Journal of Environmental Economics and Management 73 (2015) 32–49

Contents lists available at ScienceDirect

Journal of Environmental Economics and Management

journal homepage: www.elsevier.com/locate/jeem

Declining discount rates and the Fisher Effect: Inflated past, discounted future?

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ARTICLE INFO

Article history:
Received 11 July 2013
Available online 17 June 2015

JEL:
Q48
C13
C53
E43

Keywords:
Social discounting
Declining discount rates
Fisher effect
Real and nominal interest rates
Social cost of carbon

ABSTRACT

Uncertain and persistent real interest rates underpin one argument for using a declining term structure of social discount rates in the Expected Net Present Value (ENPV) framework. Despite being controversial, this approach has influenced both the Inter-Agency Working Group on Cost–Benefit Analysis and the UK government's guidelines on discounting. We first clarify the theoretical basis of the ENPV approach. Then, rather than following previous work which used a single series of U.S. Treasury bond returns, we treat nominal interest rates and inflation as co-integrated series and estimate the empirical term structure of discount rates via the 'Fisher Effect'. This nests previous empirical models and is more flexible. It also addresses an irregularity in previous work which used data on nominal interest rates until 1950, and real interest rates thereafter. As we show, the real and nominal data have very different time series properties. This paper therefore provides a robustness check on previous discounting advice and updated methodological guidance at a time when governments around the world are reviewing their guidelines on social discounting. The policy implications are discussed in the context of the Social Cost of Carbon, nuclear decommissioning and public health.

Introduction

Despite some puzzles along the way, the burgeoning theoretical literature on discounting distant time horizons points more or less unanimously towards the use of a declining term structure of social discount rates (DDRs) for risk free public projects. (Gollier, 2008, 2009; Traeger, 2013; Weitzman, 1998, 2007).[1] This conclusion is more or less robust to one's stance on the normative-positivist debate provided that the primitives of the discounting problem, growth or the interest rate exhibit persistence over time (Arrow et al., 2013, 2014; Freeman and Groom, 2015; Gollier, 2008).[2] Consensus in an area of theory as potentially fraught as social discounting is a rare thing. Perhaps for this reason the literature on DDRs has been highly influential in policy circles, and many governments have either adopted DDRs or are in the process of considering

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[1] This is for risk-free discounting of certainty-equivalent future cash flows. See Gollier, 2012 for a discussion about project risk in discounting.
[2] Strictly speaking, the social planner must exhibit 'prudence' (e.g. Gollier, 2008).

http://dx.doi.org/10.1016/j.jeem.2015.06.003

them.[3] Yet, it has become clear that there is no consensus on how to operationalize a schedule of DDRs for use in Cost–Benefit Analysis (CBA). One need only look atthe different and occasionally ad hoc motivations for current policies as evidence for this (e.g. (HMT, 2003; Weitzman, 2001; Newell and Pizer, 2003)). This lack of consensus turns out to be important since evaluation of intergenerational projects is very sensitive to the discount rates deployed. Indeed, the range of policy prescriptions arising from different approaches to estimating the DDR schedule is comparable to that arising from the thorny normative-positive debate that characterized the aftermath of the Stern Review (Nordhaus, 2007; Groom et al., 2007; Freeman and Groom, 2015).

In this paper we explore the empirical sensitivities of the DDR term structure associated with the Expected Net Present Value (ENPV) approach proposed by Martin Weitzman Weitzman (1998). Our main objective is to advance new empirical practices which operationalize this approach and thereby inform government guidelines and policy. There are three main contributions in this direction. First, we clarify the theoretical basis of the ENPV approach. Second, we generalize the empirical methods for analyzing historical interest rate data in this context. Specifically we estimate the 'Fisher Effect', which allows the real interest rate to be modeled in terms of its component parts: the nominal interest rate and inflation. Third, our approach addresses an important irregularity in the interest rate series used before. The overall contribution is to develop an empirical method which encompasses and supersedes the approaches used previously.

In the ENPV framework, DDRs are driven by uncertainty over long-term average future Treasury bonds yields. The result stems from the fact that the ENPV approach values the future using the expected discount factor, not the expected discount rate. The associated certainty equivalent discount rate is declining with the time horizon because costs and benefits in future states of the world with persistently high discount rates contribute less to the overall evaluation. The ENPV of the distant future is dominated by the low discount rate states of the world, and hence the appropriate discount rate for the distant future converges to the lowest possible future rate. One way to understand the behavioral underpinnings of this phenomenon is to recognize, through the Ramsey Rule for example, that interest rates are highly positively correlated with the expectation of future economic growth. If expected growth is high, our descendants in the distant future will be substantially wealthier than us, and we will be prepared to save less today on their behalf compared to when low growth is expected. This leads to higher interest rates and lower valuations of projects with intergenerational consequences. Current investments for the distant future are then primarily driven by the possibility that growth, and hence the interest rate, is persistently low in the future. To understand how this works, we need to introduce uncertainty about the future state of the world. A numerical example illustrates the basic idea. Suppose it is equally likely that growth is low or high in the future, and interest rates are either 1–7%. In this case the present value of $1 in t years time will either be $P_l = \exp(-0.01t)$or$P_h = \exp(-0.07t)$. The ENPV approach takes the average of these valuations and calculates the certainty equivalent rate, $r(t)$, which in this case is defined by $\exp(-\mathrm{tr}(t)) = 0.5(\exp(-0.01t) + \exp(-0.07t))$. For time horizons of $t = [1, 30, 200, 400]$, the certainty equivalent rate is [4.0%, 2.8%, 1.7%, 1.2%] respectively. This result can be generalized, with the decline of the term structure increasing with both the persistence over time and the volatility of interest rates.[4]

These are the simple mechanics of the ENPV approach. A deeper story is that the declining term structure reflects a precautionary savings motive that increases the further one looks into the future (Gollier and Weitzman, 2010; Gollier, 2008). With persistence in interest rates coming from, say, different possible states of mean growth, compounding effects make uncertainty appear greater the further one looks into the future. The precautionary savings effect therefore increases with the time horizon and the discount rate term structure is declining. When formalizing this argument, though, the devil is in the detail and careful interpretation is needed (Gollier, 2014). The first contribution of this paper, therefore, is to clarify the theoretical motivation for the ENPV approach and the implications this has for empirical work. We do this by taking ENPV out of its rather ad hoc theoretical origins (e.g. (Weitzman, 1998)) and placing it within the asset pricing literature (e.g. Coxetal81).

The main contribution of this paper is empirical. The context is that the ENPV approach is operationalized using historical interest rate data, rather than expert opinion (Freeman and Groom, 2015; Weitzman, 2001). Previous work of this type has illustrated the importance of careful modeling to establish the time series properties of the series, particularly persistence and volatility. Newell and Pizer (2003) (henceforth N & P) showed that U.S. bond yields have exhibited sufficient persistence in the past two centuries for the empirical term structure of discount rates to exhibit a rapid decline. This decline raises the social cost of carbon (SCC) from $5.7/tC to between $6.5/tC and $10.4/tC in the process (US $2000; see also Newell and Pizer, 2001). Yet, these results were shown to be highly sensitive to the time-series model used to characterize interest rate uncertainty. Subsequent work by Groom et al. (2007) (henceforth GKPP) showed that more flexible characterizations of interest rate uncertainty lead to a schedule of DDRs that raises the SCC yet further to $14.4/tC. Similar

[3] The UK, French and Norwegian governments now recommend DDRs for intergenerational Cost–Benefit Analysis (HMT, 2003; Lebegue, 2005; MNOF, 2012). The U.S. Environmental Protection Agency (USEPA) and U.S. Inter-agency Working Group on the Social Cost of Carbon both recommend lower discount rates for intergenerational projects on the basis of DDRs (USEPA, 2010; IAWG, 2010), and DDRs are still being considered as a result of a joint USEPA, Office for the Management of Budgets (OMB), Resources for the Future expert panel meeting (Freeman et al., 2014; Arrow et al., 2014). The Dutch government, the UK Treasury, the Cypriot government and the OECD International Transport Forum are reviewing their guidelines on long-term discounting.

[4] In this simple framework, and in many applications, the term structure declines from the historic average at $t=0$, thereby abstracting away from current market interest rates. It is straightforward to include current market conditions by, for example, using the current Treasury bond yield in place of the historic average at the short end of the term structure. This may lead to an increasing, or hump-shaped, term structure, as expected growth effects vie against the precautionary savings motive.