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Inequality and growth: Understanding the link through a simulation

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As suggested in the literature, economic growth and inequality may be influenced by common determinants. One set of determinants may be stochastic production shocks, and in particular non-neutral shocks. To communicate this idea to undergraduate students, I present a model in which shocks to the capital stock introduce both growth and inequality. To engage students and reinforce the empirical consequences of this relationship, I employ an online simulation which implements the model. Representative simulation results are presented and discussed herein.

1. Introduction

Since Kuznets (1955), economists have devoted attention to the relationship between macroeconomic growth and inequality within a society. According to Lundberg and Squire (2003), two distinct strands of literature have emerged. The first examines if growth is a function of economic inequality. The second attempts to identify causal factors which influence growth and inequality independently.[1] Lundberg and Squire attempt to merge these strands by illustrating the empirical determinants of growth and inequality are not mutually exclusive. In other words, evidence suggests growth and inequality are jointly determined.

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[1] The first strand may be traced to Kaldor (1960), who argued inequality should have a positive effect on economic growth. However, the literature has failed to converge on a clear conclusion, in part because of the second strand. Alesina and Rodrik (1994), Persson and Tabellini (1994) and others found higher Gini coefficients (or their equivalent) have a significantly negative effect in neoclassical growth regressions. Li and Zou (1998), Forbes (2000) and others reexamined those data and reached the opposite conclusion.

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This dependence between growth and inequality may be explained in part by stochastic production shocks, particularly non-neutral shocks. Aghion and Williamson (1998) note that a "standard assumption in both the traditional and the more recent growth literature is that technological change is neutral," meaning that all firms experience the shock equally. However, as further noted by those authors and Fisher (2006), non-neutral shocks are almost certainly a better reflection of reality. The diffusion of technology is uneven across industrial sectors, and the ability to exploit new economic opportunities can be highly concentrated in subpopulations of the society.

Consider the technology boom of the 1990s. Shocks like the expansion of the Internet influenced workers' productivity, and consequently real wages increased. However, that shock's effect was heterogeneous across the population, and thus real wages did not rise equally. As a generalization, software engineers had more capacity to capitalize on the widespread adoption of the Internet than did high school teachers, and thus salaries for software engineers increased at a faster rate. Therefore, the same phenomenon which caused growth simultaneously resulted in higher concentrations of wealth, or inequality.

In my experience, undergraduate students in upper-level macroeconomics courses are capable of understanding this relationship. However, for most students, the notion is not immediately intuitive. To help illustrate the connection, I present a reduced-form model in which an economy is subject to stochastic shocks. An online simulation implements the model: see http://faculty.washington.edu/hanlonm/growth-inequality-simulation. Students can execute their own simulations and be tasked with interpreting the results.

This exercise is designed to illustrate several points. First, if the forces underlying growth can be accurately represented as a stochastic process, then some degree of inequality is inevitable. This is true even if the expected net rate of growth is zero (or negative). Second, holding growth rates constant, non-neutral shocks produce more inequality than neutral shocks. Third, the relationship between growth and inequality depends on two additional characteristics of the stochastic shock: (*i*) the fraction of workers who realize positive shocks, on average; and (*ii*) the magnitude of the positive shock relative to the negative shock. As demonstrated in the following sections, understanding how those margins interact is crucial toward understanding observed outcomes.

The relationship between growth and inequality is relevant to public policy debates across the social sciences. I do not suggest this model represents the only mechanism by which growth and inequality may be related. Rather, it is one plausible mechanism, and it is one that other disciplines may overlook in their treatment of the topic. Thus, I believe it is important for economists to address this issue, and my experience is that this model and simulation can engage undergraduate students in a serious and thoughtful manner.

2. Model

Consider a production economy in which capital is a proxy for wealth. During each period, a worker's capital is a function of the previous period's capital and a stochastic growth shock. This scenario is represented by Eq. (1), in which γ, k, t and w denote the shock, capital, the time period and the identity of a given worker, respectively. In a given period, the shock assumes one of two values: a negative (low) outcome, which is denoted as Π_L; or a positive (high) outcome, denoted as Π_H. Eq. (2) represents the shock in expected terms. In Eq. (2), p_L^w represents a worker's probability of realizing Π_L. Similarly, p_H^w is the probability of realizing Π_H. Since there are only two realizations of this stochastic variable, it must hold $p_L^w + p_H^w = 1$.

$$k_t^w = (\gamma_t^w)(k_{t-1}^w) \tag{1}$$

$$E[\gamma_t^w] = (p_L^w)(\Pi_L) + (p_H^w)(\Pi_H) \tag{2}$$

Payoffs are the percentage return on existing assets, and they are structured such that $0 < \Pi_L < 1 < \Pi_H$. When the Π_L is realized, the worker loses wealth ($k_t^w < k_{t-1}^w$) because $\Pi_L < 1$. The opposite holds when Π_H is realized because $1 < \Pi_H$. If p_L^w is identical for all workers in the economy, then p_H^w must necessarily also be equal for all workers and the superscripts are superfluous. In that scenario, the stochastic shock is neutral across the population.