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ORIGINAL ARTICLE

Screening signals or capability enhancement: The educational effect on the starting salary of engineering master's graduates

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ABSTRACT

The employment of college graduates has become a pressing social concern. Based on classical human capital theory and screening theory, this study analyzes the effects of human capital and educational background on the starting salary of engineering master's graduates. Educational background and hard engineering skills were found to have a distinct salary effect on engineering master's students; however, the salary effect of educational background was not based on the promotion of human capital development and exhibited clear characteristics of institution and specialty screening. Moreover, significant disparities exist between factors affecting starting salaries in engineering versus nonengineering roles. To enhance the attractiveness and quality of engineering master's programs, it is crucial to promote a diversified higher education system and develop market-driven talent cultivation models.

Key words: human capital, educational background, initial salary, engineering master's graduates

INTRODUCTION

The employment situation for college graduates in China is facing significant challenges. By June 2023, the urban surveyed unemployment rate for the population aged 16-24 was 21.3%,[1] the highest level in recent years. In terms of employment outcomes, engineering master's students have demonstrated strong performance in the labor market. On the one hand, the highly educated groups represented by masters and doctors have not only higher starting salaries but also faster growth.[2] Thus, the investment in engineering graduate education often yields substantial financial returns.[3] On the other hand, engineering graduates have an advantage over other majors in terms of initial salary.[4–6] However, a large difference in initial salary still exists among the different disciplines under the engineering category.[7,8] Some engineering master's students have high educational input and low returns. As a result, the phenomenon of "cold entrance examination" and "escape from engineering" is increasing in prevalence. Under the cognitive guidance of investment and income not being proportional, increasing numbers of engineering college students believe that the professional knowledge and skills they learned in college are not recognized in the job search process.[9] Thus, it seems that engineering ability developed through higher education does not correspond with income returns for engineering graduates.

In addition to capability, the background of the job seeker's education institution is a common "hard threshold" in the labor market. Consequently, the salary differences of engineering master's students often

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become an extension of the hierarchical nature of the higher education system in the labor market. The continuous operation of key university policies represented by Project 211, Project 985, and the Double First-Class Construction has shaped a hierarchical structure of Project 985 universities, followed by Project 211 universities, and finally, general undergraduate colleges. The stability of this rigid hierarchical framework is continuously strengthened by absorbing and accumulating all kinds of capital,[10] leading to similar hierarchical structural features manifested in various aspects of talent training, scientific research, and social recognition. In the labor market, employers list the background of the job seeker's educational institution as the threshold for entry and the standard for determining salaries. As a result, the college graduates' initial salaries closely correspond to the prestige of the institutions that they attended.

There are two primary theoretical perspectives for explaining the impact of education on the income. One posits that the income effect of education arises from education's ability to enhance individual quality and capability. The other is that education provides a means for dividing different job seekers. From the first perspective, empirical studies have pointed out that, in postgraduate students' employment process, the influence of social capital is relatively limited, and the contribution rate of human capital is greater.[11] From the second perspective, empirical studies have also proven that China's labor market follows a strong screening trend in which education,[12] while serving as a tool for distinguishing engineering master's students, fails to accurately reflect or enhance engineering capabilities due to the information asymmetry between employers and job seekers. This is particularly true when admission and graduation requirements are relatively lenient and the labor market is underdeveloped. In this case, structural challenges, such as diploma inflation and wage disparities, result in educational background functioning more as a rigid threshold than as an effective signal of engineering competence.[13]

Salary research falls within the field of occupational acquisition research. Based on existing research on occupational acquisition, the academic community primarily focuses on two aspects. First, from the perspective of social stratification and mobility, it explores how family background (or social capital) and education (or human capital) affect the occupational acquisition of college graduates,[14–16] especially regarding the role of education in intergenerational mobility and inheritance.[17–19] Second, from the perspective of labor economics and educational economics, studies investigate the rate of return and return on investment in higher education as a human capital investment in the labor market.[20–22] Few studies have deeply analyzed the relationship between human capital and educational background at the level of initial salary. Some studies have compared the income effect of educational background factors, represented by institutions and majors, with the income effect of capability factors, represented by academic performance and foreign language levels. These studies have found that the income effect of educational background is significantly higher than that of capability factors.[23] However, they did not further analyze the relationship between the two, that is, whether the income effect of educational background is based on capability factors. In the field of engineering education, few studies have focused on the initial salary of engineering graduates and their performance in the labor market—let alone, discussed the factors and mechanisms affecting their initial salary. This is perhaps because engineering is traditionally a strong subject in terms of employment, with an average initial salary higher than that of other disciplines. Thus, we ask, specifically for the group of engineering master's students, do educational background factors, such as institutions, majors, and degrees, and human capital factors, such as engineering capabilities, significantly impact their initial salary? What is the relationship between these factors? These issues have not been clarified, so this study will try to solve the above problems with theory and data.

THEORETICAL BASIS AND ANALYTICAL METHOD

The most classic explanatory theory used in salary and income research is human capital theory, which was proposed in the 1960s. The core view of this theory is that an individual's level of human capital determines their income level. However, the popularization of higher education and the "diploma inflation" problem in European and American countries in the 1970s posed significant challenges to human capital theory. This led to the emergence and widespread acceptance of screening theory. Regarding the relationship between the two, human capital theory provides a universal and fundamental explanation for analyzing salary income, while screening theory builds upon human capital to extend the analysis of salary income in complex labor markets. In the actual labor market, college graduates' salary income follows the basic laws of human capital, reflected as "the capable earn more",[24] and at the same time, is influenced by the educational signal, reflected as "background screening".[25] Currently, China's higher education is in the stage of popularization, and the labor market shows characteristics similar to those in European and American countries in the 1970s. Therefore, it is essential to employ empirical analysis methods and approaches grounded in these classic theories when exploring the impact factors and

mechanisms of the initial salary of engineering master's degree students.

Human capital theory

Schultz defined human capital as the sum of knowledge, skills, and physical strength embodied in a person and believes that the impact of human capital on income is much greater than that of tangible material capital.[26] However, in the labor market, not all human capital can be transformed into corresponding economic income, and the impact of different human capital on salary income is also not the same. Becker believed that human capital investment has long-term effects and lags, and when making decisions on human capital investment, investors will consider both its short-term and long-term benefits.[27] Therefore, he further distinguishes between specific human capital and general human capital. The former refers to professional and technical knowledge or skills that can be used only in specific industries or departments. These skills generally obtain higher returns due to their specificity. The latter refers to basic knowledge or skills obtained through training, education, and other human capital investment methods, which can be used in different production industries and departments due to their basic nature. However, the returns obtained are lower.[28]

From the perspective of human capital theory, formalized and institutionalized higher education is the most crucial way for college graduates to invest in employability,[29] and employability is directly related to their initial salary level. The engineering competencies of engineering master's students is the core component of their employability and is closely tied to their production efficiency in the engineering industry, which is the key factor in determining their salary income. The development of engineering competencies is the core element of the overall capability development of engineering master's students during their master's studies, and using the value-added of engineering competencies as a proxy variable for human capital can accurately reflect the impact of human capital on the initial salary of engineering master's students. Therefore, hard and soft engineering skills, as specific human capital, are theoretically the key factors in enhancing the initial salary of engineering master's students. Based on the above analysis, the following hypothesis is proposed. H1: Engineering skills have a significant positive impact on the initial salary of engineering master's students.

Compared to complex labor markets, human capital theory is more suited to perfectly competitive markets in which both employers and employees have transparent information. In such markets, human capital is a clearly visible attribute; therefore, the price of labor is entirely determined by its own level of human capital and is not subject to the information decisions of employers and employees. However, in the real labor market, the human capital attached to individuals is not a directly observable variable. Both employers and employees, for the sake of efficiency and benefit, need to rely on a series of background characteristics to represent and identify an individual's human capital. In this process, human capital may not directly determine an individual's initial salary, and whether they possess the background characteristics valued by employers is the key to affecting their initial salary. Therefore, the analysis of the research question requires an expansion of the theoretical perspective based on human capital.

Screening theory

The central tenet of human capital theory is that education can improve labor productivity by promoting the development of human capital. Screening theory questions the above proposition, suggesting that the economic function of education lies in its screening and signaling effects—that is, education can provide useful information to determine whether individuals have higher expected productivity and can help differentiate various talents.[30] Although the focus is different, these effects are essentially the same. The effectiveness of screening and signal effects hinges on one key premise: information asymmetry between employers and job seekers in the labor market. Specifically, in the labor market, employers cannot directly observe whether the levels and types of ability of job seekers meet employers' expectations. Educational background factors, such as institutions, degrees, and majors, differentiate individuals into educational classifications. These classifications, in turn, convey information about individuals' capabilities,[31] enabling employers to evaluate candidates and make decisions regarding hiring and salary levels.[32]

Early versions of screening theory did not acknowledge the role of education in promoting individual capability, and later supporters of screening theory gradually revised this radical view. Weiss collectively referred to the screening and signaling effects as the sorting model, with the belief that both screening and signaling effects are classification models based on abilities that cannot be directly observed and that people with stronger abilities may gain more benefits from school education. This will lead to the continual enhancement of a classification model based on ability.[33] At the same time, the sorting model challenges the tendency of traditional human capital theory to narrow down ability to cognitive ability, with the understanding that companies use educational selection to infer job seekers' unobserved, noncognitive attributes, such as those emphasized in the new human capital theory (self-esteem, locus of control, *etc.*),[34] and their tendency to quit.

Screening theory further enhances the understanding of

labor market behavior and salary income—that is, education can indirectly affect salary income through screening and signaling. For engineering master's students, their own abilities cannot be directly observed in the labor market and must be reflected indirectly through institutional background signals. The signaling effect of an institution's background is based on the screening effect of its competitive admission and advantageous training. From this theoretical level, to achieve its impact on salary income, the background of the institution mainly reflects and improves the abilities or human capital of engineering master's students. However, screening theory does not depart from the core category of human capital theory, and the essence of screening and signaling is still based on ability. This implies that two scenarios are possible: weak screening with effective signaling and strong screening with ineffective signaling. Moreover, the less competitive the sectors, the easier it is for the signaling effect to come into play.[35] In the case of a strong screening mechanism where signaling fails, the background signal of engineering master's students may not accurately reflect their engineering abilities; that is, engineering master's students from elite institutions may not all have stronger engineering abilities, but they generally have higher initial salaries due to the "halo effect". However, whether it is strong screening or weak screening requires further empirical testing. Therefore, the following hypothesis is proposed.

H2: Educational background, such as the level of the institution, the type of major, and the type of degree, has a significant positive impact on the initial salary of engineering master's students.

H3: The salary effect of the institutional level is mediated by the impact of human capital on salaries.

In the more competitive nonengineering employment market, engineering master's students may strengthen the signaling effect of their educational background through "downward compatibility", thus having a more significant promoting effect on their starting salaries. Looking at the types of human capital, engineering competencies is a kind of specific human capital that can only obtain its main value and corresponding economic benefits in the specific engineering industry. Engaging in nonengineering professions will cause the hard and soft engineering skills of engineering master's students to lose their "place to use". Accordingly, the following hypothesis is proposed.

H4: There is a significant difference in the salary effects of educational background and human capital among engineering master's students engaged in engineering professions and nonengineering professions.

Empirical analysis approach

Using the above theoretical analysis approach, this study tested the relevant hypotheses using hierarchical regression, mediation analysis, and group regression methods while controlling for a series of related variables. First, hierarchical regression was mainly used to test whether human capital and educational background factors have a significant positive impact on the initial salary of engineering master's students, and it was used to preliminarily judge whether there is a mediating effect of engineering competencies by observing the change in the regression coefficient of the institution level before and after the introduction of engineering competencies. Second, for the preliminary judgment of hierarchical regression, a further analysis of the mediating effect was carried out to determine whether there is a significant mediating effect and its effect size. Finally, group regression was used to test whether there is a significant difference in the salary effects of educational background and human capital between engineering master's students engaged in engineering professions and nonengineering professions.

RESEARCH DESIGN

Data source

The study data were derived from the "Engineering Graduate Student Survey for the Yangtze River Economic Belt" conducted by the Engineering Education Research Center of Huazhong University of Science and Technology in June 2023. The survey targeted full-time engineering master's students at universities within the Yangtze River Economic Belt region of China. It covered 10 provinces across the upper, middle, and lower reaches of the Yangtze River and involved 28 universities, 77 departments, and 9 major professional categories, making it highly representative of the national population of engineering master's students. The sample reflects the spatial distribution of China's vocational education development, which decreases from east to west, and provides a snapshot of the overall state of China's vocational education system.

Sample selection

The research object of this study was engineering master's students who have secured employment. Therefore, engineering master's students who have signed employment contracts (excluding those in flexible employment) were selected as the research sample. Some samples were removed based on two criteria: samples with missing values in the core variables. A final total of 2901 samples were used for the data analysis. Table 1 shows the demographic breakdown of the samples.

Variable descriptions

The independent variables were categorized into two groups: (1) the variables representing educational background, including the level of the institution, the type of degree, and the type of major; and (2) the variables representing human capital, that is, hard and soft engineering skills. Among them, the level of the institution can be divided into five categories: general bachelor's and master's degrees, Project 211 bachelor's and master's degrees, Project 985 bachelor's and master's degrees, rise from general bachelor's to better master's degrees, and rise from Project 211 bachelor's to better master's degrees. The type of degree was divided into academic degree and professional degree. Considering the income of different professional categories of undergraduate graduates in 2022 and the relevance between majors, the engineering majors were divided into three categories according to their market value (for cases where there is a large difference in initial salaries among different majors within the same major category, they were assigned to the corresponding category based on the average level of most majors within that major category): high market value majors (computer, electronic information, and automation); medium market value majors (*e.g.*, mechanics, machinery, electrical, energy, materials, *etc.*); and low market value majors (*e.g.*, civil engineering, water conservancy, architecture, agriculture, forestry, environmental, food engineering, chemical engineering, textile, light industry, *etc.*).

Hard and soft engineering skills measure the development of engineering abilities during the master's period.[36,37] Referring to the definition and classification of related studies, hard engineering skills are technical abilities directly related to engineering production practice, including engineering knowledge foundation, engineering practice ability, scientific research ability, and digital ability. Soft engineering skills are nontechnical capabilities that support hard skills in completing work tasks; these include team cooperation and communication ability, innovation ability, and engineering and social context integration ability. All independent variables are shown in Table 2.

The dependent variable was the initial salary—that is, the pretax initial annual salary level of engineering master's students—which was divided into seven grades and treated as a continuous variable. In the specific question design, considering that directly asking for the specific initial salary income may cause a certain estimation error of the survey object, the interval measurement method was used to ask the survey object which interval the pretax initial annual salary is in. This can reduce the intragroup differences between objects with similar initial salary levels to a certain extent and increase the intergroup differences between objects, with large differences in initial salary levels. All dependent variables are shown in Table 2.

The control variables referred to existing studies and were divided into two categories: individual factors and family background.[38,39] Individual factors included gender, age, and admission type; family background included family income, family location, father's education level, and father's occupation. All control variables are shown in Table 2.

Reliability and validity and common method bias test

Except for engineering competencies, which was assessed using a self-report scale, the rest of the variables were assessed through objective questions. Thus, only the reliability and validity of engineering competencies were analyzed. The Cronbach's α coefficients of the seven engineering capabilities were between 0.830 and 0.884, indicating good reliability for each dimension. First-order seven-factor and second-order two-factor models were constructed based on the theoretical framework, and two items were deleted after comprehensive consideration of factor loadings and theoretical coherence. The remaining items' factor loadings were between 0.723 and 0.887. The final model fitting index is shown in Table 3. The comparative fit index (CFI), Tacker-Lewis index (TLI), incremental fit index (IFI), relative fit index (RFI), and normed fit index (NFI) were greater than 0.9, and the root mean square error of approximation (RMSEA) was less than 0.08, indicating that the model fit well. Table 4 shows the composite reliability (CR) and average variance extracted (AVE) of each latent variable. The CR ranged from 0.836 to 0.921, which was higher than the acceptable standard of 0.6, indicating that the scale had high internal consistency. The AVE ranged from 0.605 to 0.744, exceeding the acceptable threshold of 0.5, indicating that the scale had good convergent validity. The correlation coefficients of engineering knowledge foundation and engineering practice ability were slightly higher than the square root of AVE, while the other correlation coefficients were all less than the square root of the corresponding variable AVE, thus proving that the scale had good discriminant validity.

To identify any bias due to the same survey method, Harman's single-factor analysis was used to test for common method bias. All scale items were used as manifest variables to construct a single-factor latent variable model for confirmatory factor analysis, and the results showed that the model's fitting index was very unreasonable (χ^2/DF = 50.525, RMSEA = 0.131, CFI = 0.737, TLI = 0.713, RFI = 0.709). Therefore, there was no significant common method bias affecting the results.

Table 1: Sample demographics (*N* = 2901)

Variables		Frequency	Proportion (%)	Variables		Frequency	Proportion (%)
Gender	Male	2207	74.4	Family annual income	High-income families	108	3.6
	Female	759	25.6		Medium-income families	1430	48.2
Admission type	Non-exempt	524	17.7		Low-income families	1428	48.1
	Exempt	2442	82.3	Family location	Townships/rural areas	1900	64.1
Whether father has an advantageous profession	Yes	547	18.4		County towns/county-converted districts	541	18.2
	No	2419	81.6		Urban/Hong Kong, Macao, Taiwan and overseas	525	17.7

Table 2: Variable design

Variables	Index	Operationalization
Independent variables	Undergraduate and postgraduate school level	Categorical variables: 1 = General bachelor's and master's degrees, 2 = Project 211 bachelor's and master's degrees, 3 = Project 985 bachelor's and master's degrees, 4 = rise from general bachelor's to better master's degrees, 5 = rise from Project 211 bachelor's to better master's degrees, with "General bachelor's and master's degrees" as reference
	Degree type	Categorical variables: 0 = master of engineering, 1 = master of engineering, with reference to master of engineering
	Type of profession	Categorical variables: 1 = high market value majors, 2 = medium market value majors, 3 = low market value majors, with low market value majors as reference
	Hard engineering skills	Continuous variable, measuring the capability increase during the master's degree: 1 = no growth, 2 = small increase, 3 = significant increase, 4 = great growth, taking the mean of the items in each dimension
	Soft engineering skills	Continuous variable, measuring the development of competence during the master's degree: 1 = no growth, 2 = small increase, 3 = significant increase, 4 = great growth, taking the mean of the items in each dimension
Dependent variable	Starting salary	Continuous variable, 7 levels from low to high, assigned 1-7 in sequence: 1 = 0-60,000 yuan, 2 = 60,000-90,000 yuan, 3 = 90,000-120,000 yuan, 4 = 120,000-180,000 yuan, 5 = 180,000-240,000 yuan, 6 = 240,000-300,000 yuan, 7 ⩾ 300,000 yuan
Moderating variable	Occupation type	Categorical variables: 1 = engineering occupation, 0 = nonengineering occupation; those engaged in engineering technology and engineering research and development, scientific research (universities, research institutes) belong to engineering occupations; those engaged in civil servants, administrative management (human resources, university administration, *etc.*), professional and technical (law, finance, primary and secondary school teachers, *etc.*), and other positions are nonengineering occupations.
Control variables	Household income	Categorical variables: 1 = low-income families (annual income of 80,000 yuan or less), 2 = middle-income families (annual income of 80,000-300,000 yuan), 3 = high-income families (annual income of 300,000 yuan or more)
	Father's education level	Continuous variable, converting the educational level into the corresponding years of education: junior high school and below = 9 years, high school/technical secondary school = 12 years, junior college = 15 years, undergraduate = 16 years, graduate school = 19 years
	Home location	Categorical variables: 1 = township/rural area, 2 = county/county transfer area, 3 = cities/Hong Kong, Macao, Taiwan, and overseas, with townships/rural areas as reference
	Father's occupation	Categorical variable, whether the father has an advantageous occupation: 0 = no, 1 = yes; advantageous occupations include the political elite (administrative), economic elite groups (private business owners) and cultural elite groups (engineers, senior intellectuals, professionals), with nonadvantageous occupations as the reference
	Gender	Categorical variables: 0 = female, 1 = male, with female as reference
	Age	Continuous variable: unit in years
	Admission type	Categorical variables: 1 = recommended admission, 0 = nonrecommended admission; nonrecommended admission used as a reference

RESULTS

Impact of human capital and educational background on the initial salary of engineering master's students

After conducting difference analysis and correlation analysis, hierarchical regression was used for preliminary analysis to clarify the direct impact of human capital and educational background on the initial salary of engineering master's students and the possible mediating effect. Hierarchical regression was divided into three steps, with initial salary as the dependent variable: the first layer included relevant control variables; the second layer included educational background factors, such as

Table 3: Fitting index of the theoretical model

Fit index	χ^2/DF	RMSEA	CFI	TLI	IFI	RFI	NFI
First-order seven factors	15.386	0.070	0.929	0.917	0.929	0.911	0.925
Second-order dual factors	16.565	0.073	0.920	0.910	0.920	0.904	0.915

RMSEA, root mean square error of approximation; CFI, comparative fit index; TLI, Tacker-Lewis index; IFI, incremental fit index; RFI, relative fit index; NFI, normed fit index.

Table 4: Construct validity of the theoretical model

Correlation coefficient	X1	X2	X3	X4	X5	X6	X7	AVE	CR
X1	0.794	-	-	-	-	-	-	0.631	0.836
X2	0.819	0.815	-	-	-	-	-	0.665	0.888
X3	0.714	0.709	0.837	-	-	-	-	0.700	0.874
X4	0.695	0.691	0.602	0.812	-	-	-	0.660	0.886
X5	0.732	0.728	0.634	0.660	0.812	-	-	0.659	0.885
X6	0.771	0.766	0.668	0.650	0.685	0.811	-	0.657	0.851
X7	0.687	0.682	0.595	0.619	0.652	0.642	0.778	0.605	0.859

X1-X7 respectively represent engineering knowledge foundation, engineering practice ability, scientific research ability, engineering and social context integration ability, team cooperation and communication ability, digital ability, and innovation ability. The bold diagonal is the square root of the AVE. AVE, average variance extracted; CR, composite reliability.

the level of the institution and the type of major; and the third layer included human capital factors, such as hard and soft engineering skills.

The results of the difference and correlation analyses (Table 5) show significant differences in starting salaries among engineering master's students with different educational backgrounds. A significant positive correlation was found between hard engineering skills and initial salary, while no significant correlation was found between soft engineering kills and initial salary.

The results of the hierarchical regression (Table 6) show that educational background and hard engineering skills have a significant positive impact on the initial salary of engineering master's students, while soft engineering skills have a significant negative impact on the initial salary of engineering master's students. According to the results of Model 2, after controlling for relevant variables, educational background can explain 16.8% of the variation in the initial salary of engineering master's students. Specifically, the most significant impact on initial salary among educational backgrounds was found for high market value majors and those with backgrounds at Project 985 institutions. According to the results of Model 3, after controlling for relevant variables, human capital can only explain 0.9% of the variation in the initial salary of engineering master's students, indicating that the impact of human capital on initial salary is relatively small.

In addition, the possibility of a mediating effect of engineering competencies is relatively small. Combining the results of Model 2 and Model 3, after introducing the human capital variables, the regression coefficient of the institution level changed little. After considering the impact of educational background factors, hard and soft engineering skills can still independently explain part of the variation. However, whether the above judgment is accurate needs to be tested through further mediating effect analysis. In view of the negative effect of soft engineering skills on initial salary, which is contrary to theoretical experience, the following section presents mediating effect tests for hard engineering skills only, and the negative effect is presented in the final discussion.

Test of the mediating effect of human capital

There are four methods for testing mediating effects: sequential test method, Bayesian method, bootstrap method, and product distribution method. These different methods have corresponding limitations.[40,41] Considering the limitations of the above methods, the bootstrap method was used to resample 5000 times, and we, in turn, tested whether the institution level had an impact on the initial salary of engineering master's students through hard engineering skills.

The results (Table 7) show that hard engineering skills have a significant negative mediating effect between the Project 985 institution level and initial salary. Looking at the effect size and proportion, the mediating effect of hard engineering skills is not only low in effect size but also has a very low proportion. Therefore, the salary

Table 5: Difference and correlation analyses results for independent and dependent variables

Variance analysis				Correlation analysis	
Education	**Level comparison**	**Mean difference**	**F(t)**	**Human capital**	**Correlation coefficient**
Undergraduate and postgraduate school level	Project 211 undergraduate and master's degree > General undergraduate and master's degree	0.518***	71.327***	Hard engineering skills	0.108***
	Project 211 undergraduate and master's degrees > rise from general undergraduate to better master's degrees	0.133		Soft engineering skills	0.003
	Project 985 undergraduate and master's degree > Project 211 undergraduate and master's degree	0.704***			
	Project 985 undergraduate and master's degree > General undergraduate and master's degree	1.222***			
	Project 985 undergraduate and master's degrees > rise from general undergraduate to better master's degrees	0.838***			
	Project 985 undergraduate and master's degrees > rise from Project 211 bachelor's to better master's degrees	0.312*			
	Rise from general undergraduate to better master's degrees > General undergraduate and master's degree	0.385***			
	Rise from Project 211 bachelor's to better master's degrees > General undergraduate and master's degree	0.910***			
	Rise from Project 211 bachelor's to better master's degrees > Project 211 undergraduate and master's degree	0.392**			
	Rise from Project 211 bachelor's to better master's degrees > rise from general undergraduate to better master's degrees	0.525***			
Type of profession	High market value > medium market value	0.482***	238.372***		
	High market value > low market value	1.249***			
	Medium market value > low market value	0.767***			
Degree type	Academic degree > professional degree	0.180***	-3.309***		

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

effect of the "Project 985 undergraduate and master's degrees" is not based on the salary effect of hard engineering skills.

Differences in initial salary-influencing factors of engineering master's students in different occupations

First, as a specific type of human capital, the income-increasing effect of engineering competencies in nonengineering occupations are limited. Second, in nonengineering job markets with less competition, the screening and signaling effects of educational background are more easily exerted. To analyze the differences in the initial salary-influencing factors of engineering master's students in different occupations, group regression was used to test the possible differences.

The analysis results (Table 8) show that the initial salary for engineering master's students engaged in nonengineering occupations is only significantly positively affected by the type of major. In contrast, for engineering master's students engaged in engineering occupations, the influencing factors and effect sizes of their initial salary are basically consistent with the total sample. The differences between the two groups are also reflected in the differences in the determination coefficient. In the engineering occupation group, educational background and human capital can independently explain 18.7% and 0.5% of the variation, respectively, while in the nonengineering occupation group, only educational background can independently explain 4.9% of the variation. Looking at the effect size in the sample of nonengineering occupations, the influence of the type of major has a significant decrease.

DISCUSSION AND IMPLICATIONS

Discussion

Salary effect of educational background

The results of the hierarchical regression show that the salary effects of educational background and hard engineering skills are significant, and the salary effect of educational background is obviously greater than that of human capital. This is generally consistent with the conclusions of previous studies.[23]

Table 6: Hierarchical regression analysis of the impact of human capital and educational background on initial salary

Control variables		Model 1	Model 2	Model 3
Gender		0.177*** (0.057)	0.136*** (0.053)	0.125*** (0.053)
Age		-0.087*** (0.018)	-0.069*** (0.016)	-0.070*** (0.016)
Recommended admission		0.204*** (0.066)	0.077*** (0.071)	0.074*** (0.071)
Father's dominant occupation		-0.003 (0.076)	0.008 (0.069)	0.006 (0.069)
Middle-income families		0.112*** (0.054)	0.098*** (0.048)	0.097*** (0.048)
High-income families		0.135*** (0.141)	0.126*** (0.127)	0.122*** (0.127)
County, county to district		0.031 (0.072)	0.031 (0.065)	0.029 (0.064)
Cities, Hong Kong, Macao, Taiwan, and overseas		0.041 (0.078)	0.030 (0.070)	0.031 (0.070)
Father's education level		-0.042 (0.032)	-0.058** (0.029)	-0.059** (0.029)
Education	Project 211 undergraduate and master's degree		0.149*** (0.065)	0.146*** (0.065)
	Project 985 undergraduate and master's degree		0.230*** (0.077)	0.233*** (0.077)
	Rise from general undergraduate to better master's degrees		0.139*** (0.058)	0.138*** (0.058)
	Rise from Project 211 bachelor's to better master's degrees		0.125*** (0.111)	0.126*** (0.110)
	High market value majors		0.403*** (0.054)	0.385*** (0.055)
	Medium market value majors		0.214*** (0.057)	0.203*** (0.057)
	Academic degree		0.033 (0.049)	0.0350* (0.049)
Human capital	Hard engineering skills			0.148*** (0.039)
	Soft engineering skills			-0.083** (0.039)
Adjusted R^2		0.099***	0.265***	0.273***
$\triangle R^2$		0.102***	0.168***	0.009***

The regression coefficients in the table are all standardized coefficients β, and the values in parentheses are standard errors, and so on. $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

Table 7: Mediating effect and proportion

Independent variable	Classification level	Effect	BootSE	95% confidence interval		Effect ratio
				LLCI	ULCI	
Undergraduate and postgraduate school level	Project 211 undergraduate and master's degrees	0.002	0.008	-0.014	0.018	-
	Project 985 undergraduate and master's degrees	-0.025	0.010	-0.046	-0.008	2.14%
	Rise from general undergraduate to better master's degrees	-0.002	0.007	-0.016	0.013	-
	Rise from Project 211 bachelor's to better master's degrees	0	0.013	-0.027	0.025	-

The mediating variable is hard engineering skills, the dependent variable is initial salary, and the 95% confidence interval does not contain 0 (that is, LLCI and ULCI have the same sign), which indicates that the mediating effect is significant. LLCI, lower level of confidence interval; ULCI, upper level of confidence interval.

Further mediating analysis found that the salary effect of the institution level is not based on the salary effect of hard engineering skills. Relevant research suggests that skill certifications, as another ability signal more closely related to human capital, can also promote an increase in starting salaries, but they do not have a significant effect on the enhancement of abilities.[42] This suggests that engineering master's students face a strong screening mechanism in the labor market, and educational background signals, such as institution and major background, almost determine their initial salary. However, the signaling effect of educational background is not based on their human capital.

Theoretically, after experiencing "diploma inflation", the ability signal by educational background signals will become progressively weaker, and the labor market will increasingly adhere to the principle of "not judging a hero by his origin". However, the result is that the labor market still shows a strong screening tendency. This occurs because, as the cost of admission and graduation continues to decrease and workers increasingly pursue higher education, companies will be more inclined to directly raise the educational threshold to reduce

Table 8: Influencing factors of initial salary for engineering master's students in different occupations

Control variables		Engineering careers	Nonengineering occupations
Education	Project 211 undergraduate and master's degrees	0.171*** (0.067)	0.004 (0.160)
	Project 985 undergraduate and master's degrees	0.269*** (0.081)	0.075 (0.185)
	Rise from general undergraduate to better master's degrees	0.168*** (0.061)	-0.001 (0.138)
	Rise from Project 211 bachelor's to better master's degrees	0.155*** (0.120)	0.073 (0.232)
	Highly marketable majors	0.406*** (0.059)	0.201*** (0.129)
	Medium market professional	0.202*** (0.060)	0.104* (0.140)
	Academic degree	0.057** (0.052)	-0.072 (0.112)
Human capital	Hard engineering skills	0.103*** (0.042)	0.087 (0.088)
	Soft engineering skills	-0.047 (0.042)	-0.020 (0.088)
Adjusted R^2		0.291***	0.115***

The regression coefficients in the table are all standardized coefficients β, and the values in parentheses are standard errors. $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

additional ability screening costs. Consequently, whether the educational background signal can accurately reflect the ability level of job seekers is no longer so important.

In addition, the labor market's preference for the signal mechanism and educational background may stem from other factors, such as turnover and personality traits.[33,43] For engineering master's students, a higher institution platform not only means better educational resources to improve ability but also provides richer employment resources, which also significantly improve the starting salary level.[44] More importantly, the type of education accurately reflects the membership of a special identity group, and the educational requirements for employment reflect the employer's attempt to hire employees who are respected and have good socialization but their lower expectations for technical abilities obtained through education.[45] Therefore, the hierarchical structure of higher education institutions has a high degree of similarity with the initial salary levels of their graduates, beyond the scope of human capital.

The overly dominant role of educational background in screening has effectively overshadowed the abilities of engineering master's students, and the development of a skill-oriented labor market requires changes to address this issue. For China's vocational and technical education, the labor market performance of graduates is directly related to the effectiveness of vocational and technical education. However, an overly dominant role of screening hampers vocational and technical education graduates from obtaining fair competition opportunities in the labor market. Therefore, to improve China's vocational and technical education, it is essential to establish a skill-oriented and more equitable labor market to reduce the obscuring of abilities by educational background.

Salary effect of human capital

Employers' preference for a strong screening mechanism in which signals fail does not mean that human capital theory is inapplicable to the labor market entered by engineering master's students. In fact, after controlling for educational background signals, hard engineering skills within engineering competencies still have a strong positive effect on starting salaries, which is consistent with the conclusions of most students.[46] Considering that the engineering ability variable in this paper measured the development of ability rather than the level of ability, the actual level of hard engineering skills may have a higher salary effect on initial salary, which is consistent with the basic tenets of human capital theory. For an engineering field oriented toward production practice, the elements contained in hard engineering skills, such as engineering practice ability, digital ability, and scientific research ability, are closely related to the production efficiency of engineering master's students in actual engineering activities. Furthermore, in research on engineers with master's degrees, the income effect of work experience was found to be five times that of education experience, indicating that the growth of engineers depends heavily on first-line engineering experience rather than school education.[47] This may be the important reason why the salary effect of human capital for engineering master's students is lower than that of educational background.

Contrary to theory and common sense, soft engineering skills not only do not promote the initial salary of engineering master's students but also have a weakening effect on the initial salary. Research on corporate employers and engineers has pointed out that nontechnical abilities, especially soft engineering skills, such as communication and teamwork, are an important part of the engineering production practice required by companies.[48–51] However, this raises the question of why soft engineering skills show a "salary penalty" effect in the labor market. Since there is a scarcity of studies exploring the initial salaries of engineering graduates, and the conclusions of previous research on the college

graduate population contradict the findings of this study, the salary penalty associated with soft engineering skills may arise from characteristics unique to the engineering field. There are several possible reasons. First, skills are often bound to specific contexts;[49] hence, different components of engineering capabilities may vary in importance across different work environments and engineering industries,[52] which may result in soft engineering skills not generating income returns in some environments and industries. Second, in the current labor market's written test and interview situations, compared with hard engineering skills, soft engineering skills are more difficult to observe. Third, the ability for engineering and social context integration of soft engineering skills includes social responsibility and environmental protection consciousness (see T/CEEAA 001-2022, Accreditation Standards for Engineering Education, published by the China Engineering Education Accreditation Association [CEEAA], for more information), such as "market, quality, and safety awareness" and "attention to environmental protection, ecological balance, and sustainable development" which may conflict with the market benefit-centered philosophy of some companies. Relevant research has shown that a sense of social responsibility and ethical considerations can influence the career choices of college graduates and significantly lower their salary levels.[50]

Hard engineering skills remain a crucial factor for engineering master's students to secure higher salaries. To improve China's vocational and technical education, greater emphasis should be placed on cultivating students' hard engineering skills. With the goal of enhancing labor market performance, it is necessary to strengthen the development of practical and useful ability signals for vocational and technical graduates in the labor market by closely integrating student training with engineering and technical practice.

Differences in initial salary-influencing factors of engineering master's students in nonengineering occupations

As Becker pointed out,[28] although specific human capital can bring substantial economic value in specific industries, it lacks a certain degree of transferability. Because of this, engineering competencies, as a specific type of human capital suitable for the engineering industry, cannot bring significant income improvement for engineering master's students in nonengineering occupations. Since information technology has fully penetrated the work practices of various industries in the information age, information technology professional abilities have gradually become general abilities that are applicable to all sectors. Therefore, engineering master's students with high market value information technology majors can also obtain higher initial salaries, even in nonengineering occupations.

It is worth noting that, in the nonengineering occupation group, only the type of major in educational background has a significant positive salary effect. However, the undergraduate and graduate university level is not significant. Labor market segmentation theory suggests that there are primary and secondary labor markets. In the secondary labor market, the work performed is not highly specialized, and professional skills, educational backgrounds, and so on are not the main factors that employers value.[53] A specific analysis of the industry destinations of engineering master's students in nonengineering occupations found that the industries with the largest inflow of such students are "public administration, social security, and social organizations" (accounting for 20.8% of the 18 industries surveyed). From the specific destinations, most engineering master's students in nonengineering occupations have entered the secondary labor market. Therefore, when engineering master's students enter the lower-threshold nonengineering industry labor market, the signaling role of their educational background will be correspondingly diminished. Even engineering master's students from elite universities cannot obtain higher starting salaries there.

Research implications

Promote the construction of a diversified higher education system

Employers' preference for a "strong screening" mechanism allows educational background to have a stronger salary effect while being unable to accurately reflect the human capital situation of engineering master's students. The formation of this mechanism depends on the hierarchical and rigid higher education structure, and as a result, it exacerbates educational inequality and the imperfection of the labor market. Therefore, to improve the strong screening mechanism, it is necessary to weaken the hierarchical and solidified higher education system in terms of policy and system and to promote the differentiation and heterogeneous development of colleges and universities. In particular, when granting policy symbols, such as economic resources and "key universities", differentiated evaluation criteria for universities in different tracks should be considered, and enough upward channels should be retained for latecomers to catch up. This would help avoid policy tools that supports the development of universities in becoming a dependent path to solidifying the hierarchical structure of the higher education system. This is not only an inherent requirement for promoting the sound development of the higher education system but also a necessary measure for expanding the development space of

China's vocational and technical education system.

The Double First-Class initiative, which began in 2016, represents a proactive government attempt to improve the rigid hierarchical structure of Chinese higher education. This policy shifted from the one-time granting characteristic of previous key university policies to a dynamic assessment cycle every five years,[54] which is conducive to the dynamic adjustment of the hierarchical structure of Chinese higher education. However, while this policy has injected vitality into universities' development, it has also triggered a new round of educational competition. Some universities blindly pursue research performance in line with the Double First-Class assessment indicators, leading to homogenized development among universities and neglect of market demands.[55] Further advancement in the construction of a diversified higher education system in China requires more beneficial attempts.

Strengthen the talent cultivation mode oriented around market demand

Universities are the key venues for cultivating engineering master's students, and aligning training with the market demand at the "exit end" is the primary path needed for universities to improve the employability of their engineering graduates. In accordance with the results of this study, universities should strengthen the talent cultivation mode oriented by market demand, with the human capital needed by the market as the core clue, and should strengthen the cultivation of the hard engineering skills of engineering master's students. This requires universities not only to consolidate the cultivation of traditional hard skills. such as scientific research ability and engineering knowledge foundation, but also to optimize students' mastery of hard skills, such as engineering practice ability and digital ability, in line with the needs of the times. However, this does not mean that soft engineering skills can be sacrificed to achieve the cultivation of hard engineering skills. In fact, not only does the cultivation of hard engineering skills rely on the collaborative development of soft engineering skills, but the return on investment in soft engineering skills is also more secretive and delayed.

CONCLUSION AND LIMITATIONS

By employing sample data with strong representativeness, this study conducted a detailed analysis of the human capital and educational background factors affecting the initial salary levels of engineering master's students. This study found that, first, hard engineering skills within human capital and the levels of undergraduate and graduate institutions and types of majors within educational background have a significant positive impact on the initial salaries of engineering master's students. However, contrary to experience, soft engineering skills have a significant negative impact on the initial salaries of engineering master's students. Second, the wage effect of educational background does not stem from the wage effect of human capital; the two are independent and show a strong screening trend. Third, there are significant differences in the main factors affecting the initial salaries of engineering master's students who engage in engineering work and those who do not.

The human capital proxy variable used in this study reflects the level of ability enhancement rather than the level of ability, and there is a lack of control for endogeneity issues, such as self-selection bias, in the use of quantitative methods. This may impose certain limitations on the research conclusions. Future related studies could further advance in the following two aspects. First, in terms of analysis methods, they could strengthen control for endogeneity issues and combine qualitative methods to conduct multidimensional verification of the "salary effects" of human capital and educational background to analyze their intrinsic connections. Second, in terms of research themes, they could further deepen the discussion on the post-graduation salary growth and development of engineering master's students to analyze the significant role of noncognitive abilities in this process.

DECLARATIONS

Author contributions

Guo H: Conceptualization, Methodology, Formal analysis, Writing—Original draft, Writing—Review and Editing, Supervision, Project administration, and Funding acquisition. Liu LS: Conceptualization, Data curation, Validation, Formal analysis, Writing—Original draft. Wang CX: Conceptualization, Validation, Writing—Review and Editing. All authors have read and approved the final version of the manuscript.

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No additional data.

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