Skill complementarities and returns to higher education: Evidence from college enrollment expansion in China☆

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ARTICLE INFO

ABSTRACT

We find that the increased supply of college graduates resulting from college enrollment expansion in China increases college premiums for older cohorts and decreases college premiums for younger cohorts. This finding is inconsistent with the canonical model that assumes substitution among workers of different ages. We subsequently build a simple model that considers complementarities among workers of different ages and different skill levels. Our model predicts that the college premium of senior workers increases with the supply of young college graduates when skill is a scarce resource. The model's predictions are supported by empirical tests.

1. Introduction

In the traditional Mincer equation, the returns to education are presumed to be the same for all age groups; the assumption is that educated workers of different ages are perfect substitutes (Tinbergen, 1974, 1975). This assumption is challenged by Card and Lemieux (2001a, 2001b), who report that the college premium increases for younger workers but remains flat for older workers in the presence of a negative shock to the supply of young college graduates in the United States, United Kingdom, and Canada. These findings suggest that educated workers of different ages are imperfect substitutes.

However, imperfect substitution cannot explain the puzzling trend in the returns to education in China in a period of dramatic positive shocks to the supply of college graduates. After a long period of slow growth, college admission in China sharply increased by 40% from 1998 to 1999 (Fig. 1). In roughly a decade, from 1998 to 2009, the number of newly admitted college students in China increased by 480% (from 1.1 million to 6.4 million, as shown in Fig. 1). The overall returns to college education (Fig. 2) increased over this period despite the dramatic increase in the supply of college graduates (see also Zhang, Zhao, Park, & Song, 2005). Even more puzzling, although the college premium for younger workers (20–24 years old) has declined with expanding college enrollment, the college premium for older workers (e.g., 51–55 years old) has increased (Fig. 2), a trend that cannot be explained by the lack of substitution among skilled workers of different ages. In this paper, we also show evidence suggesting that the lower college premium
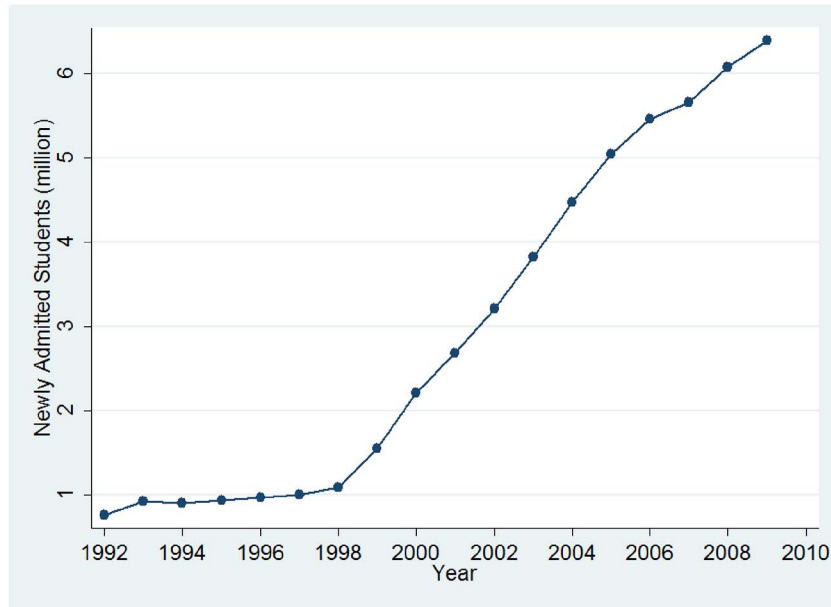
Fig. 1. Newly admitted college students in China, 1992–2009.
Source: China Education Statistical Yearbooks (1993–2010)

for younger workers cannot be explained by the possible decline of college education quality after the college enrollment expansion and that the higher college premium for older workers is not because old college-educated workers with lower wages were crowed out of the labor market by young college-educated workers after the expansion.[1]

In this study, we provide a new explanation for the diverging trends in skill premiums: we argue that skilled workers of different seniorities are complementary in production. We build a simple theoretical model based on the canonical model summarized by Acemoglu and Autor (2011).[2] In our model, workers are classified into three types: low skilled workers (without college education); young skilled workers (with college education but inexperienced); and senior skilled workers (with college education and experience). Senior skilled workers are complements to, rather than substitutes for, the first two types of workers in production. Moreover, the complementarity between senior skilled workers and young skilled workers is stronger than that between senior skilled workers and low skilled workers.[3] Our theory implies that an increase in the number of young skilled workers (relative to low skilled workers) increases the marginal product of senior skilled workers, which explains why their return to college education increases with the increasing supply of young skilled workers.

Drawing on data from the Urban Household Survey (UHS) in China, we find evidence supporting our main hypothesis, which is that the college premium of young workers decreases, whereas that of senior workers increases with the number of young skilled workers. To address endogeneity, in our analysis we use the potential college enrollment expansion, in which every province expands its enrollment in proportion to its predetermined capacity, as an instrumental variable (IV) for the number of young skilled workers. The IV estimations show that an increase in the number of young skilled workers has a positive effect on the overall college premium. However, this positive effect is mostly driven by the rising college premium for senior workers (30–60 years old). The college premium actually declines for young workers (20–24 years old). According to our estimates, an increase of one standard deviation (roughly 200 thousand) in the number of young skilled workers decreases the college premium for workers in the 20–24 age group by 5.2 percentage points. In contrast, the college premium increases by 4.5 percentage points and 6 percentage points for workers aged 30–39 and 40–60, respectively.

Our study makes several contributions to the literature. First, we extend the canonical models of college (or skill) premiums and wage inequality (Acemoglu & Autor, 2011), which treat skilled workers of different seniorities as substitutes. Unlike these models, our proposed model demonstrates that such workers are likely to be complements to each other in production. Second, although there are abundant studies that investigate the complementarities between machines (technology) and labor (Goldin & Katz, 1998; Mincer, 1989; Polgreena & Silos, 2008), we are among the first to examine the complementarities among different types of workers. The only previous study we are aware of is that of Berger (1983), who finds that young and old male workers with college degrees are

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[1] We also find that there is no change in the gender composition of the older cohorts after the college expansion, meaning that the higher college premiums of the older cohorts cannot be explained by a change in the ratio of women whose college premium is higher (Rosenzweig & Zhang, 2013).

[2] Acemoglu and Autor (2011) refer to the demand–supply framework as the canonical model. The canonical model has been empirically proven not only in the United States (Davis & Haltiwanger, 1991; Goldin & Katz, 2008; Katz & Murphy, 1992; Krueger, 1991), but also in other developed nations (Fitzenberger & Kohn, 2006; Freeman & Needels, 1993; Katz, Loveman, & Blanchflower, 1995).

[3] This assumption is supported by the estimation of a translog production function with data from manufacturing firms in China, shown in Appendix A.