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# Endogenous growth and wealth inequality under incomplete markets and idiosyncratic risk ☆

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ABSTRACT

This paper describes the equilibrium properties and dynamics of a model which combines the key features of the standard incomplete market model (Aiyagari, 1994) with a standard endogenous growth mechanism to gain a deeper understanding of the feedback effects between growth and wealth inequality in the presence of credit frictions and idiosyncratic risk. We characterize growth equilibria and find that a balanced growth path not necessarily exists if households are subject to ad hoc borrowing constraints. Growth, inequality, and risk are positively related in our model, but we also identify a hump-shaped relationship between welfare and risk, indicating a tradeoff relationship between risk-pooling and growth in the determination of welfare. The growth rate responds to changes in the wealth distribution and displays transitional dynamics towards the balanced growth path.



## 1. Introduction

The question of how growth and inequality are related has been a matter of profound interest for many economists over the last decades. The relation is considered to be an ambivalent one, the traditional view emphasizing the famous *'equity vs efficiency'* tradeoff, according to which policies targeted at greater income or wealth equality create disincentives which prove harmful to growth. Contrary, economic analysis has shown that in the presence of market imperfections inequality actually may reduce the long-run growth rate of the economy such that redistributive policies are rendered desirable.[1]

In this paper, we present a simple model of individual risk, growth, and inequality. A special feature of our approach is that both, the growth rate as well as the distribution of income and wealth are endogenously determined in equilibrium and

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[1] See the survey by Aghion et al. (1999) and references therein.

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mutually dependent. We are therefore able to study possible feedback effects to gain a deeper understanding of the implications regarding the redistributive and growth consequences of public policy. Market imperfections enter in our story twofold, firstly, by the absence of risk-sharing arrangements, and secondly, by the presence of individual borrowing constraints.

We consider the prototypical endogenous growth scenario, assuming that aggregate production is linear in the accumulating factor. This ensures that the marginal productivity of this factor is non-decreasing and incentives to accumulate do not vanish throughout the growth process. Our analysis insofar covers the *AK*-type class of growth models satisfying this condition, e.g., technical spillovers à la Romer (1986), productive government expenditures (Barro, 1990), but also the case of increasing product variety (Romer, 1990), where aggregate production is growing linearly in the number of innovating firms. We combine this with the standard incomplete market model with idiosyncratic risks and borrowing constraints in the spirit of Huggett (1993) and Aiyagari (1994, 1995), which to the best of our knowledge has not been done before.

We are aware that the underlying parsimonious modeling of endogenous growth lacks empirical realism and also neglects important economic determinants of growth as, for instance, explicit R&D investments or human capital. It, however, allows us to focus on our primary concern, namely identifying the economic channels linking growth and the distribution of income and wealth. The cause of endogenous growth is not crucial to the qualitative results we present in our paper, if it is embedded in the production sector of the economy. The endogenous feedback effects between growth and distribution arise primarily from accumulation decisions in the household sector.

Our analysis focuses on two fields. We provide necessary and sufficient conditions for the existence of a balanced growth path and demonstrate that these not necessarily have to be met. For some parametric specifications of the model an equilibrium growth path might not exist.[2] Similar to Aiyagari and McGrattan (1998) and Japelli and Pagano (1999) feasible equilibria in our model economy may also be characterized by a growth rate larger than the equilibrium interest rate. Additionally, due to the link between growth and inequality, the model features transitional dynamics, which is not the case in the complete markets setting, where the economy immediately jumps onto the steady state path. We develop a numerical procedure to assess these transitional dynamics, also allowing for welfare comparisons including transition between steady states.

Our second focus lies on role of market imperfections for the determination of growth and inequality. The agents' income and wealth heterogeneity stems from serially correlated uninsurable shocks to labor efficiency. Households are subject to borrowing constraints, restricting their means to smooth the intertemporal consumption flow. We find that the presence of risk and borrowing constraints unambiguously has a positive effect on the long-run growth rate of the economy. Aggregate savings are larger compared to the complete markets economy because of the desire of risk averse individuals to protect themselves against fluctuations in their intertemporal consumption path and the limitation of not being able to borrow, a phenomenon which is well-known from the literature and referred to as 'buffer stock saving' (Carroll, 1997). From this follows naturally that a rise in idiosyncratic risk not only increases equilibrium inequality but also the growth rate of the economy. Tightening credit constraints also raises growth, but has an equalizing effect on the wealth distribution instead, the latter also originating from the accumulation channel.

Integrating the analysis of growth and inequality regularly suffers from technical drawbacks. Either assumptions have to be restrictive to prevent models from eluding closed-form solutions, or the setting displays a typical feature of incomplete market modeling, i.e. that individual policy functions and the macroeconomic equilibrium have to be determined numerically. Here, this explicitly refers to jointly and endogenously determine both, the balanced growth rate and the equilibrium income and wealth distribution. We apply the Romer (1986) approach to endogenous growth in our numerical simulations.

Wealth heterogeneity turns out to be crucial, when it comes to the evaluation of welfare effects. We develop a procedure enabling us to assess welfare consequences of changing environments also including the transitional dynamics of the underlying economy towards a new steady state. The welfare gains and losses from changes in risk are unequally distributed across the society, closely relating our analysis to Domeij and Heathcote (2004) and Heathcote (2005).

Typically, one would expect welfare gains from both, either larger growth or lower risk. In our model, however, lower risk goes along with a disincentive to save out of precautionary motives. This leads to a decline in the growth rate and generates associated welfare losses. We illustrate this idea by performing a thought experiment on a redistributive policy aimed at completely eliminating the individual risk. Because this stands at odds with the growth target it might turn out welfare-deteriorating in the whole and also would be voted down by a majority of the population. Depending on the magnitude of risk, growth and risk-pooling effects are offsetting each other, such that we observe a hump-shaped relationship between welfare and risk in our comparative numerical analysis of the widely-used Romer (1986) model.

Our analysis relates to the literature in several ways. It contributes to the broad body of articles concerned with the relationship between growth and distribution, following initial work by Persson and Tabellini (1992), Bertola (1993), or Alesina and Rodrik (1994). In the tradition of Galor and Zeira (1993), Banerjee and Newman (1993), or Bénabou (1996, 2000), we stress the importance of risk and market imperfections.

Previous work along this line, i.e., simultaneously and endogenously determining equilibrium inequality and the growth rate of the economy, is rare. Aiyagari (1994) only shortly refers to the possibility of including exogenous technical progress in the analysis (see Aiyagari, 1994, fn. 26) and pursues this in Aiyagari and McGrattan (1998). Japelli and Pagano (1994, 1999) discuss the implications of liquidity constraints on endogenous growth and welfare but do not consider distributional consequences. Bertola (1993) assumes an exogenously given, time-invariant wealth distribution in his discussion of the

[2] To this end, our analysis completes the descriptive analysis of Bertola et al. (2006, Chapter 9.3).