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Where do STEM majors lose their advantage? Contextualizing horizontal stratification of higher education in urban China

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ABSTRACT

While the average labor market advantage of college graduates with STEM (Science, Technology, Engineering, and Mathematics) degrees relative to non-STEM students is well established, how this STEM versus non-STEM income gap varies across institutional contexts has been understudied. From the perspective of new institutionalism, we investigate the moderating effects of hierarchically situated higher education institutions and labor market sectors on the economic disparity between STEM and non-STEM majors by pooling data from two nationwide representative surveys collected in contemporary urban China. The results of median regression models suggest that (1) On average, STEM majors are more lucrative than non-STEM majors in Reform-Era China, a pattern resembling that of many other societies. (2) The vertical stratification of higher education institutions, i.e., the postsecondary education sector's segmentation into "junior" and "regular" colleges, is relevant, where a smaller STEM advantage over non-STEM fields is detected among junior college graduates after accounting for potential cohort variation. Moreover, this moderating effect of college tiers declines across birth cohorts. (3) Working in the state sector, such as the Communist Party and government department and institutions, relative to the other sectors, significantly narrows the earnings gap between STEM and non-STEM graduates. However, this labor-market-sector heterogeneity in the STEM versus non-STEM income gap also declines across birth cohorts. Theoretical implications of empirical findings are discussed.

1. Introduction

Over the past decades, a trend of higher education expansion has been witnessed across the world (Schofer & Meyer, 2005; Shavit, Arum, Gamoran, & Menahem, 2007). This increase in higher education opportunities has considerably raised the percentage of college educated individuals in many societies, driving scholars to shift attention to the horizontal aspect of higher education stratification, that is, the inequality across different *types* of education received by college attendees (Charles & Bradley, 2009; Gerber & Cheung, 2008; Gerber & Schaefer, 2004; Roksa & Levey, 2010; Roksa, 2005). The separation of students into college majors has been one of the most widely examined axes of horizontal stratification, and extant research consistently demonstrates that graduates with STEM (Science, Technology, Engineering, and Mathematics) majors receive greater economic returns to their degrees than non-STEM graduates (Roksa, 2005; Rumberger & Thomas, 1993; Thomas & Zhang, 2005). This STEM advantage has garnered a great deal of attention among scholars and policymakers alike, motivating a host of education policies aimed toward promoting STEM major enrollments, especially among disadvantaged groups (e.g. women or racial/ethnic minorities), as a means of facilitating social equality and promoting overall population wellbeing (Espinosa, 2010).

The STEM advantage over non-STEM majors, however, may vary across situations. From the perspective of new institutionalism, the STEM versus non-STEM economic gap is *embedded* within external institutions, and different institutional arrangements and logics moderate such a gap and give rise to a *heterogeneous* pattern. This point of view, however, has not yet received much attention in sociological studies of horizontal stratification. In this article, we attempt to close this gap by assessing how two types of institutional contexts may influence the wage gap between graduates from STEM and non-STEM fields. Specifically, the hierarchical structure of higher education institutions is one such context. Since college graduates learn knowledge and cultivate skills associated with STEM or non-STEM majors within a specific type of higher education institution, the vertical hierarchy of such institutions could reasonably influence the extent of STEM majors' labor market

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advantage. The other context we examine is the employment sector of the labor market. Distinct labor market sectors entail contrasting logics of resource allocation, thus potentially altering the reward disparity between workers with STEM and non-STEM degrees.

By situating the STEM versus non-STEM earnings gap in these two institutional contexts, we highlight the idiosyncratic institutional environments in which college graduates are embedded and how such environments might moderate the economic gap between STEM and non-STEM majors. In doing so, we make several conceptual and theoretical contributions to the extant literature. First, an emerging research theme in many social science disciplines is to explain the expanding wage variation *within* the category of highly educated individuals (e.g., Brand & Xie, 2010; Author Cited; Lemieux, 2006). Thus, detailing institutional heterogeneity in the economic disparity between STEM and non-STEM majors may help us better understand "the increasing variance in returns to college" and a key mechanism underlying the formation of overall social inequality (Gerber & Cheung, 2008:313).

Second, Lucas's (2001) theory of "effectively maintained inequality" predicts a transition from vertical to horizontal stratification as higher education opportunities become increasingly accessible. However, the relationship between these two types of stratification is not entirely clear (Gerber & Cheung, 2008). By analyzing the potential moderating effect of higher education hierarchy on STEM majors' advantage over non-STEM ones, this study illustrates how vertical and horizontal stratification interact with each other.

Third, the sweeping market reform in many former socialist societies encouraged an array of sociological studies on the contrast between redistributive and market institutions in rewarding educational attainment. The majority of these studies approached this question from the perspective of vertical stratification, by looking into the extent to which a college degree pays back in the process of the large-scale marketization transition (e.g. Gerber & Hout, 1998; Gerber, 2002; Nee, 1989; Wu & Xie, 2003; Zhao & Zhou, 2002). In contrast to these prior studies, we take horizontal stratification under consideration as well, and examine whether the redistributive logic of resource allocation affects the income gap between STEM and non-STEM fields, thus bringing about new insights into the social consequences of market transition in former socialist societies.

The case we use to illustrate the institutional effects of higher education's hierarchical structure and the segmented labor market is mainland China. Several features of Chinese society serve our research interest. First, China witnessed a large-scale expansion of higher education after 1999, with the gross tertiary enrollment ratio rapidly rising from 12.4 in 2002 to 20.2 in 2008 (UNESCO, 2014).[1] This comprehensive proliferation of college credentials satisfies a necessary condition for our research into the STEM versus non-STEM reward disparity by providing a relatively large population of college graduates. Second, in China, the higher education system consists of two *qualitatively* different hierarchical strata, the junior-level college (*zhuanke*) and regular-level college (*benke*). However, many STEM and non-STEM college majors are offered in both types of colleges (Yu, 2010).[2] China therefore provides a valuable opportunity to examine the interaction between horizontal and vertical stratification, further shedding light on the idiosyncratic STEM versus non-STEM earnings gap across hierarchies of colleges. Third, as noted in previous research, both redistributive and market-oriented resource allocation mechanisms still *coexist* in contemporary China, as embodied by contrasting labor market sectors (Zang, 2002). Since college graduates are likely to look for a job in either sector, we are therefore able to examine how STEM graduates' earnings advantage may vary across sectors. In light of these factors, contemporary China serves as an ideal research environment to examine institutional variation in the economic returns to college majors.

This study adds an interesting case to the extant literature by underscoring how unique institutional contexts might alter the pattern of horizontal stratification, which serves as a contrast to previously examined societies, such as the United States and Russia (Gerber & Schaefer, 2004; Roksa & Levey, 2010). The remainder of this article proceeds with a review of previous studies on the differential returns between STEM and non-STEM fields. We then follow the perspective of new institutionalism and discuss how institutional contexts in contemporary China – the hierarchical structure of higher education and labor market segmentation – might moderate STEM majors' earnings advantage, and propose a set of hypotheses. After presenting data, measures, and the empirical approach, we report major findings and discuss their implications.

2. Theoretical background

2.1. The STEM versus non-STEM disparity on the labor market

A large number of studies have noted that the economic returns to college majors on the labor market are not uniform. On the contrary, graduates from STEM fields consistently enjoy an economic advantage over graduates from other fields of study (e.g. Roksa, 2005; Rumberger & Thomas, 1993; Thomas & Zhang, 2005). To date, two schools of economic theory have been widely cited to account for this STEM versus non-STEM disparity.

Following and extending human capital theory (Becker, 1964; Mincer, 1974), Paglin and Rufolo (1990) argue that earnings on the labor market are determined not only by the *quantity* but also by the *quality* of the knowledge and skills students acquire during their college careers. In contrast to fields that emphasize general verbal skills, STEM majors make heavy use of mathematical skills. Due to the relative *scarcity* of mathematical skills over general verbal skills as demonstrated by their differential rates of high standardized test scores, STEM-majored college graduates would be better paid than non-STEM ones. Another school of theory is signaling theory, which posits that a college graduate's major serves primarily as a signal of characteristics that employers value but cannot directly assess, such as cognitive ability or work ethic (Spence, 1973; Weiss, 1995). STEM degrees thus signal a specific set of technical proficiencies, indicating that graduates from these majors may more reliably match employers' skill demands. In addition, because courses of study in STEM fields are commonly assumed to be more demanding and labor intensive than non-STEM majors, employers are likely to view a STEM degree as an indication that a potential employee possesses a desirable work-related habitus. In line with these propositions, research findings suggest that signaling effects lead STEM graduates to be more highly paid on the job market (Mortensen & Pissarides, 1999; Noelke, Gebel, & Kogan, 2012).

2.2. The significance of institutional contexts

Both human capital theory and signaling theory view the economic reward disparity between STEM and non-STEM majors

[1] The gross enrollment ratio is the number of individuals in the five-year age group following the official age of secondary graduation who are enrolled in an institution of higher education divided by the total population of same-age individuals.

[2] Although junior and regular colleges represent two distinct strata, they overlap a great deal with regard to the fields of study they offer. For instance, according to statistics released by the Ministry of Education, junior and regular colleges overlap with each other in all of the college major categories, including philosophy, economics, law, education, literature, history, science, engineering, agriculture, medicine, and management science (http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s6200/201201/129594.html).