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Trading off generations: Equity, discounting, and climate change ☆

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ABSTRACT

The prevailing literature discusses intergenerational trade-offs in climate change predominantly in terms of the Ramsey equation relying on the infinitely lived agent model. We discuss these trade-offs in a continuous time OLG framework and relate our results to the infinitely lived agent setting. We identify three shortcomings of the latter: first, underlying normative assumptions about social preferences cannot be deduced unambiguously. Second, the distribution among generations living at the same time cannot be captured. Third, the optimal solution may not be implementable in overlapping generations market economies.

1. Introduction

How much should society invest into avoiding or at least extenuating anthropogenic climate change? A key determinant of the optimal mitigation and investment levels is the social discount rate and a heated debate has evolved over its quantification. We analyze whether the infinitely lived agent (ILA) model employed in this debate is suitable to discuss the involved intergenerational trade-offs. For our analysis, we develop a new continuous time overlapping generations (OLG) growth model and compare the discounting formulas resulting from the ILA and the OLG framework. Our approach uncovers normative assumptions of calibration-based approaches to climate change assessment and explores equity and consistency concerns in normative approaches that refuse intergenerational discounting.

The Stern (2007) review on the economics of climate change, carried out by the former World Bank Chief Economist on behalf of the British government, has drawn significant attention in the political arena. It implies an optimal carbon tax that differs by an order of magnitude from the optimal tax derived by Nordhaus (2008) in his widely known integrated

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assessment model DICE.[1] Nordhaus (2007) shows that this difference is almost fully explained by the different assumptions on social discounting as summarized in the Ramsey equation.[2] Nordhaus himself favors a *positive* approach to social discounting using a calibration-based procedure that attempts to avoid explicit normative assumptions. In contrast, Stern (2007) advocates a *normative* approach emphasizing that only ethical considerations are valid to address the intergenerational trade-off.

The debate over the right discount rate almost exclusively relies on the Ramsey equation. The Ramsey equation characterizes how an ILA trades off consumption possibilities at different points in time. Contributors to the climate change discussion usually interpret the ILA framework as a utilitarian social welfare function, associating each point in time with the utility of a different generation. The real world is inhabited by overlapping generations, who value their own future consumption and possibly that of future generations. Barro (1974) shows that appropriate assumptions on altruism and operational bequests imply that finitely lived overlapping generations aggregate into a representative ILA. However, recent empirical studies indicate that the altruistic bequest motive is rather weak.[3] As a consequence, the dominant share of savings is driven by individual life-cycle planning rather then by altruistic transfers for future generations. Therefore, a calibration of the Ramsey equation to observed interest rates will necessarily reflect preference parameters that deal with individuals' life-cycle planning over their finite lifetime. Confined to an ILA framework, the current discounting debate is not capable of disentangling a social planner's discounting of future generations from an individual's discounting of his own future utility.

For our analysis, we develop a novel continuous time OLG model around two desiderata. First, in order to relate as closely as possible to the standard Ramsey equation, we choose a model in continuous time where agents live a finite deterministic life span. In contrast to the models based on Yaari (1965) and Blanchard (1985), where agents have an infinite lifetime and a constant probability of death, our model explicitly captures life-cycles. Second, we incorporate economic growth via exogenous technological change in order to make reasonable statements about intergenerational distribution. This feature is also a crucial distinction from the most closely related model in the literature by d'Albis (2007) who examines the influence of demographic structure on capital accumulation. Similar to Calvo and Obstfeld (1988), Burton (1993) and Marini and Scaramozzino (1995), we introduce a social planner maximizing the discounted life time utilities of the OLG.

Our analysis derives several theorems on the observational equivalence (identical macroeconomic aggregates) between the OLG frameworks and the ILA model. However, we show that the seemingly positive calibration of an ILA model to observed market outcomes involves normative assumptions. In particular, these assumptions imply that the social planner's pure rate of time preference is higher than that of the individuals living in the economy. Moreover, we show that the normative approach to discounting in the ILA setting overlooks a conflict between intergenerational equity and distributional equity among generations alive. Finally, we find that a social planner who is limited to tax labor and capital income cannot achieve the first-best social optimum without age-discriminatory tax schedules.

Related to our analysis, Aiyagari (1985) showed that under certain conditions an overlapping generations model with two-period-lived agents exhibits the same paths of aggregate capital and consumption as the discounted dynamic programming model with infinitely lived agents in discrete time. We complement these results by explicitly deriving the relation between the preference parameters of the OLG model and the observationally equivalent ILA framework in continuous time. The equivalence between the social planner solution in a continuous time OLG setting and an ILA model was already observed by Calvo and Obstfeld (1988). While they focus on time inconsistencies in fiscal policy, our focus is on intergenerational trade-offs.

Several environmental economic applications employ numerical simulations of integrated assessment models to compare interest rates and climate policy between ILA models and OLG frameworks in which agents live for two or three periods. Gerlagh and van der Zwaan (2000) point at differences between the models as a consequence of aging and distributional policies. Howarth (1998) compares the simulation results of a decentralized OLG, a constrained, and an unconstrained utilitarian OLG to the results obtained by Nordhaus (1994) using the ILA model DICE. While the decentralized OLG yields similar results as DICE, he finds substantial differences for the utilitarian OLGs. Calibrating time preference, Howarth (2000) shows that the unconstrained utilitarian OLG model and the ILA model can produce similar outcomes. Stephan et al. (1997) provide a simulation yielding equivalence between a decentralized OLG with bounded rationality and an ILA economy with limited foresight. In contrast, our model elaborates the analytical conditions under which the continuous time ILA and OLG frameworks are observationally equivalent. Burton (1993) and Marini and Scaramozzino (1995) analyze the relationship between individual welfare maximization and the optimal outcome of a benevolent social planner in an overlapping generations model with resources or environmental pollution. With this literature, our paper shares the insight that OLG models provide crucial insights about intergenerational trade-offs that

[1] Integrated assessment models augment economic growth models with a climate module, directly considering feedbacks between economic activity and climate change.

[2] In line with the environmental economic literature we call the Euler equation of the Ramsey–Cass–Koopmans growth model "Ramsey equation".

[3] See, e.g., Hurd (1987, 1989), Kopczuk and Lupton (2007), Laitner and Juster (1996), Laitner and Ohlsson (2001), Wilhelm (1996). These papers suggest either that the bequest motive is statistically insignificant, economically irrelevant, or, if there is a considerable bequest motive, that it is not of the altruistic type (in the sense of Barro, 1974 and Becker, 1974) but originates from other sources such as the "joy of giving". In all these cases an OLG economy does not reduce to an ILA economy.