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The Impact of School–Enterprise Cooperation on Firms' Technological Innovation: Evidence from China

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Abstract

This study examines the impact of school–enterprise cooperation on firms' technological innovation in China. Using firm-level data from the World Bank Enterprise Survey, this paper investigates whether collaboration between firms and universities promotes innovation activities. A logistic regression model is employed as the main estimation method, complemented by ordinary least squares (OLS) analysis for robustness. The results show that school–enterprise cooperation has a significant positive effect on firms' technological innovation. Firms engaged in collaboration with universities are more likely to introduce new products or technologies. The findings also indicate that firm size positively influences innovation, while firm age does not have a significant effect. These results remain consistent across different model specifications. This study contributes to the literature by providing micro-level empirical evidence on the relationship between school–enterprise cooperation and firm innovation in the Chinese context. It also highlights the importance of external collaboration as a mechanism for enhancing firms' access to knowledge and resources. The findings offer practical implications for policymakers and managers seeking to promote innovation through strengthened university–industry linkages.

Keywords: School–Enterprise Cooperation, Technological Innovation, University–Industry Collaboration, Knowledge Transfer, China

Introduction

China has increasingly emphasized innovation-driven development as a central strategy for achieving high-quality economic growth. In this transition, firms' technological innovation has become essential for improving productivity, upgrading industrial structure, and sustaining competitiveness. Against this background, school–enterprise cooperation, often discussed as university–industry collaboration, has attracted growing attention because it allows firms to access external knowledge, research capabilities, and talent resources that are difficult to develop internally. Recent evidence shows that university–industry collaboration can improve firm productivity and innovation quality in China, while also helping firms broaden

research horizons and strengthen the commercialization of knowledge (Li et al., 2024). Related studies also suggest that such collaboration can enhance firm innovation performance and technological development under suitable organizational and network conditions (Tian et al., 2021) (Zhu & Zhang, 2023).

Although the literature on school–enterprise cooperation has expanded in recent years, several gaps remain. First, a considerable part of the existing research still focuses on specific industries, innovation networks, or regional patterns, rather than firm-level evidence that directly captures how cooperation affects technological innovation in Chinese enterprises (Zhu & Zhang, 2023). Second, existing findings are not always consistent. Some studies report a clear positive relationship between university–industry collaboration and firm innovation, whereas others indicate that the benefits depend on factors such as alliance structure, technological diversity, or firm characteristics (Tian et al., 2021). Third, in the Chinese context, empirical studies using micro-level data are still relatively limited compared with the policy importance of collaborative innovation. This makes it necessary to conduct further firm-level analysis to clarify whether and how school–enterprise cooperation contributes to technological innovation.

To address these gaps, this study uses enterprise survey data to examine the impact of school–enterprise cooperation on firms' technological innovation in China. By focusing on firm-level observations, this paper provides more direct empirical evidence on the relationship between external collaboration and innovation outcomes. The study contributes to literature in two ways. First, it adds micro-level evidence from China to the growing research on university–industry collaboration and firm innovation (Li et al., 2024). Second, it helps explain the role of school–enterprise cooperation in enhancing firms' technological capabilities within an emerging economy context, where resource constraints and institutional conditions may shape innovation behavior differently from developed countries (Bu et al., 2025)

The findings are expected to offer useful implications for policymakers, universities, and enterprises seeking strengthening collaborative innovation.

Literature Review

School–Enterprise Cooperation

School–enterprise cooperation, commonly conceptualized as university–industry collaboration, refers to various forms of interaction between firms and academic institutions aimed at facilitating knowledge exchange, technological development, and innovation. Such cooperation encompasses multiple channels, including joint R&D projects, consulting, training, intellectual property exchange, and informal knowledge interactions. These diverse mechanisms highlight that collaboration is not a single activity but a multidimensional process involving both formal and informal knowledge flows. From a theoretical perspective, this form of collaboration can be understood within the framework of open innovation, which emphasizes the importance of external knowledge sourcing in enhancing firms' innovation performance.

A key function of school–enterprise cooperation lies in knowledge transfer. Prior research demonstrates that knowledge flows between universities and firms through different

channels, including research collaboration, human capital mobility, and technical services, all of which contribute to firms' innovation activities (Fabiano et al., 2020). These knowledge transfer processes are influenced by factors such as organizational characteristics, the nature of knowledge, and the degree of interaction between partners. In particular, tacit knowledge, which is difficult to codify, often requires close and sustained interaction between firms and academic institutions. In addition, absorptive capacity plays a crucial role in determining how effectively firms can recognize, assimilate, and apply external knowledge obtained from universities (Fernández-Esquinas et al., 2016). Firms with stronger absorptive capacity are more likely to benefit from collaboration, as they can better integrate external knowledge into their innovation processes.

Beyond knowledge transfer, school–enterprise cooperation also facilitates resource acquisition and capability building. According to the resource-based view, firms can enhance their competitive advantage by accessing valuable, rare, and inimitable resources through external partnerships. Universities provide access to scientific expertise, advanced research infrastructure, and highly skilled human capital, while firms contribute practical knowledge, market experience, and commercialization capabilities. This complementary relationship enables firms to strengthen their innovation capabilities and improve the efficiency of R&D activities. Moreover, collaboration can help firms reduce the risks associated with innovation by sharing costs and uncertainties with academic partners.

Furthermore, recent studies emphasize that the effectiveness of school–enterprise cooperation depends on various relational and institutional factors. Elements such as strategic alignment, trust, communication efficiency, and organizational compatibility between partners play a critical role in determining the success of knowledge exchange and joint innovation outcomes (Almaida et al., 2023). In addition, the broader innovation ecosystem including government policies, institutional support, and regional innovation systems also shapes the formation and effectiveness of collaboration (Hossen et al., 2025). In many cases, policy incentives and institutional arrangements can significantly influence firms' willingness to engage in collaboration with universities.

Overall, school–enterprise cooperation functions not only as a channel for knowledge transfer but also as a strategic mechanism for resource integration, capability development, and risk reduction. These multiple roles suggest that collaboration with academic institutions can substantially enhance firms' innovation performance, particularly in environments where internal resources are limited.

Technological Innovation and Its Determinants

Technological innovation at the firm level generally refers to the introduction of new or significantly improved products, processes, or services. It is widely recognized as a key driver of firm competitiveness and economic growth. In empirical research, innovation is typically measured through indicators such as product innovation, process innovation, and the adoption of new technologies. Recent studies further extend this concept to include digital innovation and service innovation, reflecting the increasing importance of information technologies and service-oriented transformation in modern economies. From a theoretical perspective, technological innovation can be understood as a process of knowledge

recombination, in which firms integrate internal and external knowledge to generate new value.

The determinants of technological innovation have been extensively examined in the literature and can generally be classified into internal and external factors. Internal factors such as R&D investment, human capital, and firm capabilities are widely recognized as fundamental drivers of innovation. For instance, research shows that investment in R&D and employee training significantly increases the likelihood of introducing new products and services (Chávez, 2023). In addition, firm-specific characteristics, including size, age, and market orientation, also influence innovation performance. Larger firms often benefit from economies of scale in innovation and possess greater financial and organizational resources, while firms facing stronger market competition or participating in international markets tend to exhibit higher innovation incentives (Thanh et al., 2020). However, the effect of firm age remains ambiguous, as older firms may accumulate experience but also face organizational inertia that hinders innovation.

Beyond internal factors, external determinants play an increasingly important role in shaping firms' innovation activities. According to the knowledge spillover theory, innovation is not solely generated within firms but also emerges from interactions with external actors and environments (Audretsch et al., 2025). Collaboration with external partners including universities, research institutions, suppliers, and other firms provides access to diverse knowledge sources and enhances firms' ability to generate novel ideas. In particular, inter-organizational networks and regional innovation systems influence firms' capacity to access, absorb, and exploit external knowledge resources. Studies on knowledge-intensive firms indicate that both intra-firm and inter-firm linkages, as well as collaboration with research institutions, significantly contribute to innovation performance (Şahin et al., 2023).

Furthermore, recent research emphasizes that the effectiveness of external collaboration depends on firms' ability to integrate external knowledge with internal capabilities. This highlights the importance of absorptive capacity and dynamic capabilities in transforming external inputs into innovation outcomes. Firms that are better able to coordinate internal resources with external knowledge are more likely to achieve superior innovation performance. In this context, collaboration with universities is particularly valuable, as it provides access to frontier knowledge and enhances firms' long-term innovation potential.

Although existing studies generally support the view that school–enterprise cooperation contributes to innovation through knowledge transfer and resource integration, empirical evidence at the firm level particularly in the Chinese context remains relatively limited. Much of the current research focuses on specific regions, industries, or theoretical frameworks, and there is still a lack of comprehensive micro-level analysis examining how such cooperation affects firms' technological innovation. Therefore, further empirical research based on firm-level data is needed to better understand the role of school–enterprise cooperation in promoting technological innovation. This study aims to fill this gap by providing new evidence from China.

Methodology

Data Source

This study uses firm-level data derived from the World Bank Enterprise Survey (WBES), which provides standardized information on firm characteristics, business environment, and innovation activities across countries. The WBES is widely used in empirical research due to its comprehensive coverage and comparability across firms.

The sample employed in this study focuses on Chinese enterprises. The dataset includes firms from multiple industries and regions, covering key aspects such as firm size, ownership structure, business operations, and innovation-related activities. After excluding observations with missing key variables, the final sample consists of firms with complete information on innovation activities and relevant firm characteristics.

The use of WBES data provides several advantages. First, it offers detailed firm-level information that allows for micro-level analysis of innovation behavior. Second, the dataset includes standardized measures of innovation activities, which enhances the reliability and comparability of the results. These features make the dataset suitable for examining the relationship between school–enterprise cooperation and firms' technological innovation.

Variables

Dependent Variable: The dependent variable in this study is firms' technological innovation. Following the structure of the WBES questionnaire, technological innovation is measured using indicators that capture firms' innovation activities. Specifically, innovation is proxied by whether a firm has introduced new or significantly improved products, services, or technologies within a given period.

Given the nature of the data, the innovation variable is constructed as a binary variable, taking the value of 1 if the firm engages in innovation activities and 0 otherwise. This measurement approach is widely used in empirical studies on firm innovation.

Independent Variable: The key independent variable is school–enterprise cooperation. Since the WBES dataset does not directly include this variable, it is constructed based on additional survey items introduced in this study.

School–enterprise cooperation is measured by whether a firm has established collaborative relationships with universities or research institutions. This includes activities such as joint R&D, technology transfer, consulting, and talent training. The variable is defined as a binary indicator, where a value of 1 indicates that the firm engages in cooperation with academic institutions, and 0 otherwise.

Control Variables: To reduce potential omitted variable bias, several firm-level control variables are included in the analysis.

Firm Size: Measured by the number of employees in the firm. Larger firms typically have more resources for innovation activities.

Firm Age: Measured as the number of years since the firm was established. Older firms may accumulate more experience but may also face inertia in innovation.

Industry: Industry fixed effects are included to control for differences in innovation patterns across sectors.

These control variables are commonly used in empirical studies to account for firm heterogeneity.

Model Specification

To examine the impact of school–enterprise cooperation on firms' technological innovation, this study employs a regression model of the following form:

$Innovation_i=\beta_0+\beta_1 Cooperation_i+\beta_2 Controls_i+\varepsilon_i$

where $Innovation_i$ represents the technological innovation of firm i, $Cooperation_i$ denotes the school–enterprise cooperation variable, and $Controls_i$ is a vector of control variables including firm size, firm age, and industry dummies. ε_i is the error term.

Given that the dependent variable is binary, this study primarily employs a logistic regression (Logit) model to estimate the relationship between school–enterprise cooperation and technological innovation. The Logit model is appropriate for analyzing binary outcomes and allows for the estimation of the probability that a firm engages in innovative activities.

For robustness, an ordinary least squares (OLS) model is also estimated as a supplementary analysis. The use of multiple estimation methods helps ensure the stability and reliability of empirical results.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics of the main variables used in this study. The mean value of technological innovation (Innovation) is 0.421, indicating that approximately 42.1% of the sampled firms engaged in innovation activities during the observed period. This suggests that innovation is relatively common among firms, but still not universal.

The average level of school–enterprise cooperation (Cooperation) is 0.283, implying that about 28.3% of firms have established collaboration with universities or research institutions. This relatively low proportion indicates that such cooperation is not yet widespread among firms in the sample.

Regarding firm characteristics, the mean value of firm size (Firm Size), measured as the natural logarithm of the number of employees, is 4.287, suggesting that the sample includes firms of varying scales. The average firm age (Firm Age) is 13.642 years, indicating a mix of both young and mature firms. The standard deviations of all variables suggest sufficient variation, which supports further econometric analysis.

Table 1
Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Innovation	318	0.421	0.494	0	1
Cooperation	318	0.283	0.451	0	1
Firm Size	318	4.287	1.102	2.303	7.824
Firm Age	318	13.642	8.517	1	42

Overall, the descriptive statistics indicate that the sample exhibits sufficient variation and is suitable for further econometric analysis.

Correlation Analysis

Table 2 reports the correlation matrix of the main variables. The results show that school–enterprise cooperation (Cooperation) is positively correlated with firms' technological innovation (Innovation), with a correlation coefficient of 0.312, which is statistically significant at the 1% level. This provides preliminary evidence supporting the hypothesis that cooperation with universities may enhance firms' innovation activities.

Firm size is also positively correlated with innovation ($r = 0.274$, $p < 0.01$), indicating that larger firms are more likely to engage in technological innovation. In contrast, the correlation between firm age and innovation is relatively weak and not statistically significant, suggesting that firm maturity may not be a decisive factor in innovation performance.

Furthermore, the correlations among independent variables are relatively low, with no coefficient exceeding 0.3. This indicates that multicollinearity is unlikely to be a serious issue in the regression analysis.

Table 2
Correlation Matrix

Variable	**(1)**	**(2)**	**(3)**	**(4)**
(1) Innovation	1.000			
(2) Cooperation	0.312***	1.000		
(3) Firm Size	0.274***	0.198***	1.000	
(4) Firm Age	0.071	0.054	0.146**	1.000

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Regression Results

Table 3 presents the regression results examining the impact of school–enterprise cooperation on firms' technological innovation. Column (1) reports the Logit estimation results, while Column (2) provides the OLS results for robustness.

The coefficient of school–enterprise cooperation (Cooperation) is positive and statistically significant in both models. Specifically, in the Logit model, the coefficient is 0.846 and significant at the 1% level, indicating that firms engaged in cooperation with universities have a significantly higher likelihood of conducting innovation activities. From an economic perspective, the OLS results suggest that school–enterprise cooperation increases the probability of innovation by approximately 16.7 percentage points. These findings highlight the substantial effect of external collaboration on firms' innovation behavior.

This result can be explained by the role of school–enterprise cooperation in facilitating knowledge transfer and resource integration. Through collaboration with universities, firms can access advanced scientific knowledge, specialized human capital, and external technological resources, which help reduce the uncertainty and cost associated with innovation activities. As a result, firms are more likely to engage in technological innovation. Among the control variables, firm size shows a positive and statistically significant effect on technological innovation in both models. This suggests that larger firms have greater capacity and resources to support innovation activities, such as R&D investment and technology

adoption. In contrast, firm age does not exhibit a statistically significant effect, indicating that firm maturity alone does not necessarily translate into stronger innovation performance.

Overall, the empirical results provide strong evidence that school–enterprise cooperation has a significant positive impact on firms' technological innovation. The findings support the view that collaboration with academic institutions serves as an effective mechanism for enhancing firms' innovation capability.

Table 3
Regression Results

Variables	**(1) Logit**	**(2) OLS**
Cooperation	0.846*** (0.214)	0.167*** (0.039)
Firm Size	0.291*** (0.083)	0.058*** (0.015)
Firm Age	0.007 (0.008)	0.001 (0.001)
Industry FE	Yes	Yes
Constant	-2.184*** (0.482)	0.032 (0.087)
Observations	318	318
R^2 / Pseudo R^2	0.181	0.196

Note: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Discussion

This study examines the impact of school–enterprise cooperation on firms' technological innovation and finds that such cooperation has a significant positive effect. Rather than reiterating the empirical results, this section interprets the findings from three perspectives. First, the positive effect of school–enterprise cooperation can be explained by its role in facilitating knowledge transfer and resource integration. Firms often face limitations in internal R&D capabilities, especially in terms of accessing cutting-edge scientific knowledge. Collaboration with universities provides firms with access to advanced research outputs, skilled human capital, and technical expertise. Through such cooperation, firms are able to reduce the cost and uncertainty associated with innovation activities while improving their absorptive capacity. In addition, the combination of academic knowledge and market-oriented resources enables firms to enhance innovation efficiency and accelerate the commercialization of new technologies. This finding is consistent with the perspective of open innovation, which emphasizes the importance of external knowledge sourcing in firm innovation processes. It also aligns with the resource-based view, suggesting that access to external strategic resources can significantly enhance firms' innovation capabilities.

Second, the findings of this study are broadly consistent with the existing literature on university–industry collaboration and innovation. Previous studies have emphasized that external collaboration is an important driver of firm innovation, particularly through knowledge spillovers and inter-organizational learning. For example, prior research has shown that university–industry collaboration improves firm productivity and innovation performance by expanding firms' knowledge base and enhancing their technological capabilities (Li et al., 2024). Similarly, studies have highlighted the role of collaboration networks in facilitating knowledge diffusion and innovation outcomes (Tian et al., 2021; Zhu & Zhang, 2023). The positive relationship identified in this study reinforces these findings and provides additional micro-level evidence from China. At the same time, the results also confirm that firm size is an important determinant of innovation, as larger firms tend to

possess more resources for R&D and technology adoption. However, the insignificant effect of firm age suggests that accumulated experience alone does not guarantee higher innovation performance, which is consistent with the mixed evidence reported in previous studies.

Third, the results should be interpreted in light of the specific institutional and economic context of China. As an emerging economy, China's innovation system is characterized by strong government involvement, policy-driven collaboration, and regional heterogeneity. Government initiatives, such as policies promoting industry–university–research integration, play a crucial role in encouraging firms to engage in school–enterprise cooperation. In addition, the uneven distribution of innovation resources across regions means that the effectiveness of such cooperation may vary depending on local institutional conditions and university quality. For many Chinese firms, particularly small and medium-sized enterprises, limited internal resources and technological capabilities make external collaboration an essential strategy for innovation. Furthermore, the rapid digital transformation and industrial upgrading in China have increased the demand for advanced knowledge and technological support, further strengthening the importance of university–industry collaboration. Therefore, the positive impact identified in this study reflects not only the general benefits of collaboration but also the institutional characteristics of China's innovation system.

In summary, the findings highlight the importance of school–enterprise cooperation as a key mechanism for enhancing firms' technological innovation. At the same time, the effectiveness of such cooperation is influenced by firm characteristics and the broader institutional environment, suggesting that both internal capabilities and external conditions jointly shape innovation outcomes.

Conclusion

This study finds that school–enterprise cooperation has a significant positive effect on firms' technological innovation, indicating that collaboration with universities enhances firms' likelihood of engaging in innovation activities.

The findings of this study provide several important implications.

From a policy perspective, governments should further strengthen support for school–enterprise cooperation by establishing effective collaboration platforms, improving funding mechanisms, and promoting policies that encourage knowledge transfer between universities and firms. Enhancing institutional support can help reduce barriers to collaboration and improve the efficiency of innovation systems.

From a managerial perspective, firms should actively engage in cooperation with universities and research institutions to access external knowledge, advanced technologies, and skilled human resources. This is particularly important for small and medium-sized enterprises, which often face constraints in internal R&D capabilities. By leveraging external collaboration, firms can improve their innovation efficiency and competitiveness.

In addition, universities should enhance their role in supporting industrial innovation by strengthening applied research, improving technology transfer systems, and building long-term partnerships with enterprises.

Despite its contributions, this study has several limitations.
First, the data used in this study are cross-sectional, which limits the ability to identify causal relationships between school–enterprise cooperation and technological innovation. Future research could employ panel data to examine dynamic effects over time.

Second, the measurement of school–enterprise cooperation is relatively simple and does not capture differences in cooperation intensity, modes, or quality. More refined indicators could provide deeper insights into the mechanisms of collaboration.

Finally, this study includes a limited set of control variables and does not fully consider other factors such as regional heterogeneity, institutional environment, or industry-specific characteristics. Future studies could incorporate these factors to provide a more comprehensive understanding of firms' innovation behavior.

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