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Analyzing skilled and unskilled labor efficiencies in the US

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ABSTRACT

In this paper, I analyze the time paths of the efficiencies of skilled and unskilled labor in a production framework where skilled and unskilled labor are imperfect substitutes. Their implications for economic growth and wage inequality in the US between 1950 and 2005 present two main findings. First, although skilled labor efficiency has a strong upward trend, I find no evidence of acceleration in its growth rate to support the common view that there has been an acceleration in the new skilled-biased technologies. Second, beginning around 1970, there has been a decline in the absolute level of the efficiency of unskilled labor, implying that the decline has played a significant role in the overall productivity slowdown and the substantial widening in the US wage structure.

1. Introduction

This paper investigates how skilled and unskilled labor efficiencies have evolved since 1950. Toward this end, I extend the standard two-factor production function to a four-factor production function with capital structure, capital equipment, skilled labor, and unskilled labor, where these factors are imperfect substitute with each other. Assuming that markets are competitive and parameters of the model are known, I derive time series of capital equipment, skilled, and unskilled labor efficiencies from the data.

The paper is motivated by two important facts. First, previous studies that investigate the sources of US economic growth decompose changes in output into changes in factors of production and change in overall efficiency (total factor productivity). These studies also assume that skilled and unskilled labor are perfect substitutes (see, e.g., Jones, 2002; Ha and Howitt, 2007). Considering a more general production framework in which inputs are imperfect substitutes and decomposing overall efficiency into capital, skilled, and unskilled efficiencies provides a better understanding of the sources of US growth. Second, over the last 50 years in the US, there have been dramatic changes in the relative supply of skills and the skill premium, defined as the ratio of the skilled labor wage to the unskilled labor wage. As shown in Fig. 1, despite the rapid increase in the relative supply of skills, there has been a substantial increase in the skill premium over this period. Another aspect of Fig. 1 is that the skill premium has trended sharply upward since the early 1980s. This pattern underlines the common view that

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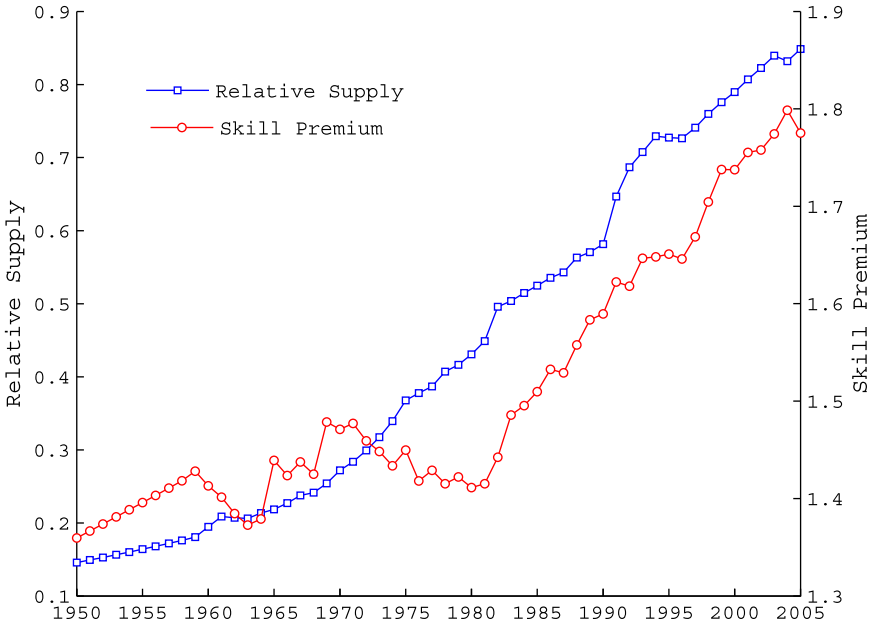

Fig. 1. Relative supply of skills vs. skill premium. *Notes:* The skilled labor class consists of college or college-plus workers and half of the workers with some college; and the unskilled labor class consists of high school dropouts, high school graduates, and half of the workers with some college. The relative supply of skills is defined as ratio of total hours worked by skilled labor to that by unskilled labor.

new technologies have been skill-biased and there has been an acceleration in skill-biased technical change.[1] One may wonder how the efficiencies of skilled and unskilled labor have changed over this period.

The main findings of this paper can be summarized as follows. First, I find that although skilled labor efficiency has a strong upward trend, there is no evidence of acceleration in its growth rate. Interestingly, I also find that beginning around 1970, there has been a *decline* in the absolute level of the efficiency of unskilled labor, although the magnitude of the decline is relatively less when there is a higher elasticity of substitution between skilled and unskilled labor. This is in sharp contrast to the period of 1950–1970, during which unskilled labor efficiency was generally rising. Finally, I find that the time paths of the capital equipment efficiency depend on the elasticity of substitution between capital equipment and skilled labor.

This paper is related to the accounting literature that investigates the sources of growth in the US economy.[2] The paper contributes to this literature by decomposing changes in overall efficiency into changes in efficiencies of capital (equipment), skilled labor, and unskilled labor.[3] In backing out the actual levels of efficiencies from the data, this paper follows Caselli and Coleman (2002) who, applying a different production framework to time series data from the US over 1963–1992, find that throughout this period efficiency of skilled labor and capital have risen, while the efficiency of the unskilled labor has fallen since the early 1970s.[4] This paper differs from theirs in two important aspects. First, it uses a more general production function in which there are two different types of capital (structure and equipment) as opposed to the single aggregate capital input in Caselli and Coleman (2002). Using a single aggregate capital input, they implicitly assume that capital structure and equipment are perfect substitutes, which is inconsistent with the data.[5] The time paths of capital equipment and skilled labor efficiencies obtained from this general production function also differ from those in Caselli and Coleman (2002).[6] Second, this paper con-

[1] The literature on this subject is vast. Important contributions are Bound and Johnson (1992), Katz and Murphy (1992), and Acemoglu (1998). See Acemoglu (2002) for a more comprehensive review of the literature.

[2] See Solow (1957), Jones (2002), and Jorgenson (2005), among many others.

[3] Growth in the efficiency of skilled labor is the largest contributor to output per hour growth in this decomposition, accounting for between about 30% and 120% of growth (depending on the exact value of parameters in the model, the definition of skilled labor, and the time period considered in the exercise), while changes in the efficiency of unskilled labor accounts for between about −90% and 50% of growth (see Sections 3 and 4).

[4] Under a different production framework, Caselli and Coleman (2006) use the same methodology to study *cross-country* differences in skilled and unskilled labor efficiencies when skilled and unskilled labor are imperfect substitutes. They show that higher-income countries use skilled labor more efficiently than lower-income countries, but they use unskilled labor relatively less efficiently. This paper shows that the efficiency of unskilled labor is not monotonically declining with an increase in the income level using the US *time-series*.

[5] The production framework used in this paper is similar to that in Krusell et al. (2000), who argue that this general production function is more consistent with the US data. Furthermore, in analyzing the effect of investment-specific technical change on productivity, Greenwood et al. (1997) find that a Cobb–Douglas production function with two different capital inputs (equipment and structure) fits the US data better.

[6] For example, when capital is complementary to skilled labor in this general framework, I find that skilled labor efficiency has grown more slowly (in particular, since the mid 1980s) than that in Caselli and Coleman (2002). However, I also find that capital equipment efficiency has grown much faster than the efficiency of (aggregate) capital in Caselli and Coleman (2002). See Section 4.3 for more details.