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Pareto distribution of income in neoclassical growth models ☆

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ABSTRACT

We construct a neoclassical growth model with heterogeneous households that accounts for the Pareto distributions of income and wealth in the upper tail. In an otherwise standard Bewley model, we feature households' business productivity risks and borrowing constraints, which we find generate the Pareto distributions. Households with low productivity rely on wages and returns from safe assets, while high productivity households choose not to diversify their business risks. The model can quantitatively account for the observed income distribution in the U.S. under reasonable calibrations. Furthermore, we conduct several comparative statics to examine how changes in parameters affect the Pareto distributions. In particular, we find that the change in the top tax rates in the 1980s potentially accounts for much of the observed increase in top income dispersion in the last decades. Our analytical result provides a coherent interpretation for the numerical comparative statics.

1. Introduction

The issue of national income and wealth distribution has become a prominent subject of both scholarly inquiry and public discussion. Scholars investigating this topic, such as Piketty and Saez (2003), have been particularly concerned with understanding the share of wealth held by the wealthiest individuals in the economy. It has been commonly observed that the income and wealth of this segment follow Pareto distributions. An important property of Pareto distributions is that they have a fat tail. In the real world, this means that the wealthiest one percent of population possesses a substantially larger portion of the national income and wealth than would be predicted by extrapolating the distribution of middle income earners. Accordingly, greater understanding of the overall concentration of income and wealth requires increased attention be paid to why the distributions of top earners universally follow the Pareto distribution. Moreover, it is important to analyze income distribution in a general equilibrium model, because many variables that influence the distribution, such as wage rates, capital returns, or the aggregate capital level, are endogenously determined, as emphasized by Jones (2015).

The purpose of this paper is to construct a neoclassical growth model that accounts for the observed Pareto distribution and examine what variables quantitatively affect the distributions of income and wealth. For this purpose, we embed in an otherwise standard Bewley model idiosyncratic risks on households' business productivity. In the model, each household is endowed with a "backyard" production technology. Households which expect low productivity rely on wages and returns

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from safe assets, while households which expect high productivity choose to take business risks and invest capital into their backyard technology. Thus, this model captures an economy wherein a fraction of households choose to become entrepreneurs, while others choose to become workers.

We show that Pareto distributions of income and wealth obtain in the Bewley model with (i) CRRA preferences and (ii) either a borrowing constraint or stochastic death, in addition to (iii) business productivity risks. CRRA preferences lead to an asymptotically constant marginal propensity to consume from wealth and an asymptotically constant level of portfolio risk as wealth becomes large. Business productivity risk combined with a linear savings function constitutes a multiplicative shock in the wealth accumulation process, leading to the diffusion effect that generates the fat-tailed distribution. It is well known that a stochastic process with a multiplicative shock generates a fat-tailed distribution, but diverges indefinitely in the absence of an influx effect. The presence of a borrowing constraint or stochastic death induces a net influx of households into the high wealth group from below, which prevents the wealth distribution from diverging. We obtain a closed-form formula for the Pareto exponent, the parameter that determines the concentration of top income and wealth in the Pareto distribution, using a reduced-form version of the model assuming a Solow-type consumption function. The formula summarizes our main argument that the Pareto exponent is determined by two opposing forces: business productivity risk that diffuses the wealth across households within the high wealth group, and the influx of households at the lower end of the high wealth group.

Given the analytical result in the reduced-form model, we examine quantitative implications of our Bewley model where households optimally solve their savings and portfolio problem. First, we check whether the model replicates the distribution characteristics of income and wealth in the U.S., such as the Pareto exponent, the quintiles of income distribution, the Gini coefficient, and the top income and wealth shares. Second, we conduct several comparative statics to examine how the income and wealth distributions are affected by changes in parameters such as idiosyncratic business productivity and labor shock volatility, tax rates, borrowing constraints, and the exogenous growth rate. We find that the change in the top tax rates in the 1980s potentially accounts for much of the observed increase in top income dispersion in the last decades. We also find that loose borrowing constraints increase top income dispersion. Consideration of the diffusion and influx effects enables us to interpret our comparative statics results obtained through numerical analysis of the Bewley model. In particular, we obtain that a stricter borrowing constraint reduces wealth concentration through an increased influx effect, whereas an increase in the top marginal tax rate reduces wealth concentration through both a diminished diffusion effect and an augmented influx effect.

We derive our results by combining the literature on Bewley models with insights from research on multiplicative idiosyncratic shocks and Pareto distributions. Idiosyncratic business productivity shocks and an influx into the high wealth group from below, the two elements that generate the Pareto distribution as discussed above, fit naturally into the standard Bewley model. Following Quadrini (1999) and Cagetti and De Nardi (2009) in spirit, and adopting the modeling strategy of Covas (2006), Angeletos (2007), and Panousi (2012), we construct an entrepreneurial economy, wherein households bear income risk by investing physical capital in its own firm. Under CRRA preferences, the fraction of the risky asset in the household portfolio is asymptotically constant among wealthy households. Thus, the distribution of the wealth growth rate becomes independent of the wealth level—i.e., Gibrat's law applies for the wealthy group. Hence, the wealth accumulation of the wealthy households follows a multiplicative process that is driven by business productivity risks.

It is known that the multiplicative process generates the Pareto distribution, once it is combined with stochastic death, inheritance, or a lower bound on income (Champernowne, 1953; Wold and Whittle, 1957; Dutta and Michel, 1998; Reed, 2001; Benhabib et al., 2011, 2014a; Toda, 2014). We note that the savings of households in the low and middle wealth groups also generate an influx effect that prevents the multiplicative process from diverging. As shown by Carroll and Kimball (1996) and the papers cited therein, a household's consumption function is generically concave if the household with CRRA preferences faces a borrowing constraint or labor income shocks. We feature such households in a Bewley model and show that the precautionary savings induced by the borrowing constraint constitute an influx effect. The idea of the influx effect for generating a power-law distribution is formulated by Kesten (1973) and used by Gabaix (1999). Nirei and Souma (2007) apply this mechanism to the processes of income and wealth and argue that rate-of-return shocks generate the Pareto distribution, while additive shocks in labor income generate exponential decay in the low and middle incomes. This paper extends their result by incorporating idiosyncratic business productivity shocks and earning shocks in the Bewley model, and obtains new testable implications, such as that a strict borrowing constraint or greater risk in labor income increases the Pareto exponent.

In our model, business productivity shocks mainly affect the top part of the income distribution, while the low and middle parts of the distribution are shaped mostly by labor income shocks, as in the previous Bewley models of income distribution. While the previous studies are successful in accounting for the distribution of low and middle incomes, they do not fully explain the distribution in the upper tail (Aiyagari, 1994; Huggett, 1996; Quadrini and Ríos-Rull, 1997; Castañeda et al., 1998, 2003; Panousi, 2012). Benhabib et al. (2014b) recently derive a Pareto distribution in a Bewley model. Their paper shows an asymptotically linear savings function under CRRA and applies a generalized version of the Kesten processes that are used in Nirei and Souma (2007). The present paper differs from theirs in exploring the general equilibrium implications of the Bewley model. In particular, we find that labor earnings play an important role in the tail distribution, contrary to their claim. This paper examines the impacts on tail distributions of various parameters, such as borrowing limits, tax rates, the exogenous growth rate, and shock volatilities, going beyond the working paper version (Nirei, 2011).