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International comparative analysis of the industry-education relationship in vocational education and training: From the perspective of economic sociology

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ABSTRACT

The relationship between industry and education serves as a focal point in research on vocational education. Previous studies using rigid Weberian ideal types of behavior struggle to capture the complex realities and notable variations both within and across developing countries and often fail to consider the impact of educational systems and the connection between education and employment. This article endeavors to introduce a new framework for international comparative analysis through the lens of economic sociology. This analytical framework examines three key dimensions: the readiness and capacity of industries to engage in vocational education, the willingness of students to enroll in vocational education, and the influence of labor market and education institutions on both industries and students in relation to vocational education. Its purpose is to explore the relationships and critical factors that affect the interactions between industry and education in Germany, the US, and China. The findings can be summarized as follows: In the US, industry has a relatively low demand for a skilled workforce and a diminished inclination to invest in vocational education and training (VET), and the willingness of students to engage in VET is also relatively low. Certain characteristics of US labor market and education system also present significant challenges for the industry-education relationship in VET. In Germany, the industry has a relatively high demand for skilled workers, and there is an interest in investing in VET, and some students are willing to choose VET. The labor markets and education systems in each country also affect the involvement of stakeholders in VET. In China, a more mixed picture can be observed, with a closer similarity to the US in terms of the industry-education relationship in VET, with the exception that the government plays a more active role in this.

Key words: vocational education, industry-education relationship, economic sociology, comparative analysis

INTRODUCTION

One of the fundamental themes in vocational education and training (VET) is the relationship between industry and education. Industry involvement is a crucial prerequisite for high-quality workplace learning and significantly influences the quality of VET. Meanwhile, numerous international organizations and governments regard supporting the economy and industrial development as a key function of VET, which also shapes its standards and objectives.

Scholars from various academic backgrounds have discussed the relationship between industry and education in vocational education extensively and systematically. Yet, international comparative research

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on this topic remains limited, particularly in terms of cross-country comparative studies that analyze the industry-education relationship within a specified international comparative framework. Drawing upon both domestic and international research, this paper develops a new analytical framework to examine the industry-education relationship in Germany, the US, and China, as well as the factors that influence this association. The objective is to deepen our understanding of the differences in VET among these nations, as well as the economic and social elements that drive these variations. Additionally, this paper seeks to offer an exploratory analysis of critical issues that have impeded the progression of VET globally, through a lens of international comparison.

CLASSIC FRAMEWORKS FOR COMPARING INTERNATIONAL VOCATIONAL EDUCATION SYSTEMS

In the field of international comparative vocational education research, few studies specifically explore the relationship between industry and education. Nevertheless, within various classic analytical frameworks, the interplay between industry and VET is regarded as the primary focus. We will first examine and summarize these classic international comparison frameworks to establish a foundation for developing a new analytical framework.

Greinert's market, school, and dual-system models

Greinert categorized VET systems of different countries into three models, focusing on the role and function of the government: the school model, the market model, and the government-regulated market model, also known as the dual model.[1]

The predominant feature of the school model, which can be seen in France, is that VET is primarily the government's responsibility and is offered through public schools. In contrast, the UK's market model is characterized by minimal governmental interference in VET. Germany's government-regulated market model is characterized by a shared responsibility for vocational training between industry and the government, where the government provides a regulatory framework, and the industry delivers the substantive training content.

The Organization for Economic Cooperation and Development's (OECD)'s comparative school-to-work transition model

The OECD categorizes pathways for school-to-work transitions in different countries into three types: apprenticeship pathways, school-based vocational education pathways, and general education pathways.[2] This category examines how VET are organized and connected to the youth labor market, emphasizing the places where students learn prior to their formal entry into the workplace.[2] The model illustrates the interconnection between governments, schools, and employers, as well as the extent of integration between production and education.

Comparison of skill formation systems in political economy

Scholars from political economy and related academic fields have examined VET through the lens of the relationship between the market and government. In their 2012 study, Busemeyer and Trampusch developed a framework to compare different skill formation systems from the perspective of political economy. They categorized skill formation systems into four models—liberal, segmental, statist, and collective—according to the degree of corporate involvement in the provision of initial vocational training, as well as the level of public commitment to work training.[3]

The liberal model, exemplified by the US and the UK, features minimal government responsibility, limited corporate engagement, weaker vocational education, and a focus on general education as a pathway from school to employment. The segmentation model, as can be seen in Japan, involves a high degree of corporate participation and minimal government intervention, where young individuals typically enter large corporations' internal labor markets, receive training, and progress career-wise after completing general education. The statist model, adopted by Sweden and France, is characterized by low corporate but high governmental involvement, where public policymakers endorse VET as a viable substitute for academic higher education, seamlessly integrating it with the educational framework. Lastly, the collective model in Germany means robust involvement and investment in VET by both businesses and the government, with employer associations and labor unions playing pivotal roles in managing VET.

This analytical framework from the perspective of political economy considers the dimensions of both enterprise and government, emphasizing the relationships between industry, educational institutions, and the government. It possesses greater complexity and explanatory power, gaining widespread recognition within the academic community. This analytical framework predominantly operates within the political economy research paradigm, significantly extending and developing capitalism theory. However, scholars specializing in vocational pedagogy argue that this framework fails to consider the intrinsic logic of the education system and the vocational learning process.[4]

Inadequate attention paid to developing countries in existing analytical frameworks

Although scholars have developed models for comparing VET internationally within the contexts of vocational pedagogy and political economy paradigms, they predominantly concentrate on developed industrial nations and Western parliamentary democracies, paying limited attention to developing countries. When these models are applied to developing nations, they struggle, in a manner reminiscent of Weber's rigid ideal-type approach, to adequately accommodate the vast and varied realities and distinctions both between and within these countries.

Taking China as an example, when examining VET within the contexts mentioned in the analytical frameworks above, it is apparent that elements from a variety of models are being practiced, including the traditional school-based VET system, as well as the dual-system model and other integrated forms. Furthermore, when viewed through the broader lens of political economy, China's VET not only reflects nationalist influences at the policy level but also displays tendencies toward segmentalist and liberal models at various other levels. The numerous models of VET described by the previous frameworks may manifest themselves simultaneously in a complex manner within the context of China.

Moreover, traditional models used for international comparisons in VET often overlook the impact of educational systems and the connection between vocational education and general education. The interplay between vocational education and students' and the general public's interest in it is a critical issue, that deeply intertwined with and significantly impacted by the education system and its associated institutional frameworks. In various countries and regions, students' eagerness and enthusiasm for vocational education can vary and are influenced by distinct educational systems and their respective general and vocational education. Hence, it is essential to take into account how the willingness of students to participate in vocational education may affect the quality of VET as well as the relationship between industry and education.

In summary, the existing frameworks for international comparative analysis fall short in accounting for the major variations in the relationship between industry and education within vocational sectors across countries, notably between developed and developing nations. These frameworks face additional challenges in addressing the discrepancies in VET both between and within developing countries often due to regional inequalities, diverse types of enterprise ownership, and multiple forms of foreign investment. Hence, it is essential to create a new comparative framework for industrial-educational collaboration in VET to analyze such collaborations across a broader range of countries and regions, including those that are developing.

A NEW INTERNATIONAL COMPARATIVE FRAMEWORK

As previously noted, a revised framework for comparing VET in developing countries such as China with international standards is necessary. This new model should account for the complexities of the realities in developing countries and align closely with the actual challenges of integrating industry and education in these countries. This would provide greater explanatory strength when analyzing the disparities between developing and developed countries.

From this viewpoint, when developing a new analytic framework, it is essential to take into consideration the realities of developing countries. The framework should be constructed with an awareness of the significant challenges encountered within the vocational education-industry relationship. VET is an interdisciplinary field that encompasses various stakeholders including students, businesses, and the government. The decisions and choices made by each of these groups affect the level of business engagement in VET. Consequently, to thoroughly analyze this issue, a new analytical framework is required that considers the perspectives of all stakeholders involved. Moreover, because the decisions of these stakeholders are shaped by the external institutions they are part of, this framework should also take into account the relevant institutional contexts.

Existing research, along with the author's observations and investigations in China and Southeast Asian countries, highlights certain challenges in the ties between employers and educational institutions within VET in developing countries. Primarily, there is a general lack of motivation for industry involvement in vocational training, characterized by minimal necessary participation by companies, partly due to industrial development. Furthermore, some companies exploit vocational school students or apprentices as cheap labor, resulting in a diminished quality of workplace learning. Secondly, the reluctance of students to enroll in vocational schools or colleges frequently stems from their inability to pursue general education subsequently, forcing them into a choice that contributes to a lack of competent candidates for vocational education. Furthermore, some students display deficiencies in fundamental learning skills, abilities, and attitudes. Third, the existing institutions relevant to VET are not supportive and comprehensive, hindering the collaboration between industry and education and impeding the improvement of the quality of VET, these will be

defined in the next paragraph.

Based on the arguments above, we suggest developing an international comparative framework of the relationship between education and industry in VET with a focus on three primary dimensions: industry, students, and external institutions, which includes both educational and other broader social institutions that may have an impact on enterprises and students, such as labor-market institutions and characteristics of education system. The proposed analytical structure includes: (1) the industry's readiness and capacity to engage in VET, influenced by industry characteristics, such as organizational structures in production; (2) the eagerness and interest of students in participating in VET, which is largely dependent on the social income structures and the availability and quality of vocational schools; and (3) the effect of institutions on both industry and students, especially concerning labor market dynamics, labor relations, and educational systems. This research endeavors to offer an alternative approach to comparing VET systems and their relationship with industries in various countries and regions by addressing the following three key questions. What are the demands of enterprises for skilled workforce? To what extent are students willing to choose VET, and what are their reasons for doing so? What impact do institutions have on enterprises and students?

This analytical framework could potentially accommodate a wide range of stakeholders, including businesses, students/residents, and government agencies, aligning closely with the theoretical assumptions and the approaches toward understanding reality contained within theories of economic sociology. There are two reasons for adopting economic sociology as the main analytical perspective in our research methodology. First and foremost, within the scope of economic sociology, it is essential to recognize that the rational behavior of actors is not simply presupposed as a basis for further research; rather, it is a phenomenon that requires explanation in itself. The engagement of businesses in VET exemplifies such rational behavior, and it should not be assumed as self-evident; instead, it requires analysis and explanation. Secondly, economic sociology, unlike traditional microeconomic analysis, not only considers individuals but also encompasses groups and institutions. It emphasizes the role of actors as social constructs, recognizing the presence of connections and reciprocal influences among them. The relationship between industry and education in vocational education is intimately linked with the decisions of its primary stakeholders such as businesses and students, and it is significantly shaped by overarching institutional influences, which also affect the dynamics between industry and students. Meanwhile, the relationships and interactions between industry, students, and vocational education institutions are a force of social construction, which also impacts industry and education systems. From this perspective, an economic sociology approach is appropriate for examining the relationship between industry and education in VET.

EXPLORING THE INDUSTRY-EDUCATION RELATIONSHIP IN VET ACROSS THREE COUNTRIES

This study compares the relationship between industry and education in VET in the US, Germany, and China. These countries were chosen for their statuses as the most developed country, the nation with the highest global reputation in vocational education, and the largest developing country, respectively. Moreover, the VET systems, labor markets, and government roles in the US, Germany, and China exhibit substantial differences, which facilitate the analysis of decisions made by various stakeholders, including businesses, citizens, and governments across diverse institutions and environments.

It is important to mention the limitations of the following analysis here. It includes generalizations that tend to treat each country's society and VET system as ideal types and inevitably neglect the complex realities of each country and focus on some of their most visible features. We are fully aware of the possibility of oversimplification in this research.

The relationship between vocational education and industry in the US

For the dimension of the willingness and ability of industry to participate in VET, the US exhibits a low demand for skills and a limited inclination within the industrial sector to invest in VET. The low level of demand for technically skilled workforces in the US industry is related to a historical tendency toward de-skilling and a trajectory toward financialized economic development. The US initially pursued an industrial development trajectory during its early industrialization in the 19th century that significantly decreased its dependence on worker skills, leading to a de-skilling pathway. Later in the first half of the 20th century, through a revolution in management style, control over labor processes was established and complex skills were systematically stripped from workers through the implementation of mass production.[5] The characteristics of this industry pathway have influenced the demand for workforce knowledge and skills across several sectors in the US, resulting in a greater dependency on highly automated machinery and therefore reducing the need for knowledge and skill for the majority of workers. Consequently, many companies now offer minimal, nonsystematic training for their employees. This is a trend that continues to influence

American enterprises. Additionally, since the 1980s, the financialization of the US economy has further altered corporate behaviors, affecting and molding numerous facets of the industry, including vocational training. A large number of companies are increasingly pursuing value extraction rather than value creation. Instead of investing profits in research and development (R & D) and improving employee competence, they are downsizing and cutting costs, paying high dividends to shareholders, and offering share buybacks.[6] This shift in the behavioral motivation of companies affects their attitude toward employee training, as employees are viewed primarily as financial burdens, which results in diminishing investment in vocational training.[7] This effect is verified in both the time and the cross-sectional comparison dimensions. From the 1980s to the first decade of this century, the proportion of profits invested in R & D by the US firms continued to decrease, while the spending on share buybacks and dividends continued to increase.[8] In a cross-sectional comparison, US private firms spend twice as much as publicly traded firms on building factories, employee training, product development, and other long-term investments.[9] However, there are still many manufacturing jobs in the US, especially in the highly unionized automotive and aircraft manufacturing industries, where companies are willing to invest in the training of personnel.

Looking at the dimension of the willingness and interest of students to choose VET, the shrinking middle class, worsening social inequality, and a solidified class structure within the American social framework have significantly influenced employment opportunities in vocational education, subsequently impacting students' interest in and willingness to pursue such educational paths. The contraction of the middle-income class suggests a decrease in job opportunities for graduates of vocational education, leading invariably to diminished benefits from this education pathway. Between 1917 and 1972, the incomes of different groups grew rapidly, but from the 1980s to the present, the income growth of the lower and middle classes gradually stagnated, while the incomes of the richer classes continued to increase rapidly, leading to a widening income gap between the different classes.[10,11] Research in labor economics indicates a clear tendency of polarization within the labor market in the US between the 1980s and 2010s, revealing that between 1979 and 2010, employment growth increasingly focused on the highest and lowest ends of the occupational skill spectrum: high-education, high-wage jobs and low-education, low-wage jobs. Conversely, jobs that require medium levels of education and offer medium wage levels, including roles in production, maintenance, assembly, administrative management, and sales, experienced less growth.[12] Societal changes have shifted the structure from a predominately middle-class, "diamond-shaped" society prior to the 1970s to one characterized by expanding social inequality and a rigid class system. This transformation has increasingly constrained the options available to ordinary people, thereby diminishing their inclination toward choosing vocational education.

In terms of its institutional impact, the liberal labor market in the US affects business participation in VET, while problems within the education system lead to difficulties in vocational education. In the US, the economy is predominantly liberal market-oriented, where the development and accumulation of skills depend on market forces. In this system, both the government and businesses play a minimal role in vocational education, resulting in significant labor market mobility. Employers primarily recruit workers with specialized skills.[13] Furthermore, in the US, the skill training system is predominantly based on general education,[14] and vocational education faces additional challenges posed by the educational system itself. Educational institutions also play a role in this. Constrained by educational inequality and fundamental educational shortcomings faced by many schools, a substantial proportion of students enrolling in community colleges that offer VET programs do not possess sufficient basic knowledge and learning skills required for a college education. Many students at institutions such as community colleges do not continue their education after the first year because they experience learning difficulties. The proportion of these students in schools with few barriers to entry is chronically higher and can reach more than 40 percent.[15,16] Additionally, influenced by neoliberal ideologies, some community colleges face issues concerning the quality of education provided. Consequently, many students from lower and middle-income backgrounds struggle academically and incur substantial economic burdens post-graduation, adversely affecting their long-term career prospects.[17] Under the influence of neoliberal ideology, institutions of higher education have become more dependent on private sector funding and more concerned with economic efficiency, and community colleges are no exception.[18] Remedial courses, which used to be part of traditional credit courses, have been converted to non-credit courses at some schools, and paying for them has become the responsibility of the students themselves.[19] Many students from lower- and middle-class backgrounds have to apply for student loans, which affects them long-term after graduation.

In summary, in the US, the de-skilling and the financialization of industry pathways have led to a reduced demand for a skilled workforce and a diminished inclination to invest in employee training. The decline of the middle-income group and substantial income disparities have resulted in the diminished interest and willingness of students to engage in vocational

education. The liberal labor market and education system also present notable difficulties that substantially influence the willingness of relevant stakeholders to participate in VET, and together, the above-mentioned factors negatively influence the relationship between industry and education and therefore result in possible damage to the quality of VET.

The relationship between vocational education and industry in Germany

For the dimension of the willingness and ability of industry to participate in VET, German companies inherently have a high demand for a skilled workforce, therefore, there is a greater willingness and capacity to participate in VET. German manufacturing companies, in particular, possess advanced technological capabilities and their products offer substantial added value, which grants them prominent positions in numerous niche markets. These companies have stable prospects for future growth, with their profitability largely reliant on the quality of their products and services rather than on financial markets. Meanwhile, German companies often prioritize high-quality, diversity, and precision in the organization of their production, adopting flat internal hierarchical structures with specialized divisions of labor. Thus, these corporations typically have higher and sometimes unique expectations for their employees' knowledge and skills. Many workers engaged in production and maintenance work take on more responsibilities, with a higher degree of freedom and relatively complex vocational abilities not only to perform relatively simple tasks such as handling, loading and unloading but also to prepare, plan, and evaluate work.[20] The demand for company-specific skills generated by many firms further increases the incentive to participate in vocational education, as it is difficult to recruit workers with these skills from the labor market, and they have to train them themselves.[21] Consequently, there is a strong incentive and motivation to engage and invest in VET, with the goal of boosting the overall production and operation of companies through the enhancement of employee skills.

On the dimension of the willingness and interest of students to choose VET, German pupils enrolled in vocational education programs tend to make active choices based on their interests and readiness to work, and they possess a clearer intention to seek employment. In Germany, the middle-income group forms the backbone of the social income structure. Participating in the dual vocational education system typically yields middle-level earnings, facilitating a seamless transition from education to employment, which helps individuals maintain their social status. With the improvement of professional competencies through additional training and education pathways, their income can increase further. Vocational education through a dual system therefore offers a valuable alternative pathway of career advancement other than university education.

Germany's institutional framework also enhances enterprises' demand for a skilled workforce and therefore strengthens industry's involvement in VET, as well as influencing students' willingness to participate in VET. Germany exemplifies a coordinated market economy where the imperfect labor market mechanism mitigates concerns about employee poaching among companies. The collective wage bargaining system narrows wage disparities. Moreover, skill specificity in some companies may further bolster the demand for training in the form of apprenticeships within companies. Meanwhile, through organizations and mechanisms that represent it, industry maintains a dominant role in VET decision-making.[22,23] Industry manages to participate actively in VET and shape various elements of its policy, thereby protecting its own interests.[24] Furthermore, the German education system possesses a robust capacity to segregate and categorize students. A substantial portion of secondary school graduates choose vocational education, due to, to a certain extent, the existing educational pathwayad and for apprenticesnflucn. The internal streaming of secondary education in Germany takes place at an early stage, with pupils having to choose between a general secondary, practical, or grammar school (or a combination of all three) at the end of elementary school. While the majority of grammar school pupils go on to university studies after graduation and the majority of practical school pupils go on to vocational education, pupils in main schools face certain difficulties as many do not go on to vocational education and have to enter a transition system (Übergangssystem). Despite the possibility of interconnection between these different schools, the fact that a considerable number of pupils who do not make it to grammar schools are confined to vocational paths at an earlier stage objectively guarantees the number of pupils who choose vocational schools.[25,26] While there has been a recent trend of greater permeability between vocational education and higher education, both systems still preserve their independence. In recent years, a relatively low percentage of vocational education graduates in Germany have opted to pursue further studies at universities directly.[27] This could successfully safeguard the unique attributes and quality benchmarks of both vocational education and higher education. This arrangement therefore sends explicit quality signals to both students and businesses, thereby ensuring the ongoing demand for VET. However, German VET is also facing some challenges recently, such as the declining number of companies investing in it, the lack of readiness of apprentices for vocational training, as

well as pupils' growing preference for higher education over VET.

In summary, the distinctive features of German industry generate a substantial demand for a skilled workforce. Vocational education offers middle income and social status and therefore is not viewed as being a "bad" educational choice. The imperfect labor market mechanisms within a coordinated economy, along with collective wage bargaining, provide strong incentives for businesses to engage in vocational education. Moreover, the configuration of the education system allows industry to significantly influence vocational education. Additionally, the nature of the education pathway contributes to maintaining a high number of students choosing VET.

The relationship between vocational education and industry in China

For the dimension of the willingness and ability of industry to participate in VET, differences in regional development, diverse company ownership, and varying degrees of foreign capital participation have resulted in considerable complexity and diversity within China. Enterprises with lower technological capabilities often exhibit minimal interest and engagement in vocational education. This can be attributed to factors such as their productivity, profitability, and human resource management model. Consequently, these enterprises may hesitate to commit fully to vocational education or might only employ interns and apprentices as inexpensive labor during collaborations with educational institutions.[28] As production technology advances and the added value of products increases, many companies are taking initiatives to independently research and develop new production processes and undertake equipment and process upgrades, which has resulted in the creation of roles that necessitate the operation of specialized equipment and the application of unique production techniques, and consequently, increasing industry's incentive to invest in VET.

Regarding the enthusiasm and interest of students to participate in vocational education, the situation in China bears more resemblance to the US than to Germany. This similarity can be attributed to the fact that the middle-income group is relatively small, and an increasing number of occupations demand higher-education qualifications. The diminished prestige of vocational education diplomas, in contrast to the escalating public demand for higher education, poses a challenge. This situation, combined with the specialized educational requirements for regional economic services and specific majors, creates a dilemma in attracting students to secondary vocational education.[29] A national survey of 10,660 secondary vocational school students revealed a strong inclination toward further education, particularly undergraduate studies. Students from graduating classes, along with those who exhibit a high level of self-efficacy in learning, are more inclined to opt for higher education.[30]

With regards to the impact of institutions, the high degree of mobility of the labor market, the predominant role of the government in an industry-education relationship, and the possibility of vocational school students choosing higher education, which is the result of high permeability between VET and higher education, have resulted in a lack of incentive for Chinese companies to engage in vocational training and a heightened inclination among students to seek advanced education.

Firstly, against the background of China's system of autonomous and flexible employment, the labor market exhibits a high level of mobility. Employees can acquire new skills through job transitions, and the widening wage differentials have further enhanced labor market fluidity. This increased mobility has frequently led companies to "poach" skilled workers as a means of addressing their skill requirements.[31] This creates a disincentive for companies to invest in vocational training.

Secondly, in contrast to the US and Germany, the Chinese government plays a more significant role in fostering industry-education collaborations within VET through the provision of extensive and varied levels of guidance and incentives. Over the past few years, the government, on both a central and regional level, has been exploring different methods of enhancing vocational education's capacity to support local economies and promote the involvement of industrial enterprises. Despite various policy incentives, the connection between educational institutions and industry enterprises might not necessarily improve. Instead, with the growth in incentives, vocational education institutions tend to establish stronger relationships with government bodies. Many vocational schools, once deeply embedded in the development of regional skills and local economies, are loosening their ties with local industries and increasingly seeking support and recognition from government entities.

Furthermore, China's vocational education system has not succeeded in facilitating the active involvement of industry in developing vocational education standards. The participation of Chinese industrial enterprises in vocational education primarily focuses on the curriculum and teaching content during the teaching process, with minor engagement in formulating vocational education standards before the program is implemented.

Last but not least, motivated by the development of a modern vocational education system, alongside the policy of merging vocational and general education through various public policies, an increasing number of secondary vocational school students are opting to pursue further education rather than enter the job market immediately. Consequently, there has been a steady decline in terms of vocational school graduates from which companies can recruit, leading firms to increasingly rely on higher-vocational colleges to recruit their technical workforce. The connection between secondary vocational education and industry has diminished over time, with higher vocational education becoming more pivotal in shaping regional skills.

In summary, due to varied productivities within the industry, firms with limited technological expertise exhibit a low desire and capacity for engaging in vocational education. Conversely, enterprises that possess independent R & D capabilities as well as specialized production processes show a substantial interest in actively participating in vocational education by establishing skill-specific positions tailored to their operations. The middle-income group remains comparatively small and represents a minor segment of society. Many occupations require higher-education qualifications, which discourages students from opting for vocational education. Within the framework of autonomous and flexible employment in Chinese enterprises, the nature of the labor market, which exhibits high mobility and increasing wage gaps, leads to the further decrease of incentives for businesses to engage in vocational training. The Chinese government maintains a significant influence over the vocational education sector and while the bond between educational institutions and the government grows stronger, the relationship between vocational education institutions with industrial enterprises weakens. Moreover, there are inadequate institutional mechanisms to allow businesses to actively participate in establishing educational standards. Additionally, driven by public policies such as the development of a modern vocational education system and the merging of vocational and general education, students show a greater inclination to further their education rather than enter the job market.

CONCLUSION

The analysis reveals significant national variances in the crucial aspects of the industry-education linkage in VET in the US, Germany, and China.

In terms of the willingness and ability of industry to participate in VET, German companies exhibit a high demand for skilled employees and a strong motivation to engage in vocational education, demonstrating both willingness and capability. In contrast, American companies typically have lower skill requirements and a limited inclination to invest in training. In China, companies with lower technical levels show a limited willingness and capacity for participating in vocational education, but those companies with a higher level of productivity are more willing to invest in vocational training.

Regarding the dimension of the willingness and interest of students to choose VET, the decline of the middle-income group in the US, coupled with significant income disparities, has resulted in limited willingness and interest among the public in pursuing vocational education. In Germany, the return on investment for middle-income earners attending the dual system vocational education is typically attractive, motivating students to voluntarily opt for VET. In China, the proportion of the middle-income demographic remains relatively small within the broader society. This, coupled with the requisite of higher-education qualifications for many positions of employment, diminishes the inclination of students to opt for vocational education.

On the dimension of the influence of institutions, in the US, where a liberal market economy prevails, corporations have limited involvement in VET. Crucial issues within educational institutions, such as educational inequality and difficulties for disadvantaged schools, have led to learning difficulties for many college students, therefore, pose further challenges to the relationship between industry and education. In Germany, the coordinated economy with an imperfect labor market and a collective wage bargaining arrangement, together with a system that allows industry influence in VET, all encourage industries to engage in VET. The education system in Germany, such as streaming from an early stage in education and the relative separation between VET and higher education, also helps to guarantee the number of students enrolling in VET. In China, because of high labor market mobility together with rising corporate demands for higher-education qualifications, companies have little incentive to engage in VET. Meanwhile, key educational institutions in China allowing higher permeability between VET and higher education is contributing to the difficulties of the industry-education relationship with students in VET showing a greater inclination toward pursuing further education rather than entering the job market directly.

The analysis above concentrates primarily on how industry, social structure, and institutions influence the relationship between industry and education in VET. Nonetheless, it is crucial to recognize that VET is not merely shaped by these economic and social factors, there are more intricate interactive dynamics at play among these various factors. The impact of industrial characteristics on businesses' active participation in vocational education should not be perceived merely as

a one-dimensional factor determining the industry's demand for skilled workforces but also as being influenced by the realities of skill formation. The industrial development trajectory of any country or region is not solely based on arbitrary decisions made in isolation by its industries alone but is instead shaped and influenced by distinct pathways of the industrial evolution and the allocation of its social resources. The composition and quality of the workforce, encompassing engineers and technical workers, which are socially constructed during historical developments, have a significant influence on industries and ultimately contribute to the unique industrial development traits of certain countries or regions, and industry's competitiveness hinges on the overall skills and qualities of its workers.

This study's limitations arise from its comparative analysis framework, which largely focuses on the actual challenges faced by developing countries such as China. As a result, the framework's suitability for the international context remains uncertain. Moreover, the study is somewhat biased by a perspective shaped by the conditions in developing nations and pays limited attention to the inherent development and challenges of vocational education institutions. As mentioned earlier, another weakness is that the analysis treats VETs in the analyzed country as ideal types and by focusing on the most visible features of each country and VET system, it inevitably neglects the complex realities within the country.

DECLARATIONS

Author contributions

Li J: Conceptualization, Writing—Original draft, Writing—Review and Editing. Huang MX: Writing—Original draft, Writing—Review and Editing. All authors have read and approved the final version of the manuscript.

Ethics approval

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Data availability statement

No additional data.

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