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Is Education in China Served for Productivity Augmenting? ——An Empirical Test about Educational Signaling Hypothesis

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Abstract: *This study applies an empirical approach based upon Employer Learning and Statistical Discrimination Model to examine education's role in China and analyzes difference in returns of schooling in context of urban rural segmentation. An Ordinary Least Square estimation and Quantile Regression are conducted with micro data from China Family Panel Study (CFPS). Evidence support education signaling hypothesis overall, and a longer lasting signaling effect is found in rural area. A sensitivity analysis by quantile regression confirms a universality of our result in all income quartiles in China but strength of education signaling varies across earning groups.*

Keywords: *China, Education, Screening Hypothesis, Signaling Hypothesis, Employer Learning, CFPS.*

1. Introduction

The Human Capital Theory has been thought of as a breakthrough in the 20th century and has a pivotal role in the formulation of education policies by Western governments. Along with the rapid expansion of education in various countries, however, it has not brought the sizeable economic growth as expected. Nevertheless, issues about the unemployment among fresh graduates and the widening gap between the rich and the poor residents among Western countries have arisen, violating the core concept of Human Capital Theory, brought considerable critical attention to it. In the 1970s, labor economists denied the contribution of education to productivity and demonstrated the role of educational signals from the perspective of employers. Spence (1973) proposed that level of schooling, as an identity index, signaling individuals' innate ability, allow firms to screen job candidates. There are also similar studies that explain effect of education, such as Filter Theory by Arrow (1973) and Screening Hypothesis by Stiglitz (1975). Two competing hypothesis were unified by Riley (1976), presuming education assist both job signal and human capital accumulation. Thus, the screening hypothesis are subdivided into two types: The Strong Screening Hypothesis (SSH) and The Weak Screening Hypothesis (WSH). SSH suggests that school education merely serves as a signal and cannot facilitate productivity development, while WSH indicates that the main function of academic education is to send signals, but it can also enhance productivity.

Contribution of education is a topic broadly related to economic development. Academic qualifications do allow employers to screen job applicants when there is an absence of information related to ability. However, if a strong screening theory exists widely in a country and have a profound impact, it will be detrimental to the progress of productivity in the long run. Education's credentialling effect forces people, in order to gain advantages in labor market, to increase investment in education, which will cause household and individual education decisions to deviate from the ideal Barro-Becker model (Becker, 1981). In an individual perspective, over investment in education means extra expenditure and loss in forgone income as an opportunity cost. Excessive demand for education will prompt the government to spend more money in public education.

The issue of education's function also puzzles developing countries. The policy of expanding the scale of higher education in 1970s has improved equality in education attainment and fulfilled people's needs. We have witnessed the rapid expansion of Chinese education. The gross enrollment rate of post-secondary education rose from 9.8% in 1998 to 51.6% in 2019, and the number of students enrolled in general higher education reached 9.149 million. Moreover, China's education investment will exceed 349.1 billion RMB in 2020 and will maintain a long-term growth trend. Conversely, under the remarkable amount of enrollment and investment in education, it seemingly leads to a negative social consequence where unacceptable low return and unsatisfied labor market outcome. Unemployment rate for educated

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workers, particularly for those who obtain college, stay steadily at a high level. The role of higher education aroused scholars' debate over whether school attainment augment productivity or simply served for employment screening. This paper intends to study the role education system played in China's labor market, and to identify that education in China belong to WSH or to SSH hypothesis, which is to examine whether education serve for productivity development and signaling simultaneously. Employer Learning and Statistical Discrimination model is introduced to investigate the dynamic relationship between benefits for education and experience. Through this approach, we corroborate signaling effect of education in China, and find evidence to support a Weak Screen Hypothesis.

2. Theoretical Framework and Empirical Implementation

2.1 Theoretical Framework

To test for signaling hypothesis of education in China against human capital model, this paper adopts the landmark approach "Employer Learning and Statistical Discrimination" (EL-SD) developed by Faber and Gibbons (1996) and Altonji and Pierret (2001). Our model investigates the dynamic relationship between wage premium for education attainment and work experience.

The intuition hides under this model is that at a beginning stage, due to information asymmetry in labor market, employers cannot observe the true productivity of job candidates, instead they can only assess the productivity of employees based on a series of observable personal characteristics, such as education level and race. If these characteristics which are used to evaluate the personal abilities of employees cannot reliably and completely reflect the ability of job applicants, this will cause bias in estimates based on these characteristics or lead to people with certain traits attaining an advantage in productivity forecasting. This is when "Statistical Discrimination" occurs. Over time as work experience rises, employer have more opportunity to being conscious of real work performance of employees, so at this stage employer gradually become aware of worker's proper productivity and make adjustment to wage. As employer learned more, the more likely that earning by workers will converge to its actual ability level.

2.2 Data Source and Variables

This empirical analysis investigates on individual level data from China Family Panel Studies (CFPS) in 2014-2018 waves. The baseline sample covers 25 provinces, representing 95% of China's population. By collecting data at three levels of individuals, families, and communities through tracking to reflect the changes in Chinese society, economy, population, education and health. The 2010 baseline survey interviewed 14,960 households and 42,590 individuals, and a longitudinal study of the individual samples was conducted per 2 years. The reason we chose this data set for our empirical analysis is that it can almost meet all the requirements for variables in our theoretical framework, and the representativeness and accuracy of the survey results are guaranteed through sampling design and survey methodologies.

We screened the respondents in the sample, and the sample used in this study meets the following eligibility criteria: (i) 16 to 40 years old. The upper bound is restricted to not older than 40 years old due to evidence provided by Lange (2007) that employers can extract 95% information in the first three years after recruitment, EL-SD mostly happen in early stage of career. (ii) Possess at least 9 years of education history. (iii) have a full-time main job work experience which work at least 35 hours per week and reported an annual wage in CFPS dataset. (iii) Be in labor force market and employed by private sector, public sector (including civil service, public institution and state-owned enterprise) and self-employed enterprise. This paper aims to examine the impact of education on the overall productivity of society, not just the employment market. Moreover, according to China's Company Law and Civil Code, professional service institutes must exist in the form of "Special Ordinary Partnerships", and is classified as "self-employed" in the CFPS. The income of the owners of this type of business is largely derived from professional skills rather than financial assets, so it should be included in the sample. (iv) Removal of abnormal outliers whose annual salary income is less than $120 or greater than $50 million. Under above restrictions, we have 9846 observations about their age-earning profile.

2.3 Empirical Specification

We implement our empirical test suggested by our theoretical model presented above. Education signaling hypothesis and EL-SD behavior are investigated by Ordinary Least Square (OLS) Regression

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on log income by education, unobserved ability, experience, interaction between above terms, and controls for other individual and employment traits in the following equation:

$$y_{it} = \beta_s school_i + \beta_z ability_i + \beta_{st}(school_i \times experience_i) + \beta_{zt}(ability_i \times experience_i) + \beta_t experience_i^3 + \beta_\Phi^X \Phi_i + \varepsilon_i$$

Where y_{it} is monthly wage of individual i. Unobserved ability is proxied by two measurements: (i) EL-SD examination by Altonji & Pierret (2001), Pinkston (2006), Lange (2007) and Arcidiacono (2010) all select AFQT score as the proxy for ability. Neal and Johnson (1996) have proved an intense explanation power of AFQT in wage gap. We employ score of cognitive tests which composed of mathematic and verbal module, which can quantify respondents' text comprehension ability and intelligence level. Since there is no similar study toward education signaling in China who adopt the similar strategy, we carry out a correlation analysis controlled in terms of education level and find a strong positive connection between cognitive score and log income at 99% confidence level. (ii) parents' education background. Exposure to well-educated family playing a vital role in development of ability including some personal behavior traits such as persistence, punctuality and integrity. This approach was also widely used in relevant studies on returns of schooling such as Bauer & Haisken (2001) , Altonji & Pierret (2001) and Card (1999).

As suggested by Altonji & Pierret (2001), we apply potential experience, derived by age subtract by 6 and formal education year. Education year is converted from highest level of formal degree obtained by respondents. Φ_i denotes a set of control variables in order to take difference in employment, demographic and geographic level into account. For demography, we control gender, marital status. For geographics, we include dummies of province, urban-rural. We wish to control features related to employer contains firm size, industry and occupations, but those variables are missing in the dataset for considerable amount individuals. These control variables not only help to improve the fitness of the empirical model and lessen bias in estimation caused by individual and regional fixed effect, but also allow us to implement more analysis and comparisons among different cohorts which share common attributes.

3. Results and Discussion

3.1 Baseline Results

First, we present the empirical result for our basic EL-SD testing model. Key Ordinary Least Square (OLS) estimation coefficients are reported in Table 1. In column (1) we estimated our empirical specification model with cognitive test score as proxy variable for unobserved ability. Taking into account the ability of employees to perform in the workplace, in addition to the cognitive and intellectual levels that can be scored, there are also some personal traits that are closely linked to productivity that will be affected by the parent's educational background. Thus, in the column (2) of regression, we added parental education as another proxy variable of ability. The column (3) and (4) shows regression estimation controlling for fixed effect of urban or rural, survey year and province of residence. All of our specifications control a cubic term in potential experience simultaneously. The overall goodness of fit (R-Square) value of model with control variables is 34.5%.

EL-SD model aims to investigate the dynamic relation between employment experience and return to education. Thus, our focal points are on the interaction term for Edu*Experience/10^{-2}, Cognitive*Exp/10^{-2} and Parent Edu*Exp/10^{-2} , which denotes Δ_{st} and Δ_{zt} corresponding to our theoretical model, respectively. By draw our eyes upon the interaction terms, we can gain knowledge how marginal contributions of education and unobserved ability to productivity varies with work history in an individual's career path, to reach a conclusion about existence of Employer Learning and signaling effect of education. For our regression in column (4), the coefficient on interaction between schooling year and experience is -.529 with is significant at 1% level. The large negative coefficient suggests relatively drastically declines of reward for schooling with years. In contrast, we capture a positive marginal contribution of unobserved ability with the growth of experience. Its coefficient with highly significant implies that the one-point cognitive score higher, the return of cognitive ability calculated in percentage term to productivity will increase by .0366% during the first ten years of experience, while at the same time, return of one extra years of education to productivity in logarithm term descend by 0.529 with work experience for 10 years. If we move to analyze on the partial effect of parental education, the similar trends as variables for cognitive ability was still revealed.

To find evidence about Statistical Discrimination during recruitment, we identify $\beta_{st} = \varphi_{s0} + \Delta_{st}$

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and $\beta_{st} = \varphi_{s0} + \Delta_{st}$ at t=0, theoretically, and experience=0 empirically. At this point, attending school one more year produce employer forecast of productivity increase by 0.189% higher. The small negative value on effect of invisible ability at t=0 means that conditional on education, ability score has a small negative effect on productivity estimation. It indicates that employer cannot obtain productive information about ability initially, and even make biased estimation based on contribution of cognitive score and family education. From what our theory proposed: $\beta_{zt} = \varphi_{z0} + \Delta_{zt}$, $\varphi_{z0} = \Delta_{qz}$, we infer that the bias is partially due to error generated when build expectation of based upon interview and resume, which denoted by Δ_{qz}. This inference is reasonable in reality, because job candidates usually exaggerate their content on resumes and carefully prepare for interviews in order to obtain better career opportunities. However, contributions of unobserved ability gradually converge to its proper value in subsequent period as employer perceive deviations in productivity expectations.

Table 1 Basic OLS EL-SD Model Estimation

	(1) Productivity	(2) Productivity	(3) Productivity	(4) Productivity
Education	.229***	.245***	.205***	.189***
	(.009)	(.009)	(.009)	(.009)
Edu*Experience/10^{-2}	-.476***	-.608***	-.528***	-.529***
	(.071)	(.075)	(.073)	(.071)
Cognitive Score	-.06***	-.062***	-.054***	-.054***
	(.003)	(.003)	(.003)	(.003)
Cognitive*Exp/10^{-2}	.395***	.417***	.372***	.366***
	(.02)	(.021)	(.021)	(.02)
Parent Edu	---	-.024	-.011	-.013
		(.017)	(.017)	(.017)
Parent Edu*Exp/10^{-2}	---	.086***	.056*	.066**
		(.032)	(.031)	(.031)
Male	.38***	.388***	.398***	.393***
	(.021)	(.023)	(.022)	(.022)
Urban	---	---	.167***	.078***
Year Dummies			(.024)	(.024)
2014	---	---	---	---
2016	---	---	.35***	.35***
			(.034)	(.033)
2018	---	---	.524***	.551***
			(.025)	(.024)
Region Dummies				
Provinces	(No)	(No)	(No)	(Yes)
Constants	8.711***	8.624***	8.536***	9.286***
	(.068)	(.08)	(.078)	(.116)
Observations	9846	8775	8775	8775
R-squared	.246	.258	.298	.345

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

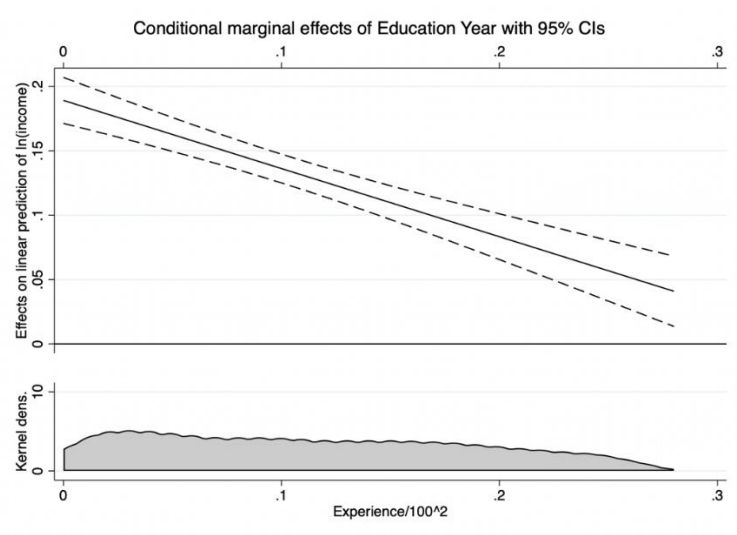

Figure 1 Conditional Marginal Effect of Education

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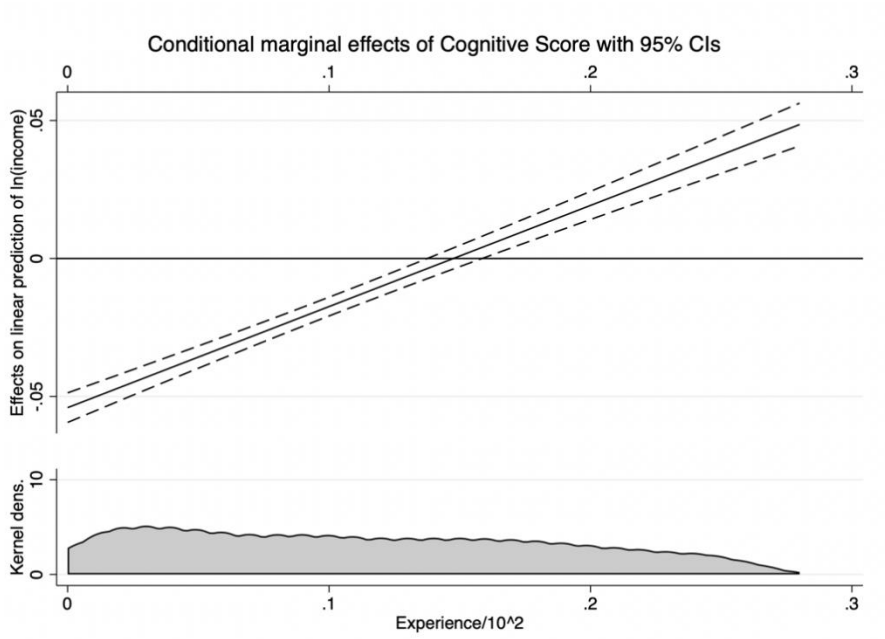

Figure 2 Conditional Marginal Effect of Cognitive Ability

Figure 1 and 2 displays the conditional marginal effect in regression (4) of education and cognitive score with increase in experience respectively. Dynamics for cognitive score shows that employer put more weight on ability rather than education to judge workers' productivity as more work histories are exposed.

Results for the baseline specification generally supports our hypothesis in Employer Learning and Statistical Discrimination. Education do play a signaling rule at the beginning and its effect is persistent in employee's career. Although, the extent of the decline in the marginal contribution to productivity by education over time is considerable. we cannot deny the schooling do aid the productivity enhancing since marginal effect does not drop down to a level below zero in one's career life.

So far, we have examined the role of education as a personal variable visible to employers in productivity assessment. We infer that the marginal effects of education and unobservable abilities that contribute to productivity as experience changes are not homogeneous. We need to explore the possibility of the above-mentioned overall results being heterogeneous among groups of individuals with different characteristics. Another advantage of conducting heterogeneity analysis is that we can get the size of the contribution of education to productivity in subdivision of a society, so as to better obtain the optimal allocation of educational resources to maximize the return of educational investment.

4. Conclusion

In this study, by investigating EL-SD dynamics in Chinese labor market, we discover that marginal contribution of education is decreasing but nonnegative as experience grows, confirming education in China served for both signaling and productivity augmenting, which supports a weak screening hypothesis in China. Reward for schooling is initially high and dominates a decisive weight in firm's estimation of employee productivity but decline over time. Since return for education never drop down to zero in one's lifetime, we conclude education are still serving for human capital accumulation. Our quantile analysis lessens possibility of endogeneity issue caused by different level of employer attention and reaches a robust conclusion of education signaling. As a more formal labor market, the signaling effect of education, to denote individual's ability, is weakened more immediately in urban. Returns of parental education shows a diverse pattern for rural and urban area. We hypothesized that positive return of parent education is due to that it stands for advantage in social network, which is positively correlated to earnings. However, the implicit mechanism for parental background is understudied, which could be a shortcoming of our study.

In fact, the signal effect of education is not a bad thing, because a labor market with asymmetric information needs an index of representative ability after all. Educational background, as a more uniform

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and fairer standard compared with other observable personal characteristics, such as race and gender, can more efficiently match talents to positions that meet their productivity levels. However, if education cannot fully represent the level of personal productivity, then the incorrect signal sent by educational qualification will lead to mismatch in job and resources, assigning people with less true ability but higher education to more important position, which generating social losses. In an optimistic aspect, larger decline in contribution of education in earning of urban indicates that employers are actively fix their anticipation error about output. However, on the other hand, we need to recognize social loss caused by the signal and critically think about why it is the employer's responsibility to correct the deviation caused by the education signal and why can't our education send more true signals about the level of personal output? Although education has a net benefit in Chinese economic development, we may need to seek progress in educational system, or developing a more unbiased and universal indicator of labor's ability if possible. This topic worth to be discussed in further research.

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