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Skills gap: The timing of technical change☆

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ABSTRACT

This article generalizes the business cycle model in Jovanovic (2006) along two important and meaningful dimensions: (i) more general utility function; (ii) more realistic distribution properties of the productivity shocks. Unlike the original model, I assume the power utility function of the representative agent, and a non-zero expected value of the distribution of the shocks. I include the non-zero expected value of the productivity shocks to account for the skill-biased nature of the technical change in the post-war period. The model implies an endogenous time-varying technical change as an optimal investment policy, consistent with the data.

1. Introduction

According to the 2005 survey by the National Association of Manufacturers, "more than three quarters of US manufacturers say that a scarcity of skilled workers is holding back their business." A lot of low and moderate skilled jobs in the United States have been lost, but it is difficult to satisfy a growing demand for highly skilled workers that is caused by the adoption of new technologies. A report from the Public Policy Institute of California (Johnson and Sengupta, 2009) informs that by 2025, 41% of the jobs in California will require at least a bachelor's degree, but only 35% of Californians will have one. California will face a shortage of 1 million college graduates. The shortfall of skilled

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labor is empirically time-varying, and in principle related to the demographic characteristics of the workforce and the general state of the economy. In this article I show that the optimal technical change, moving the productivity frontier forward, should be a time-varying function of the mismatch between technology and skills.

Black (1995) should be credited for the idea of the match between "wants and resources", equivalent to the skills gap in this article. Black (1995, p. 27) defines good times as "when we see a good match between wants and resources", and bad times as "when we see a poor match". Here, the skills gap arises due to a bad match between the required and actual level of labor inputs to production (type of skills). Black (1995, p. 48) specifies the match at two other levels: the level of consumer goods and services, and the level of inventories and work in process, which are not considered here. The mismatch between technology and skills is also modeled in Jovanovic (2006), which analyzes a representative agent business cycle model with a skills gap. In Jovanovic's model the optimal investment policy yields asymmetric business cycles and a constant rate of technical change in the economy. The representative agent has a logarithmic utility with the coefficient of risk aversion $\gamma = 1$. Productivity shocks in Jovanovic's model are distributed as $\varepsilon \sim N(0, \sigma^2)$. In this article I introduce a model which extends that of Jovanovic (2006) along two important and meaningful dimensions: (i) risk aversion of the representative agent is now $\gamma \neq 1$; (ii) productivity shocks are assumed to be distributed according to $\varepsilon \sim N(\mu, \sigma^2)$ and $\mu \neq 0$. As I show below, either of these two assumptions implies a time-varying optimal technical change in the economy. When the economy is in a trough, the model predicts that companies will invest in uncertain technologies if they expect that future skills will be more compatible with the new technology. This will be the case when current skill level is insufficient to efficiently operate existing technology (e.g. the mismatch is negative), $\mu > 0$ and, on average, future mismatch is expected to be lower than the current one.

Why does the non-zero expected value of the productivity shocks matter? Because it implies that technical change is skill-biased (directed), which is consistent with the data. A zero expected value of the shocks in Jovanovic (2006) means that the technical change is neutral in the sense that it does not favor one production factor over another. However, empirically we observe that the wage of skilled workers relative to unskilled workers increased in the post-war period, together with their supply, which suggests that the traditional factor-neutral approach is not consistent with the data. The technical change is skill-biased as it favors skilled production factors. Assuming a factor-neutral and time-invariant technical change as in Jovanovic (2006) is inconsistent with the skill-biased technical change observed in the post-war data. In that period, the aggregate technical change favored skilled workers, with new technologies compatible with more unique skills. Skill-biased technical change was studied first by Griliches (1969) and then many followers, including Krusell, Ohanian, Ríos-Rull, and Violante (2000). What makes this article different from the existing literature is that I study a skill-biased technical change in a non-hierarchical sense: the technical change is biased toward not the quantity of skill, but a particular type of skill. Another article with a similar focus is Prescott and Visscher (1980), who study the organization capital in the firm and its importance for the production process. They introduce a mismatch between tasks and workers' abilities (parameter θ), which enters the production function as the information capital. Similar to this article, a high rate of growth is constrained by substantial adjustment costs. Workers first need to establish their level of skill through a screening task, unlike in my model where the new technology is introduced even if it is not compatible with workers' skills. In Prescott and Visscher (1980), the per unit cost of production decreases with the number of screening tasks performed, as in their equation (3), when workers learn about the probable value of their θ and a greater match may be achieved. This is a different mechanism to the one in my model, where workers learn about the match ex post, after the technology is implemented, and have no impact on the match itself. In Prescott and Visscher (1980, p. 453), the ratio of personnel assigned to two available jobs is constant, unlike in this article, where the relative supply of one type of skill versus another is the source of aggregate uncertainty.

2. Model

The model setup is identical to Jovanovic (2006). Generalization of the utility function of the representative agent and the productivity shocks' distribution enables me to obtain time-varying optimal