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Be careful what you calibrate for: Social discounting in general equilibrium

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ABSTRACT

Concerns about intergenerational equity have led to an influential practice of setting social utility discount rates based on ethical considerations rather than to match household behavior, particularly in climate change economics (e.g., Stern, 2006). This paper formalizes the broader policy implications of this approach in general equilibrium by characterizing jointly optimal environmental and fiscal policies in a climate-economy model with differential planner-household discounting. First, I show that decentralizing the optimal allocation requires not only high carbon prices but also fundamental changes to tax policy: If the government discounts the future less than households, implementing the optimal allocation requires an effective capital income subsidy (a negative intertemporal wedge), and, in a setting with distortionary taxation, an effective labor-consumption tax wedge that is decreasing over time. Second, if the government cannot subsidize capital income, the *constrained-optimal* carbon tax may be up to 50% below the present value of marginal damages (the social cost of carbon) due to the general equilibrium effects of climate policy on household savings. Third, given the choice to optimize either carbon, capital, or labor income taxes, the socially discounting planner's welfare ranking is ambiguous over a standard range of parameters. Overall, in general equilibrium, a policy-maker's choice to adopt differential social discounting may thus overturn conventional recommendations for both environmental and fiscal policy.

1. Introduction

Economists have long debated the appropriate social rate of discount with which policy-makers should value the future.[1] Recently, in the context of the economics of climate change, the question of social discounting has again risen to the forefront of academic and policy debates (e.g., Arrow et al., 1996, 2012). As the impacts of greenhouse gas emissions occur over long time horizons, optimal climate policy depends critically on discounting parameters (Nordhaus, 2007, 2008; Interagency Working Group, 2010). One influential view posits that it is "ethically indefensible" to discount the utility of future generations, as famously stated by Ramsey (1928). Economists embracing this view have incorporated near-zero pure rates of social time preference into their models, yielding aggressive climate policy recommendations (Stern, 2006; Cline, 1992). This approach has been controversial for several reasons, including the fact that it does not align with households' intertemporal preferences as revealed through their savings behavior (Nordhaus, 2007; Dasgupta, 2008). Indeed, Ramsey himself noted that " the rate of saving which the [zero-discounting optimality] rule requires is greatly in excess of that which anyone would normally suggest " (Ramsey, 1928). While Ramsey's ethical critique is widely cited in support of near-zero discounting (e.g., Interagency Working Group, 2010), his work also reminds us that such discounting does not match household behavior. Several studies have thus proposed frameworks where agents and the planner discount utility differently (e.g., Farhi and Werning, 2005, 2007, 2010; Kaplow et al., 2010; Goulder and Williams, 2012; von Below, 2012; Belfiori, 2017). This approach can be formally microfounded by an overlapping generations model where the planner places a higher welfare weight on future generations above the current generation's private altruism towards the future (Bernheim, 1989; Farhi and Werning, 2005, 2007; Belfiori, 2017; described below). While social discounting can thus be used to address intergenerational ethical concerns in climate policy, it should also be expected to have implications for, e.g., capital allocations and fiscal policy. Though the potential for such broader implications has been frequently noted (e.g., Manne, 1995; Caplin and Leahy, 2004; Goulder and Williams, 2012), few studies have formalized these effects to date.

This paper thus formalizes and quantifies the broader policy implications of differential discounting in a dynamic general equilibrium climate-economy model. I theoretically characterize jointly optimal

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[1] This vast literature ranges from debates on the fundamental principles of what discounting should capture (e.g., Baumol, 1968; Sen, 1982; Lind, 1982) to modern treatments about the implications of factors such as heterogeneity (e.g., Gollier and Zeckhauser, 2005; Heal and Millner, 2013), uncertainty (e.g., Newell and Pizer, 2003; Gollier and Weitzman, 2010), the structure of preferences (e.g., Caplin and Leahy, 2004), and commitment (Sleet and Yeltekin, 2006), inter alia.

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climate and fiscal policy across three settings: a first-best setting, a second-best setting where the planner is constrained in his ability to subsidize capital income, and a second-best fiscal setting in the Ramsey tradition where the planner must raise revenues from distortionary taxes. I then quantify optimal policies and welfare by integrating differential discounting into two climate-economy models: the generalized numerical implementation of Golosov, Hassler, Krusell, and Tsyvinski's model (2014, "GHKT") by Barrage (2014), and the COMET model (Barrage, 2016) which extends the seminal DICE framework of Nordhaus (see, e.g., Nordhaus, 2008, 2010a,b) to incorporate distortionary taxation and government expenditures.

The approach of this paper seeks to contribute to the prior literature in several ways. On the one hand, both von Below (2012) and Belfiori (2017) study differential discounting in general equilibrium climate-economy models, but focus on energy and climate policy implications in a first-best setting where the planner can freely subsidize capital income (von Below, 2012) or where oil is the only factor of production (Belfiori, 2017), so that there is no role for fiscally constrained or broader tax policy. On the other hand, Farhi and Werning (2005, 2010) study differential discounting and fiscal policy, but focus on a Mirrleesian economy (without climate change). In this setting, tax policy is designed to trade off insurance and incentives for agents that experience productivity shocks, and face the risk of being born into families with less productive parents. Distortions arise as the planner cannot observe households' work effort or productivity. In contrast, in the Ramsey setting considered here, distortions arise as the government must raise revenues but cannot impose lump-sum taxes. The main results of the analysis are as follows.

First, differential discounting fundamentally alters optimal tax policy prescriptions. In a first-best setting, decentralizing the optimal allocation requires both high carbon taxes and capital income subsidies. Intuitively, this is because households are too impatient from the planner's perspective, and consequently fail to invest sufficiently in the economy's capital stocks. While this insight was previously formalized by von Below (2012) in the first-best, I further show that it holds even in a fiscal setting where government revenues must be raised from distortionary taxes. In this case, if the government values the future more than households, decentralizing the optimal allocation requires not only capital income subsidies but also an effective labor-consumption tax wedge that is decreasing over time. These policies stand in stark contrast to the classic Ramsey prescriptions of zero capital income taxes (i.e., no intertemporal distortions), and constant (smooth) intratemporal distortions through, e.g., constant labor income taxes (see, e.g., Chari and Kehoe, 1999; Atkeson et al., 1999). These changes are moreover quantitatively significant: Adopting the pure rate of social time preference advocated by Stern (2006) (0.1% per year) yields optimal capital income subsidies ranging from 30% to 75%, and changes optimal labor income taxes from a constant rate of 41% with standard discounting to a high initial rate of 53% that decreases to 33% by the end of the century. Though different from the standard Ramsey setting, the results broadly align with Farhi and Werning's (2005, 2010) finding that – in a Mirrleesian economy with social discounting – the constrained-efficient allocation can be decentralized by negative marginal estate taxes, indicating that bequests should be subsidized. While Mirrleessian and Ramsey economies generally lead to different tax policy recommendations, with differential discounting, the results of this paper suggest that both frameworks broadly agree on the desirability of subsidies to increase the returns to savings.

In reality, most countries *tax* capital income, calling into question the political feasibility of capital income subsidies. Second, I thus consider policy design from the perspective of a socially discounting planner who cannot subsidize capital income. Given this basic constraint, I find that even a planner adopting the social discounting preferences advocated by Stern (2006) may not want to impose a 'Sternian' carbon tax (i.e., a tax equal to the socially discounted marginal damages of emissions) if he cannot subsidize savings at the same time. More formally, the constrained-optimal carbon tax must be adjusted for the general equilibrium effects of climate policy on households' incentives to save: (i) If climate change decreases the returns to capital, a component must be added to the optimal carbon tax, ceteris paribus. (ii) If energy and capital are complements in production, a component must be subtracted from the optimal carbon tax, ceteris paribus. Intuitively, without a capital income subsidy, private returns to savings are too low. To the extent that climate policy decreases (increases) the returns to capital, it therefore exacerbates (mitigates) this inefficiency, and must be adjusted accordingly.[2] Theoretically, the net sign of these adjustments is ambiguous. Quantitatively, I find that optimal carbon taxes are 5–40 % *lower* if the planner cannot subsidize capital income, and 10–60 % lower if the planner cannot reduce capital income taxes below a positive level of 30%. The largest downward adjustments occur when energy and capital are complements in production, as higher energy prices reduce the marginal product of capital. Since the planner cares about the overall level of assets given to future generations – both natural and man-made – he adjusts carbon taxes downward to mitigate their undesirable effects on capital accumulation. While the size of this adjustment is sensitive to the parameters, the results imply that a constrained fiscal environment may significantly decrease optimal carbon taxes even from the perspective of a socially discounting planner.

Finally, I compare the welfare gains that a planner with a near-zero pure rate of social time preference would achieve by optimizing either carbon, capital income, or labor income taxes. Perhaps surprisingly, the relative importance of these policy levers is ambiguous, and depends critically on the parameters. For example, the benchmark calibration assumes a consumption elasticity of $\sigma = 1.5$. In this setting, the welfare benefits from adjusting carbon taxes from standard to socially discounted levels (+0.96% permanent consumption increase equivalent) are lower than those from adjusting either capital income taxes (+1.36%) or labor income taxes (+2.30%). In contrast, a planner with logarithmic preferences would indeed achieve significantly larger welfare gains from adjusting climate policy than fiscal policy. While these calculations abstract from many important complexities and are subject to many caveats, they do illustrate that climate protection is only one of various investments society can make to benefit future generations (e.g., health, education, and private capital). A government that weighs the utility of future households more highly than its citizens should thus incentivize larger investments in an appropriately balanced portfolio of all such assets.

Of course there are a number of important reasons why investments in the climate may still need to be discounted differently from other assets in such a portfolio. For example, climate investments accrue benefits over much longer time horizons than other assets, and recent empirical evidence points to a significantly downward-sloping term structure of discount rates over such time horizons (Giglio et al., 2014). Several underlying factors could generate this pattern, including uncertainty over growth (see, e.g., Gollier, 2016, Gollier and Weitzman, 2010) or the structure of household preferences. The results of this paper highlight the potential importance of formally incorporating such microfoundations into macro-climate-economy models in order to assess their policy implications comprehensively.

The remainder of this paper proceeds as follows. Section 2 sets up the benchmark model and describes policies that decentralize the optimal allocation in the first-best. Section 3 characterizes constrained-optimal policy for a planner who cannot subsidize capital income. Section 4 presents the analysis in a setting with distortionary taxes. Section 5 summarizes the calibration and the quantitative results.

[2] One could also ask how capital should be taxed when carbon cannot be priced. For a treatment of this issue in a decentralized economy with altruistic households that invest in dirty capital to protect their offspring against climate change (but thereby exacerbate the externality), see Asheim and Nesje (2016).