices adopt a descriptive approach in the sense that an attempt is made to fully substantiate the discount rate in the actual behavior of individuals via the two theoretical frameworks: 'opportunity cost of capital' or 'consumption behavior approach' (first row). Most of the empirical arguments that are used to underpin discounting policies are in line with what is already reported in existing literature. However, in two cases the arguments seem to contradict this literature. Firstly, non-diversifiable risk is not incorporated in the UK discounting policy, since it was argued that non-diversifiable risk is usually negligible for individual projects. Both Hagen et al. (2012) and Hultkrantz et al. (2014) observe that this claim is not underpinned with specific reasons or references. The UK policy is convincing for marginal projects but seems to be difficult to defend for multi-billion projects, such as High-Speed 2. As a result of the project's size, it is not obvious that all the risks can be diversified away. Although various risks were thoroughly analyzed in the Economic Case for High Speed 2 (DfT, 2013) the project's contribution to the macro-economic risk wasn't investigated. Hence, not incorporating risk via the discount rate probably means that the CBA results for projects that contribute heavily to the aggregate risk might be too optimistic. Secondly, even though literature prescribes that risks should not be double counted (e.g., Damodaram, 2008), aggregate risk is handled in the Dutch discounting policy through both a 'risk-adjusted discount rate' and 'macro-economic scenario analysis'. In Norway and Denmark a 'risk-adjusted discount rate' and 'sensitivity analysis' are combined. When macro-economic risk is handled through these sensitivity analyses, it is conceivable that macro-economic risk is also double counted in these practices. The observation that in two cases empirical arguments seem to contradict with the prevailing literature was an unexpected result of this study, considering the emphasis in the guidelines to base the discount rate on empirical information, and the observation of several scholars that the five countries included in this study have a serious CBA track record (e.g., Mackie and Worsley, 2013).

Table 3 also provides insights into underlying explanations for the differences between the discounting policies identified in Table 1. Table 2 shows that the starting percentages of the risk-free discount rates applied in the five practices are underpinned with empirical arguments and judgments based on inconclusive empirical evidence. Hence, it is conceivable that differences between risk-free discount rates can be explained by both empirical characteristics (e.g., the real interest rate differs between country A and country B) and by differences in judgments made (e.g., which risk-free discount rate is selected, based on the inconclusive empirical evidence?). Practical reasons explain why Sweden, unlike the United Kingdom, Norway and Denmark, does not use a declining discount rate. The Swedish modelling tools used for CBA are not designed to handle variable discount rates. Moreover, the urgency of rectifying this practical obstacle is relatively low because, due to the 40-year time horizon, the impact of using a flat or declining discount rate is rather low. Dutch Guidelines use both arguments derived from scientific literature and practical arguments to specify why a constant discount rate is used instead of a

declining discount rate. Both empirical arguments and differences in judgment explain why countries have different policies with respect to handling risk in the discount rate. Based on unspecified judgment, the United Kingdom and Sweden decided not to handle risk through the discount rate. The Dutch Working Group's recommendation to use a 4.5% risk premium for discounting the effects of transport projects does not provide any references to empirical evidence. Because the Dutch and the British practices underpin (part of) their decision to (not) incorporate macro-economic risk without any specific references to empirical evidence and/or ethical considerations, it is difficult to explain differences between these policies.

In addition to the explanations listed above, Swedish and Danish respondents emphasized that political-administrative arguments played a vital role in establishing their discounting policies. Fostering political or administrative goals was identified as an underlying reason for decisions with respect to the discounting policies in these practices. However, respondents were not able to fully explain which components of the discount rate were (not) influenced by these negotiations. Nevertheless, for both practices it can be concluded that the applied discount rate is influenced by the relative power of institutions preferring a high discount rate compared to institutions preferring a low discount rate. An interesting feature of the political-administrative arguments is that they were not explicitly addressed in the guidelines.

Arguments to derive the social discount rate from fundamental ethical views (e.g., Davidson, 2006; Ramsey, 1928; Shively, 2002; Stern, 2008; van Liederkerke, 2004) were discussed in some of the guidelines. However, such prescriptive arguments did not seem to have an explicit role in the final underpinning of the discounting policies that this paper scrutinized. A statement along the lines of 'for ethical reasons, we select discount rate  $X$ ' was not found in any CBA guideline and Stern's suggestion (2008) to select discount rates based on thought experiments was not adopted in any of the practices. An underlying study, supporting the British discounting policy (Oxera, 2002), outlines ethical arguments for applying a zero pure rate of time preference. However, the British Guidelines do not discuss these arguments explicitly (Treasury of the United Kingdom, 2003; p.97): "*other literature suggests it lies between 0.0 and 0.5. However, if zero, this implies pure time preference does not exist, which is not regarded as plausible*". In fact, the British Guidelines evade the ethical question as to whether a pure rate of time preference 'ought' to be included. Accordingly, this argument suffers from the "is-ought fallacy", articulated by David Hume, which implies that just because something is a certain way, it does not necessarily mean that it ought to be that way. The Dutch Working Group establishes that ethical arguments exist for adopting a rate of pure time preference of 0%, but this argument does not seem to play a role in the final underpinning of the discounting policy, which is primarily grounded in the 'opportunity cost of capital' framework. One Dutch respondent argued that one can safely use an empirically-based discount rate for the evaluation of transport projects as ethical considerations only matter when establishing discount rates for the evaluation of government policies which clearly affect future generations (e.g., decisions concerning the size of the national debt and climate change policies). Another respondent argued that ethical arguments were discussed in the Dutch Discount Rate Working Group (2015). However, because the Working Group aspired to make a value-neutral choice regarding the discount rate, they decided to use empirical arguments instead of ethical arguments in the underpinning of the discounting policy. Most importantly, neither of the arguments presented by the Dutch respondents were addressed in the extensive report made by the Dutch Discount Rate Working Group (2015).

## 6. Conclusions and discussion

This study analyzes how the rationales and arguments for underpinning discounting policies provided by existing literature are translated into five practices: the Netherlands, the United Kingdom, Norway, Sweden and Denmark. This study observes that the five practices adopt a

descriptive approach in the sense that an attempt is made to fully substantiate the discount rate in the actual behavior of individuals. Prescriptive arguments to derive the social discount rate from fundamental ethical views are sometimes discussed in the guidelines, but these types of arguments did not seem to play a role in the final underpinning of discounting policies. Another observation is that although most of the empirical arguments underpinning discounting policies are in line with the literature, some of the arguments seem to contradict this existing literature. Bearing in mind the decisive impact of the discount rate on CBA outcomes, it is recommendable to critically assess and reconsider these arguments.

Apart from empirical evidence, discounting policies in the five countries are based on judgmental arguments, political-administrative arguments and practical arguments. Practical arguments are used in the Dutch and Swedish practice to underpin the choice for a constant risk-free discount rate. Political-administrative bargaining processes between institutions preferring a high (low) discount rate particularly played a vital role in the establishment of the discount rate in Sweden and Denmark. One insight of our study, which hasn't been seen before in existing literature, is that the political-administrative negotiations in these practices are both fueled and restricted by empirical observations. On the one hand, a situation in which results from empirical observations or (academic) studies dispute the soundness of the existing discount rate is perfect soil for the reopening of a bargaining process to adjust the discount rate. On the other hand, empirical observations also set the boundaries for the 'discounting policy bargaining process', as it is difficult for actors to argue in favor of a discount rate which they cannot reasonably justify, based on empirical evidence. Furthermore, this study demonstrates that 'judgment' plays a significant role in the establishment of discount rates. The fact that analysts inevitably need to make value judgments when selecting discount rates is well covered in existing literature (e.g., Baum, 2009; Boadway, 2006). However, a new insight of our study is that discounting policies are not only established based on 'inevitable judgment', but also on 'unspecified judgment'. Decisions in the Swedish, Dutch and British practice regarding the incorporation of macro-economic risk in the discount rate were made in a discretionary way without any specific references to empirical evidence.

Probably the most important conclusion of this study is that both the political-administrative arguments and the judgmental arguments are not – or are poorly – communicated in the guidelines of the five practices. The main problem resulting from this poor communication of the judgmental (and sometimes political) character of discount rates is that it is difficult for Members of Parliament and/or other actors and institutions who aspire to use CBA (from now on: CBA users) to decide whether they agree with the reasonableness of the judgments. When the judgmental aspects of the discount rate are not made explicit, this can prevent CBA users from assessing the judgments made, from disagreeing with these judgments and from asking for a recalculation of the CBA based on a discount rate which coincides with their own judgments. Another problem resulting from the poor communication of judgments is that it is difficult to learn from (the differences between) the five practices investigated in this study. To illustrate, because the Dutch and the British practice underpin their decision to (not) incorporate macro-economic risk without any specific references to empirical evidence and/or ethical considerations, it is difficult for countries that aspire to institutionalize CBA to learn from these mature practices.

The next question is: how can the communication of the judgmental character of discounting policies be improved? First and foremost, judgments should be made transparent. Below, we discuss four ways in which the transparency of the guidelines of the five practices can be improved. Although this discussion focuses on the five practices investigated in this study, we believe that these recommendations can be useful for other practices as well. The first recommendation is that practices who adopt a descriptive approach should make it clear why

they have adopted a descriptive, instead of a prescriptive approach. In the case of the Netherlands, members of the Working Group that are responsible for establishing the discount rate, discussed these arguments internally, but this discussion did not materialize in the guidelines. One respondent argued that the Working Group's decision was grounded in empirical arguments, because they aspired to make a value-neutral choice about the discount rate. According to this interviewee it is up to politicians, and not academics, to make ethical decisions. However, because this critical decision did not materialize on paper, it is very difficult for politicians and other CBA users to be aware of the fact that it is even possible to determine the discount rate on prescriptive arguments that do not match market interest rates. The ambition of the Working Group to make a value-neutral choice when selecting the discount rate is also interesting because it contradicts Baum's conclusion (2009) that analysts cannot avoid injecting their value judgments on the selection of the discount rate. Our second recommendation to analysts, who choose to adopt a descriptive approach when selecting a social discount rate is to make the arguments explicit that underpin the choice between using public discount rates (how does society think that the government should discount the impacts of public investments) or private discount rates (based on market behavior). Thirdly, when countries choose to determine the social discount rate based on private discount rates, it is recommended that they clearly communicate why one particular market rate has been selected from the multiple market rates that are available. For instance, in the Norwegian Guideline (Hagen et al., 2012, p. 77) the judgmental character of the selection of one market rate from the multitude of rates available is explicitly communicated: *"there is no one correct way of providing specific estimates for the risk-free market interest rate, the risk premium and the time profile of interest rate developments. However, a reasonable approach may be to assume that it will, under normal market conditions, be possible to secure a risk-free real interest rate of 2.5 percent within a time span of 40 years through investments in the international financial market."* However, although the judgmental character of this decision is explicitly communicated, no additional arguments are provided to explain why the decision to select a 2.5 percent risk-free interest rate was more reasonable than another risk-free discount rate that could also be selected from the inconclusive empirical evidence. In this case, it is recommended that arguments are explicitly addressed to explain why a certain rate was selected in the guidelines. Fourthly, transparency can be improved by providing specific underpinnings, in case components of the discounting policy are based on discretionary decisions made without any specific references to empirical evidence and/or ethical considerations (unspecified judgments).<sup>10</sup> Finally, academics who aspire to conduct research that would better equip practitioners to design discounting policies in the face of varying recommendations from the literature are encouraged to investigate how these four recommendations can be further specified.

Apart from providing solid underpinnings for the judgements made when designing discounting policies, various scholars argue that it is important to conduct sensitivity analyses on the normative judgments in the discounting policy and to inform CBA users about alternative CBA outcomes based on these sensitivity analyses (e.g., Boadway, 2006; Kaplow et al., 2010; Nordhaus, 2007; Stern, 2008). This allows CBA users to consider CBA outcomes which coincide with their own belief system. Interestingly, this view is shared by both leading descriptivist and prescriptivist scholars. For instance, Nordhaus (2007, page 701) argues that no sensible policy maker would base decisions on a single model or a single ethical perspective: *"sensible decision making requires a robust set of alternative scenarios and sensitivity analyses"*. Stern (2008), in turn, argues that value judgments must be discussed explicitly and the implications of different judgments should be examined. Kaplow et al. (2010) propose carrying out sensitivity analyses when an element of the discount rate 'is' grounded in empirical information but 'could be' based

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<sup>10</sup> Ideally, political-administrative judgments should also be made more transparent in the guidelines. However, as one reviewer rightfully noted, it is questionable whether it is realistic for such considerations to be communicated explicitly.

on fundamental ethical views, since this enables the CBA user with ethical views that do not coincide with the empirical information to make their own assessment.<sup>11</sup> According to Kaplow et al. (2010) sensitivity analyses are often used when empirical parameters are uncertain, but the method is rarely used to analyze the impacts of diverging ethical judgments. Several scholars state that a clean separation of empirical and normative arguments in discounting policies is a clear benefit of normative sensitivity analyses (e.g., Goulder and Williams, 2012; Kaplow et al., 2010). This makes discounting policies more transparent and easier to interpret. It also responds to the ambition of the Dutch Working Group to charge researchers with making value-neutral decisions, and to leave the ethical decisions to politicians. Normative sensitivity analyses can clarify to politicians and other CBA users that value judgments are inevitable when establishing discount rates. Mouter (2017a) finds that this can increase politicians' use of CBA when forming judgments about candidate transport projects, as politicians argue that their trust in CBA's impartiality increases when normative choices are made transparent. Furthermore, politicians state that increasing the awareness and recognition of the normative judgments underlying CBA diminishes the probability that politicians will kill the political debate using CBA (Mouter, 2017b). Killing the political debate using CBA means that politicians portray CBA as an instrument which makes further political discussion obsolete because it covers the total political trade-off in an unambiguous and scientific way. This is regarded as one of the main downsides of CBA among Dutch politicians (Mouter, 2017b).

One implication of incorporating normative sensitivity analyses into guidelines is that CBAs present two or more results. To assist CBA users in weighing up the multiple results, it is useful to thoroughly underpin the arguments for each set of value judgments.<sup>12</sup> For instance, when CBA users receive CBAs which calculate net present values based on discount rates grounded in a descriptive and a prescriptive approach, it can be useful to list the arguments defending each approach. For instance, one argument to defend the descriptive approach is that using a prescriptivist social discount rate that is (substantially) lower than the market interest rate might divert financial resources from being put to better use and create an inefficient allocation of funds (Azar, 2007; Nordhaus, 2007). Moreover, it is recommended to communicate to CBA users that some prescriptive arguments that apply to transport projects that last a long time, with benefits accruing to both current and future cohorts (e.g., a new high-speed rail line or subsidizing electric vehicles), do not – or only to a limited extent – apply to transport projects with only intra-temporal impacts (e.g., a modest road expansion).<sup>13</sup> This enables CBA users to draw the conclusion that the descriptive approach is probably more relevant for the evaluation of projects with short term impacts than projects with long term impacts.

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<sup>11</sup> Examples of ethical arguments are discussed in section 3.1.

<sup>12</sup> Many of such arguments can be inferred from the literature review and the country reports (sections 3 and 4).

<sup>13</sup> For instance, issues with standing of future generations, and arguments to adopt a pure rate of time preference of zero, see section 3.1.

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