The impact of the reforms in the Chinese Equities Exchange and Quotations on innovation in cross-border e-commerce enterprises

Abstract

This study empirically assesses the impact of the National Equities Exchange and Quotations (NEEQ) reform on Chinese cross-border e-commerce (CBEC) innovation. The NEEQ reform, enacted by the Securities and Exchange Commission in 2019, was found to significantly suppress innovation in CBEC enterprises. This effect was attributed to policy incentives and signaling effects. Regulatory tests indicated varied effects of stock liquidity and innovation information disclosure on the reform's impact. Different types of CBEC enterprises exhibit different inhibitory effects. This study highlights the importance of critically evaluating the implications of NEEQ listing. While it may offer short-term capital advantages, the long-term impact on innovation could undermine a company's competitiveness in a rapidly evolving market. This study provides valuable insights into how such policies may reshape the trajectory of emerging industries, offering theoretical reference for CBEC enterprises landing on the NEEQ in the future.

Keywords: CBEC enterprises innovation；innovation information disclosure; NEEQ reform; policy incentive effect; signaling effect; stock liquidity.

Introduction

In recent years, cross-border e-commerce (CBEC) has become a central component of global trade transformation, particularly in the background of the rapidly evolving digital economy (Wang and Ma, 2024; Xia et al., 2024). According to the

United Nations Conference on Trade and Development (UNCTAD), global CBEC sales have been growing at an exponential rate, driven by advances in digital technology and increasing internet penetration (Wu et al., 2024). This shift has particularly affected developing countries and regions like Asia, where both established and emerging markets are leveraging e-commerce platforms to facilitate trade and expand their international reach (Wen et al., 2024). Within this expansive market, China's position is particularly noteworthy, as the country has firmly established itself as the largest e-commerce market worldwide, with domestic and CBEC both thriving (Koh & Liu,2024).

Specifically, in 2023, China's total import and export value reached CNY 41.76 trillion, a 0.2% increase, with CBEC contributing CNY 2.38 trillion, a 15.6% rise (Yuan et al.,2024). Of this, exports accounted for CNY 1.83 trillion, a 19.6% increase. The Ministry of Commerce reported that CBEC's share of Chinese foreign trade grew from under 1% to approximately 5% in just five years, highlighting its burgeoning importance in the global trade ecosystem (Li et al.,2023). As the fastest-growing sector, CBEC has become a significant driver of China's economic growth (Yin & Choi,2023).

Since the US-China trade war, the Chinese economy is under downward pressure, disproportionately affecting private enterprises and small and medium-sized enterprises (SMEs) (Song & Zhou, 2020). These challenges stem from economic slowdown, regulatory changes, and rising competition, leading to financial strain and limited access to affordable capital (Kaplinsky & Kraemer-Mbula,2022). SMEs, lacking established credit histories and financial resources, struggle to invest in innovation or

expand (Lu et al.,2024). In contrast, large firms, with strong financial backing, access to international markets, and economies of scale, can better absorb economic shocks and maintain innovation (Kyrdoda et al.,2023). This disparity widens the gap between large and small enterprises. Addressing capital constraints for SMEs is crucial to support their innovation and competitiveness in the global market (Chiappini et al.,2022).

Innovation, as the primary driver of corporate development, and equity trading markets, as the main channel for innovation financing, have become critical in promoting the innovative development of SMEs (Amoozad Mahdiraji et al.,2024). Theoretically, firms would opt for listing only if it were beneficial for their long-term development (Buchanan & Deakin,2024; Wang et al.,2025). However, empirical studies have shown that going public can be a double-edged sword for companies (Reischauer & Ringel, 2023). For enterprises listed on the NEEQ, maintaining continuous innovation investment and high-quality innovation output was essential for their sustainable development (Sarpong et al.,2022; Li et al.,2025). Since 2017, the NEEQ has regulated stock listings and transfers for unlisted companies (Zhang et al., 2022), enhancing China's multi-level capital market and supporting its innovation-driven economic transformation (Jiang et al., 2024; Li et al., 2024).

The equity exchange market, particularly NEEQ plays a crucial role in SME innovation and financing (Xia et al.,2025). While going public benefits long-term development, it can also create challenges, as evidenced by empirical studies (Xiao et al., 2024). For NEEQ-listed enterprises, sustained investment in high-quality

innovation is vital, though listing may exacerbate agency problems, especially for those reliant on internal financing (Legesse and Guo, 2020). NEEQ policies tend to support innovative enterprises (Xia et al., 2022), but CBEC enterprises face higher innovation costs and challenges related to transparency and international regulations (Liu et al., 2021). The reliance on digital technology demands continuous investment to keep pace with market trends (Fromhold-Eisebith et al.,2021). Despite efforts to improve business conditions through NEEQ listing, many CBEC enterprises have faced deteriorating conditions, leading to delisting, raising questions about the reforms' impact on CBEC innovation (Ghosh & Wei, 2024). These reforms provide systemic advantages for innovation-driven enterprises, creating new market opportunities, streamlining IPO processes, reducing financing costs, and fostering greater investment in innovation (Zhao & Zhu, 2025). However, NEEQ-listed enterprises in the innovation tier face stricter disclosure requirements, and investors' short-term focus may lead to market speculation (Penasse & Renneboog, 2022). Excessively stringent regulations could also hinder enterprises' innovative activities (Liu et al., 2023). The market tiers and promotion system of NEEQ are shown in Figure 1.

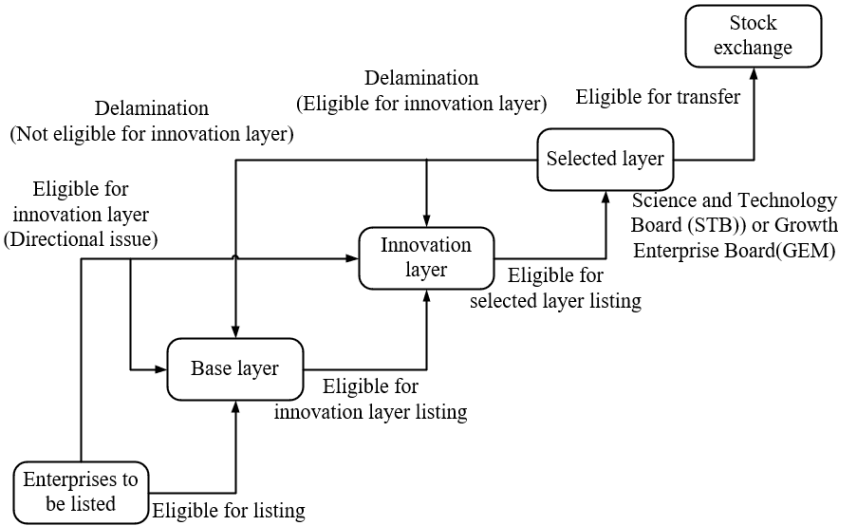

Figure 1. The tiers of NEEQ and promotion system

Previous studies highlighted that NEEQ listing alleviated financing constraints and improved access to capital for R&D, enhancing innovation through better disclosure and market reputation (Li et al., 2024; Feng et al., 2023). Government policies like tax incentives and subsidies further supported R&D investment (Ahn et al., 2020). However, the listing also introduced agency problems, particularly for SMEs, which hindered innovation (Kirikkaleli and Adebayo, 2024). Larger enterprises could manage costs and disclosures without affecting performance, whereas SMEs faced challenges in asset collateralization and financing, limiting their innovation capacity (Arduini et al., 2024; Baumgartner et al., 2020; Hilson et al., 2021). NEEQ reforms increased compliance costs for CBEC enterprises, diverting resources from innovation, while investors' short-term focus discouraged long-term innovation (Ghanbarpour and Gustafsson, 2022; Li et al., 2024). Few studies have addressed the unique challenges of CBEC enterprises under NEEQ reforms, creating a research gap this study aims to fill.

The selection of CBEC enterprises was made because, unlike other SMEs, the

development of CBEC enterprises is highly dependent on the policy environment, including trade policies, tax policies, and financial support policies (Abdulkarem & Hou, 2022). Consequently, changes in policy directly affect their operating costs, market access, and innovation investment (Kang et al., 2025). Additionally, CBEC enterprises have a high level of global market participation (Koh & Liu, 2024). Due to the unique nature of CBEC trade, achieving compliance (referred to as "sunshine" practices) is challenging (Li & Lu, 2022). Some CBEC transactions are characterised by small-batch, high-frequency purchases, and as a result, the documentation for the sale of products is sometimes incomplete, making it difficult to ensure full compliance (Iswanto & Prasetyo, 2025). After listing on the NEEQ, the audit service fees that enterprises are required to pay are also substantial (Madah Marzuki & Muhammad Al-Amin, 2021). Therefore, these characteristics render CBEC enterprises highly representative in the study of the impact of NEEQ reforms on SME innovation, providing valuable insights for policymakers.

The study sought to answer the following three core questions: (1) Did the NEEQ reform policies influence, and if so, how did they impact the innovation activities of CBEC enterprises? (2) How were these impacts transmitted through policy incentives and signalling effects? Did stock liquidity and information disclosure play a moderating role in these relationships? (3) Were there any differences in the effects across enterprises with different characteristics?

This study makes marginal contributions in three key areas. First, the study focused on the emerging industry of CBEC, examining whether and how listing on the

NEEQ influenced the innovative capabilities of CBEC firms. This provided valuable insights and guidance for future CBEC firms considering NEEQ listings, as well as for those weighing the relationship between short-term capital advantages and long-term innovation capacity. Second, it analyzes the internal mechanisms of NEEQ reform, emphasizing the "policy incentive effect" and "signaling effect" on innovation. Policy incentives can guide CBEC firms to allocate resources effectively towards innovation activities. Meanwhile, signalling can assist firms in conveying their quality and potential to the market, thereby reducing financing costs. Communication with the market helps to mitigate market frictions caused by information asymmetry and enhances the market's informational efficiency. Empirical data on the relationship between NEEQ policies and innovation during the early stages of capital market involvement is provided, with stock liquidity and information disclosure introduced as regulatory variables, offering new perspectives for NEEQ reform research. Third, this study expanded the innovation theory by challenging the traditional notion that financial market reforms necessarily promote corporate innovation. The research found that the NEEQ reform may have suppressed innovation due to enterprises' pursuit of policy incentives and misinterpretation of market signals. This enriched the discussion on the relationship between policy and innovation within the innovation theory framework and provided empirical evidence for policymakers regarding the impact of the NEEQ reform.

Literature review

The academic community has yet to reach a consensus on how the NEEQ reform

affects the innovation of CBEC enterprises (Zhang & Kong, 2022). Existing research presents two main perspectives: the incentive perspective and the catering perspective (Li et al.,2021; Connelly et al.,2025).

Innovation decisions in enterprises are influenced by various factors, including internal governance, ownership type, market strategy, and managerial incentives (Gilje et al., 2020; Kuo et al., 2021; Wu et al., 2025). The NEEQ policy has been found to help bridge the R&D financing gap by enabling access to external funding options like equity pledge loans and private debt issuance (Xu et al., 2020; Zhang et al., 2021; Zeng et al., 2025a). NEEQ listing improves financial transparency, corporate governance, and risk management, which in turn attracts venture capital and enhances innovation (Zhang et al., 2021). Market strategy also benefits, as listing increases exposure, consolidates resources, and drives deeper innovation through higher R&D investment and product development. However, some studies argue that alternative financing options may limit access to funds, potentially restricting innovation (Lu et al., 2020).

From a macro perspective, research has focused on the impact of policy factors (e.g., subsidies, tax incentives) and institutional factors (e.g., financial development) on innovation (Zhu and Tan, 2022; Abedin et al., 2024). NEEQ provides SMEs with access to capital markets and government support, but tax incentives may have limited or negative effects on R&D investment, particularly for private enterprises (Gao et al., 2023; Hasan et al., 2024). Studies also highlight potential drawbacks of government incentives, such as crowding out innovation and reducing R&D quality post-IPO (Nemlioglu and Mallick, 2020).

Existing research on NEEQ's impact primarily explores R&D investment, technological innovation, and market exposure from macro and microeconomic perspectives (Harrigan et al., 2010; Yuan and Zhang, 2020; Zeng et al., 2025b). However, gaps remain in understanding the underlying mechanisms of corporate innovation and the complexities of the NEEQ policy's effects. This paper hypothesizes that the NEEQ reform influences CBEC innovation through policy incentives and signalling effects. An econometric model was developed to test the hypotheses, incorporating stock liquidity as a moderating variable. The findings are tested for robustness and heterogeneity, with conclusions drawn and recommendations provided.

Theoretical background

The theoretical background in this context is based on two key concepts: incentive theory and signalling theory (Li et al.,2021; Connelly et al.,2025), both of which are crucial for understanding the impact of the NEEQ reforms on enterprise innovation in the CBEC sector (Zhou et al.,2023).

Incentive theory. Incentive theory posits that well-designed policy incentives can motivate firms to invest in innovation, leading to enhanced productivity and competitiveness (Van Vo et al.,2025; Wen et al.,2025). In the case of NEEQ, the introduction of the Selected Tier, Innovation Tier, and Basic Tier creates differentiated institutional structures tailored to the specific needs of enterprises (Reiter et al.,2024). These tiers offer a variety of support mechanisms, such as tax incentives and research and development subsidies, which are particularly beneficial for SMEs (Dimos et al., 2022). For example, when NetEase Kaola entered the NEEQ Innovation Tier, it gained

access to lower-cost financing, which was crucial for accelerating its digital transformation, improving logistics efficiency (Tijan et al.,2021), and boosting its global market competitiveness (Streimikiene et al.,2021). Similarly, subsidiaries of Skyworth Group utilized local government R&D subsidies after entering the Innovation Tier, enabling them to develop an intelligent cross-border logistics system that reduced costs and enhanced operational efficiency (Xiao, 2023).

However, the theory also suggests that these incentives can backfire if they are poorly designed (Alfitian et al.,2024). If the incentives do not align with the actual challenges faced by enterprises, they may fail to stimulate meaningful innovation (Dai & Chapman, 2022). This is evident in cases where companies, despite receiving financial or policy support, fail to effectively utilize these resources for technological advancements (Jiakui et al.,2023). The mismatch between incentives and enterprise needs can hinder innovation and lead to reduced market competitiveness (Lin & Zhang, 2023).

Signalling theory. Signalling theory suggests that regulatory reforms and policies send signals to the market, influencing how firms perceive the environment and their innovation strategies (Gupta, 2021). Positive signals, such as support policies for firms in the NEEQ Innovation Tier, can boost firm confidence and encourage investment in innovation (Fu et al.,2022). For instance, Haier Group leveraged its position in the Innovation Tier to gain early public attention and attract investor trust, which accelerated its market expansion and product promotion (Shi, 2024). This positive signalling reinforces the company's commitment to innovation and encourages more

resource allocation toward R&D activities (Sun et al.,2024).

On the other hand, negative or uncertain signals can create hesitation among firms, especially when there are policy ambiguities or shifts (Kim et al.,2024). For example, unclear implementation guidelines after policy changes may lead firms to adopt a more cautious approach, scaling back their innovative efforts or reducing R&D budgets out of fear of risks (Quas et al., 2022). The uncertainty surrounding the implementation of regulatory reforms can thus dampen the positive effects intended by the policy, limiting its potential to stimulate innovation (Van Der Linden & Shirazi, 2023; Wu et al.,2025).

The dual perspectives of incentive theory and signaling theory underscore the complex relationship between policy reforms, enterprise innovation, and market outcomes (Chen et al.,2023). While targeted incentives can drive innovation, they must be carefully aligned with enterprise needs to avoid inefficiencies (Tian et al.,2025). Simultaneously, regulatory reforms must be communicated clearly and consistently to avoid creating uncertainty that could hinder innovation (Borozan, 2022). A robust policy framework that incorporates both well-designed incentives and clear signals can enhance the effectiveness of NEEQ reforms, driving technological advancements and fostering growth in the CBEC sector (Ebabu et al.,2025).

Hypotheses

From the incentive perspective, many CBEC enterprises, primarily SMEs, face challenges in financing R&D activities with limited internal funds (Wang et al., 2023). NEEQ listing provides access to external financing, addressing issues of limited financing channels, high costs, and low efficiency, thus facilitating the implementation

of government innovation incentives (Zhou et al.,2023). Liu (2022) found that declining financing efficiency was a key factor in NEEQ delisting, while Yan et al. (2019) argued that the NEEQ stratification system reduced information asymmetry, boosting innovation input and output for innovation-tier firms. Improved stock liquidity and transparency enhanced financing access and promoted innovation (Chen et al., 2017; Li and Wan, 2023; Wu et al., 2024). Additionally, government industrial policies, including tax incentives and subsidies, further incentivized R&D participation (Wu et al., 2023).

In contrast, the catering viewpoint proposes that NEEQ has become the primary channel for many SMEs to enter the capital market due to its low registration threshold and short audit process (Feng et al.,2024). For start-up non-listed enterprises, listing on the NEEQ provided some degree of equity capital support, but enterprises sometimes acted opportunistically to meet policy requirements, resulting in a weaker policy implementation effect (Jia et al., 2021; Zeng et al., 2024a). Li (2024), based on NEEQ listing data, found that venture capital betting agreements impacted the earnings management of start-up enterprises. When enterprises with low venture capital reputations and those in non-policy-supported industries listed on the NEEQ, the performance of enterprises with betting agreements declined (Croxson & James Reade, 2014). Additionally, the high investment in innovation projects and the uncertainty of innovation outcomes made it hard for government departments to get information related to enterprises' innovation and identify the strengths and weaknesses of innovation projects (Lou et al., 2022; Zeng et al., 2024b). Enterprise innovation is

persistent and high-risk, and since CBEC enterprises operate internationally, the transaction process is not easily transparent, making timely disclosure of financial reports challenging, which affects enterprise operations (Tibiletti et al., 2021). These different views reflect the complexity and multidimensionality of the influence of the NEEQ reform on the innovation of CBEC enterprises, indicating the need for further in-depth research and discussion (Zhou et al.,2023). In this paper, the subsequent hypotheses are hereby put forth.

Hypothesis 1: Following the announcement of the NEEQ reform policy, innovation in CBEC enterprises significantly declined.

Regarding the transmission mechanism of the NEEQ reform on the innovation of CBEC enterprises, this article focuses on the policy incentive influence and the signaling effect.

Policy incentive effect. The goal of the NEEQ reform policy was to support the development of SMEs. To this end, the government often implemented a series of fiscal support and tax incentive policies to encourage companies to list and expand their market share (Slattery and Zidar, 2020). In the context of an imperfect market mechanism, tax incentives and government subsidies effectively increased companies' internal liquidity (Sun et al., 2020). This provided firms with sufficient funds to recruit high-end research and development (R&D) talent, which could, in turn, promote innovation within the company (Ma and Yu, 2021). However, the actual effects of these policies may have had a negative impact on the innovative activities of CBEC enterprises.

The reason for this is that CBEC enterprises typically faced pressure to rapidly expand their markets and, in the context of intense market competition, often prioritised short-term profits and cash flow (DesJardine & Durand, 2020). Although tax incentives could reduce the tax burden and increase liquidity, this might have led CBEC enterprises to allocate more resources towards short-term market expansion or operational costs, rather than investing in long-term technological innovation or R&D activities (Gao et al., 2021). Furthermore, research found that CBEC enterprises, which became reliant on government fiscal support and tax incentives over the long term, could exploit regulatory loopholes and unreasonable pricing mechanisms (Pang & Hua, 2024). This behaviour potentially undermined market fairness and transparency (Li et al., 2021). In some cases, companies might have engaged in speculative practices, such as fraudulent export tax refunds, tax evasion, or even bribing government officials to obtain sensitive company data and confidential information to gain a competitive advantage (Andrade-Rojas & Erskine, 2024). Ultimately, this behaviour could have crowded out innovation (Gauthier et al., 2021). Such short-term, policy-driven behaviours made these enterprises increasingly reliant on government policies, rather than fostering endogenous innovation (Zhao & Omran, 2025; Shen et al.,2025). As a result, they likely overlooked the importance of technological research, development, and innovation activities, leading to insufficient support for innovation within the company (Stornelli et al., 2021). This paper puts forth the next hypotheses.

Hypothesis 2: After the NEEQ reform policy was introduced, CBEC enterprises increased government subsidies and tax rebates to curb innovation within their

companies.

Government subsidies and tax rebates for CBEC enterprises will be increased after the promulgation of the NSS reform policy in order to discourage cross-border e-commerce firms from innovating.

Signaling effect. The signaling effect suggests that the party with an informational advantage can leverage its superior knowledge to obtain benefits (Xu & Dukes, 2022). When it actively transmits reliable information to the less informed party, it sends a positive signal to the market, enhancing its credibility, alleviating information asymmetry, and mitigating the negative effects of adverse selection (Yasar et al., 2020). One significant aspect of a company listing on the NEEQ is that it provides a positive signal to commercial banks, facilitating the acquisition of credit support (Zhang et al., 2021). Companies applying for listing on the NEEQ undergo a rigorous financial audit process, which excludes firms with poor operational conditions or uncertain development prospects (Kim et al.,2024). This process sends a favorable signal to investors, indicating that the company is a viable candidate for listing (Sembiring and Sukamulja, 2023).

CBEC companies are predominantly SMEs, characterized by weak management capabilities, low levels of intellectual property protection, and high human capital dispersion (Kong et al., 2022). In a highly competitive and uncertain market environment, although credit financing can quickly replenish the cash flow of CBEC enterprises, the associated interest and repayment pressures may encourage these companies to focus more on short-term cash flow and market expansion, rather than

long-term investment in R&D (Igbinenikaro and Adewusi, 2024). The heavy debt burden means that firms might prioritize using available funds to service debt, pay interest, and expand market reach, potentially delaying investments in new technologies or products (Alfandia, 2024). They may instead opt to enhance operational efficiency or reduce costs in response to financial pressures, rather than investing in innovative activities (Boubaker et al.,2022). This paper formulates the following hypotheses.

Hypothesis 3: After the NEEQ reform policy was introduced, CBEC enterprises reduced the credit financing to curb innovation within their companies.

The stock market, a key element of the capital market, has a significant impact on corporate innovation, primarily through stock liquidity (Chen et al., 2023). However, it remains inconclusive whether this influence facilitates or impedes innovation.

Theoretically, some scholars suggest that stock liquidity promotes technological innovation by enhancing governance and reducing management speculation (Moshirian et al.,2021). Large shareholders improve decision-making, while liquid markets facilitate share transactions, deter harmful management actions, and align interests (Stein, 1988). Conversely, others argue liquidity hinders innovation. Short-term liquidity demands, acquisition risks, and anticipated returns influence management's focus on immediate profits, sidelining long-term R&D (Kyle and Vila, 1991). Porter (1992) contends that high liquidity attracts short-term investors, exacerbating managerial short-sightedness, while low liquidity and high transaction costs encourage long-term investment, benefiting corporate governance.

These findings, primarily based on A-share markets in Europe, the US, and China, are not directly applicable to the NEEQ market (Peng et al.,2024). Zhang et al. (2017) found that, in hostile takeovers, Chinese target companies emphasized ownership concentration over stock liquidity. A-share listed companies, typically larger and more stable, contrasted with the smaller, less stable SMEs in the NEEQ market, where liquidity was limited, hindering short-term speculators. This theory does not align with the realities of the NEEQ market and overlooks key mechanisms through which SME stock liquidity influences corporate innovation (Liu & Suzuki, 2024). Le et al. (2020) proposed an alternative hypothesis, suggesting that increased liquidity in the NEEQ market enhances stock price information, reducing information asymmetry. This allows external institutional investors to better monitor firms, curb managerial short-termism, and encourage investment in R&D innovation. Therefore, hypothesis H4a was proposed.

Hypothesis 4a: Stock liquidity strengthens the negative influence of the NEEQ reform policy on CBEC enterprises innovation and has a positive moderating impact.

Following the NEEQ reform, SFC introduced differentiated disclosure obligations for listed firms, requiring the disclosure of material information that could impact share prices and investor decisions (Grewal et al., 2021). Innovation-related disclosures, historically focused on R&D investment and patents, have expanded to include more detailed, unstructured data, such as descriptions of innovative activities (Glaeser & Lang, 2024). This shift aims to reduce information asymmetry, support firm valuation, and assist in investment decisions (Salvi et al., 2021; Saidi and Žaldokas, 2021).

Scholars have widely studied the impact of innovation disclosure on market value, investor trust, and corporate innovation. Positive findings indicate that innovation disclosure signals competitive advantages, boosts investor expectations (Shi et al., 2022), fosters trust from banks and investors (Liu et al., 2023), reduces financing costs (Cailou et al., 2021), and enhances innovation performance (Leung and Sharma, 2021). Jia (2017) found a link between higher innovation disclosure in analyst reports and increased future innovation. Chen et al. (2022) highlighted its positive effect, especially in high-quality firms. Voluntary disclosure helps address agency problems by enhancing trust between shareholders and managers (Flammer et al., 2021). Scholars also considered factors like information interpretation ability (Li et al., 2022) and the quality of innovation disclosure (Dyer et al., 2024), which influence the effectiveness of disclosure's impact (Chkir et al., 2021).

Some scholars argue that innovation disclosure does not significantly promote corporate innovation, citing factors such as ineffective disclosure (Dyer et al., 2024), mature capital markets, or internal governance issues (Xue et al., 2022). Simpson and Tamayo (2022) found that ineffective innovation disclosure hindered firms' access to external finance. In developed markets, disclosure failed to alleviate financing constraints in a way that translated into innovation (Zhang and Lucey, 2022). In firms with severe agency problems, innovation disclosure reduced financing pressure but also eased constraints on ineffective investments, resulting in mixed effects and an insignificant relationship with innovation outcomes (Feng et al., 2022).

In summary, existing studies have yet to reach a consensus on how innovation

disclosure impacts corporate innovation. CBEC firms may possess business secrets, such as new technologies, products, and market strategies. Strict disclosure requirements could lead to concerns about competitors accessing these secrets, prompting firms to limit their disclosures. Additionally, CBEC firms operating across different regions must comply with diverse regulations, and increased disclosure requirements may raise compliance complexity, diverting resources and potentially inhibiting innovation. Accordingly, the following hypothesis is proposed.

Hypothesis 4b: Innovation disclosure strengthens the negative influence of the NEEQ reform policy on CBEC enterprises innovation and has a positive moderating effect.

The following is a test analysis of the hypothesis, and the theoretical structure of this article is illustrated in Figure 2.

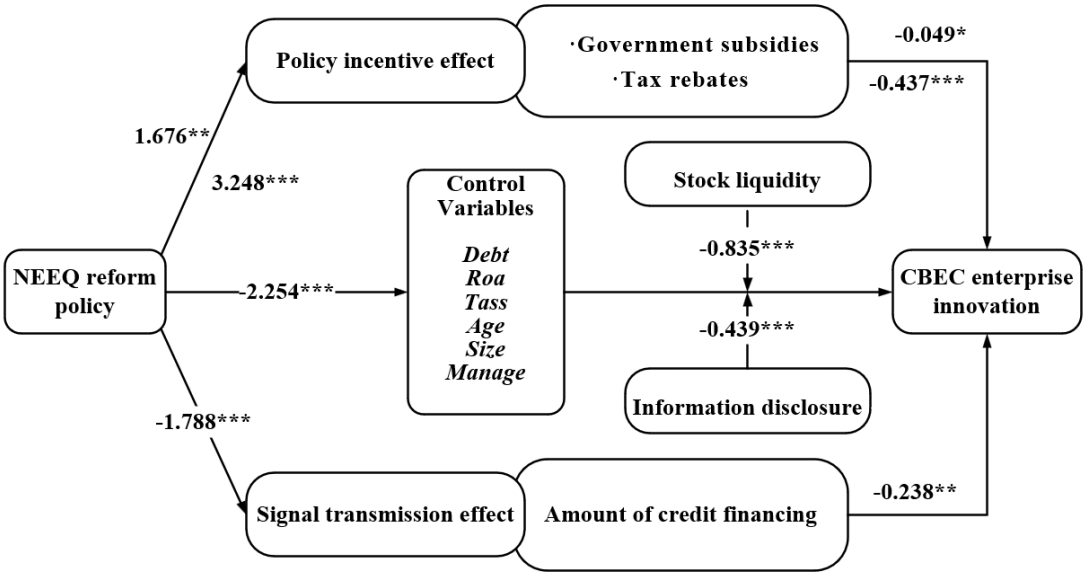

Figure 2. Theoretical model diagram

Data analysis and methodology

Data sources

The main variables are specified in Table 1.

Table 1. Explanation of main variables

	Notation	Variant	Definition	Mean	Standard deviation
Dependent variables	*RDI*	R&D investment intensity	Ratio of R&D expenditures to total revenue	0.0477	0.2670
	Patent	Total amount of patents granted to enterprises	The number of patents is logarithmized by adding 1 to the number of patents	0.9173	1.1157
Independent variables	*After*	Time-variant	Taken in 2019 and beyond 1	0.5983	0.5012
	Treat	Grouping variable	Take 1 for cross-border e-commerce enterprises listed the NEEQ, otherwise take 0.	0.5072	0.4486
Control variables	*Debt*	Debt to assets ratio	Ratio of total liabilities to total assets of the enterprises	0.6356	0.6792
	Roa	Return on assets	Earnings before interest and taxes to total assets	0.3936	3.1617
	Tass	Total assets of the enterprises	Logarithmic value of total enterprises assets	16.3168	6.6916
	Age	Years of existence of the enterprises	Age of enterprises	2.2518	0.6390
	Size	Size of the enterprises	Logarithm of enterprises income	20.9166	2.0350
	Manage	Percentage of executives	Management shareholding	2.1049	5.5520
Regulatory variables	*GS*	Government subsidy	Government subsidies taken as logarithms	12.6995	2.6836
	TR	Tax rebate	Tax rebates taken as logarithmic	11.8059	2.3510
	CF	Amount of credit facilities	Logarithmic value of credit facilities	22.2677	2.2901
Adjustment variable	*IQ*	Stock liquidity	Illiquidity index	1.5038	3.6633
	ID	Information disclosure	Number of news releases by enterprises	0.6892	0.3495

Note: In this article, the enterprise patent data originates from the Patent Database of Baoteng.com, and the enterprise financial and governance micro data is obtained from the stock codes of CBEC enterprises queried from the NetScience Database and matched with the CSMAR Database and WIND Database. Limited to the missing CBEC data as well as the lag, the final data includes 171 CBEC enterprises with a total of 1,120 observations during the period of 2017-2023. The dependent variable in this article is innovation in CBEC enterprises, measured in terms of both innovation inputs (R&D investment intensity) and innovation outputs (Total enterprises patents). The independent variable is whether the CBEC enterprises are listed on the NEEQ (*Treat*×*After*) to measure. The selection of control variables is mainly measured from the financial aspect: debt to assets ratio (*Debt*), return on assets *(Roa*) and total assets of the enterprises (*Tass*), and the governance aspect: years of existence of the enterprise (*Age*), size of the enterprise (*Size*) and percentage of executives (*Manage*).

Econometric modeling

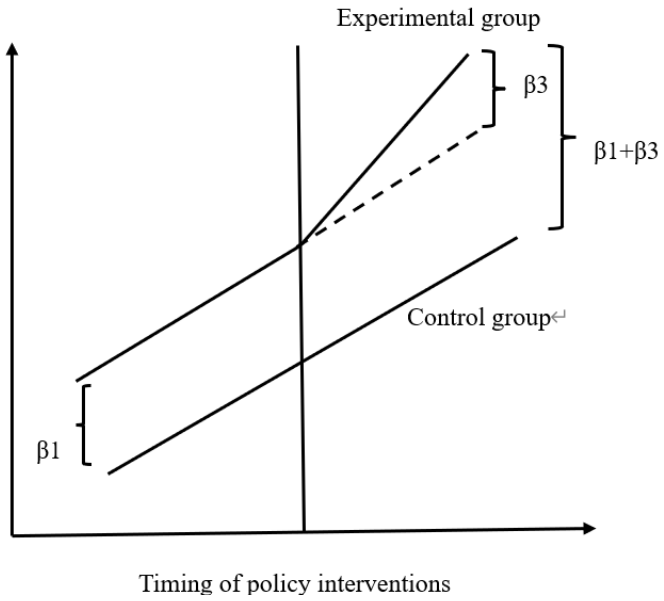

Figure 3. DID principle

Notes: The DID model is shown in model (1), where *i* stands for individual and *t* stands for time, $Treat_i$ is a group dummy variable. If an individual *i* belongs to the experimental group, then $Treat_i = 1$, otherwise $Treat_i = 0$. $After_t$ is a staged dummy variable, if time *t* is after the policy event, then $After_t = 1$, otherwise, $After_t = 0$. $Treat_i \times After_t$ is the interaction term, and its coefficient (β_3), is the net effect of the policy implementation that is the focus of the double-difference model. (As shown in figure 3 below)

$$Y_{it} = \alpha + \beta_1 Treat_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + Controls_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (1)$$

This paper uses DID to examine how the NEEQ reform policy issued by the Securities and Exchange Commission in 2019 affects the innovation of CBEC enterprises. The primary advantage of the DID method is its ability to control for time-invariant unobserved heterogeneity between treated and control groups. In this case, the treatment group is composed of CBEC enterprises that list on the NEEQ after the reform, while the control group consists of CBEC enterprises that did not list. By comparing the difference in innovation outcomes between these groups before and after the policy implementation, the DID model helps isolate the effect of the NEEQ reform from other confounding factors that may simultaneously affect both groups (Lei and

Xue, 2024). Among them, the grouping variable *Treat is* set, which takes the value of 1 if the CBEC enterprises land on the NEEQ, and 0 otherwise. Meanwhile, the time variable *After* is set according to the time of the policy introduction, which takes the value of 1 when the sample observations are located after 2019, and 0 otherwise. Setting the *TD* dummy variable as *Treat*×*After*, the establishment of the model (2) is shown below.

$$Patent_{i,t} = \alpha + \beta TD_{i,t} + Controls_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (2)$$

$$RDI_{i,t} = \alpha + \beta TD_{i,t} + Controls_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (3)$$

In model (2) and (3), subscript *i* indicates the company and *t* indicates the year. $RDI_{i,t}$ and $Patent_{i,t}$ are the enterprise's innovation. $Controls_{i,t}$ are enterprise-level control variables, and μ_i is the individual effect, *t* is the time effect, and ρ_t is the time effect, and $\varepsilon_{i,t}$ is the standard deviation. Meanwhile, a two-way fixed-effects model with enterprises' individual and time effects is used for empirical tests, and coefficients β measures the causal effect of the NEEQ policy shock on the innovation of Chinese CBEC enterprises.

Empirical analysis

Descriptive results

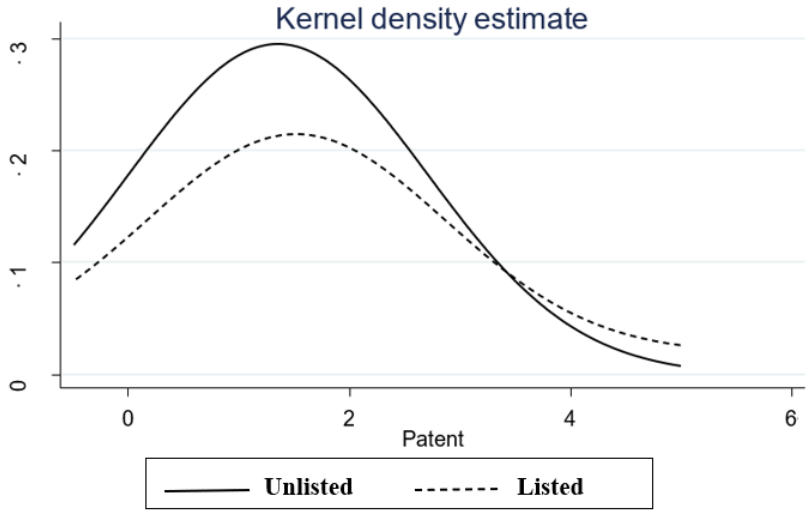

Figure 4. Innovation status of CBEC enterprises in different subgroups

Note: We tried to categorize the CBEC enterprises into two groups of NEEQ-listed and NEEQ-unlisted (see Figure 4 for the results). As can be seen in Figure 4 after comparing the kernel density

plots of the two groups, we found that the innovation mean of the CBEC enterprises listed on NEEQ is smaller. Figure 4 intuitively proves that the NEEQ policy reform may have a dampening effect on CBEC enterprises' innovation.

Benchmark regression

This paper conducts the following three empirical tests. Firstly, it plots the time trend of corporate innovation in the experimental and control groups. Secondly, it applies to the univariate double-difference method to examine the influence of the NEEQ policy on CBEC enterprise innovation. Finally, it adds the control variables of corporate characteristics and conducts an empirical test of the double-difference model.

Trends in time to innovation for enterprises

On the basis of calculating the innovation of enterprises, this article plots the time trend of innovation of enterprises in the experimental group (CBEC listed on the NEEQ) and the control group (CBEC enterprises outside of the NEEQ) in order to intuitively reveal the difference in the change of innovation of the enterprises in the two groups. As shown in Figure 5 and Figure 6, Innovation in CBEC enterprises is measured in terms of R&D investment intensity in Figure 5 and in terms of number of patents in Figure 6. Prior to the 2019 NEEQ policy reform, the innovation of enterprises in the experimental and control groups remained almost unchanged, and the two groups of enterprises maintained essentially parallel time trends. However, after the introduction of the policy, the innovation of the two groups of enterprises shows a diametrically opposite trend of change, for the experimental group of enterprises, their innovation shows a time trend of decline followed by an increase, in contrast to the control group of enterprises whose innovation shows a time trend of increase followed by a decrease.

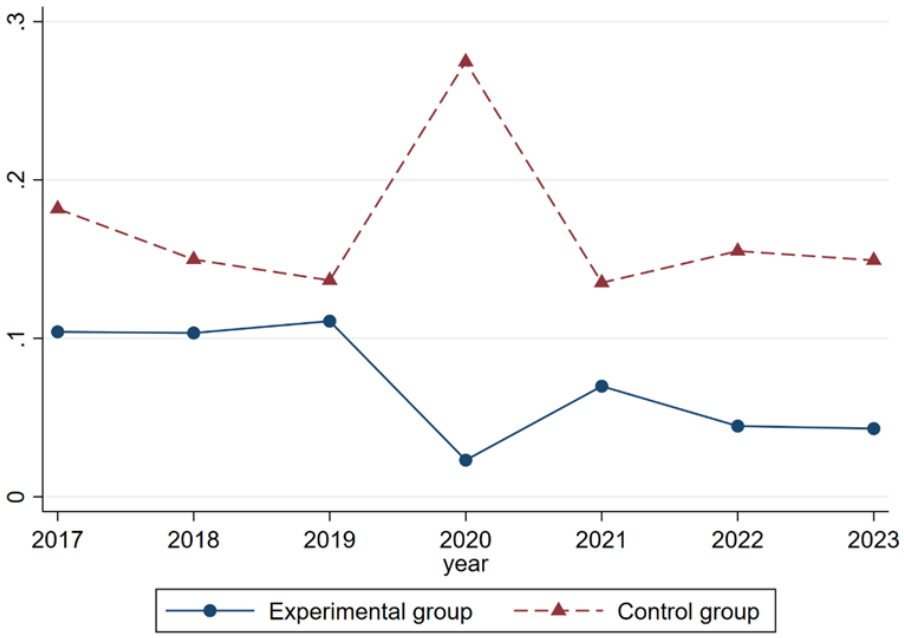

Figure 5. Parallel trend test for RDI

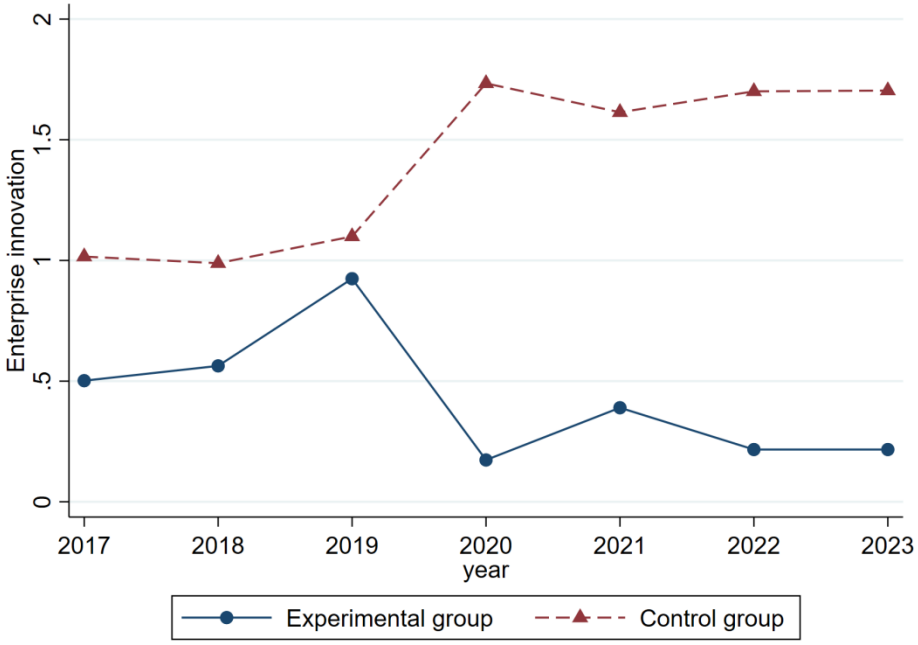

Figure 6. Parallel trend test for Patent

Table 2. Univariate double difference test

Panel A			
Enterprise Innovation (RDI)	Control subjects	Experimental group	Diff
Before	0.198	-0.748	-0.946*** (0.0000)
After	0.664	-1.277	-1.941***

			(0.0000)
$Diff_1$	0.466***	-0.529***	-0.995***
	（0.0000）	（0.0000）	(0.0000)
Panel B			
Enterprise Innovation (Patent)	Control subjects	Experimental group	Diff
Before	0.384	-0.470	-0.854*** (0.000)
After	0.533	-1.186	-1.719*** (0.000)
Diff1	0.149*** (0.000)	-0.716*** (0.000)	-0.865*** (0.000)

Note: Tables *, ** and *** indicate 10%, 5% and 1% significance levels, respectively, as indicated by the corresponding *p*-values in parentheses.

Univariate double difference results: The univariate double difference method was used for the empirical test, with *Before* denoting the period before the policy (2017-2019) and *After* denoting the period after the policy (2020-2023). On this basis, the average values of enterprise innovation in experimental and control groups in the *Before* and *After* periods are calculated separately. Where *Diff* denotes the mean value of innovation of enterprises in the experimental group minus the mean value of innovation of enterprises in the control group; *Diff1* denotes the mean value of innovation of enterprises in the *After* period minus the mean value of innovation of enterprises in the *Before* period. Finally, the t-test is applied to examine whether the differences in enterprise innovation between the two groups show systematic differences before and after the introduction of the policy. As shown in Table 2 panel A, the mean value of innovation of enterprises in the control group was 0.198 before the policy and increased by 0.466 after the industrial policy. In contrast, enterprises in the experimental group decreased by 0.529 after the policy, an effect that is significant at the 1% level. As shown in Table 2 panel B, the mean value of innovation of enterprises in the control group was 0.384 before the policy and increased by 0.149 after the industrial policy. In contrast, enterprises in the experimental group decreased by 0.716 after the policy, an effect that is significant at the 1% level. These results suggest that after the introduction of the policy, the value of innovation decreased for enterprises in the experimental

group but increased for enterprises in the control group. Overall, the introduction of the policy led to a notable decrease in the value of innovation of enterprises in the experimental group compared to the control group, with a policy effect of 0.865.

Table 3. Mean and dynamic effects test results

Variant	*RDI*				*Patent*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Average effect		Dynamic effect		Average effect		Dynamic effect	
TD	-0.688***	-0.450***			-3.531***	-2.254***		
	(-6.002)	(-5.671)			(-5.450)	(-4.688)		
TD2020			-0.799***	-0.682***			-0.910***	-0.823***
			(-7.342)	(-5.119)			(-3.394)	(-2.955)
TD2021			-0.621***	-0.535***			-0.574**	-0.662***
			(-6.198)	(-4.770)			(-2.183)	(-2.893)
TD2022			-0.683***	-0.588***			-0.834***	-0.759***
			(-7.544)	(-5.987)			(-3.182)	(-2.852)
TD2023			-0.683**	-0.683***			-0.715***	-0.519***
			(-2.215)	(-6.508)			(-3.420)	(-2.724)
Control	NO	YES	NO	YES	NO	YES	NO	YES
cons	2.111	-1.090	1.053***	-0.749***	-3.208***	-3.111	0.759***	0.118
	(1.238)	(-0.746)	(7.666)	(-5.450)	(-7.106)	(-0.988)	(6.110)	(0.044)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.056	0.101	0.075	0.256	0.291	0.280	0.112	0.181
N	1120	1120	1120	1120	1120	1120	1120	1120

Note: Tables *, ** and *** indicate significance levels of 10%, 5% and 1%, respectively, with *t*-values in parentheses.

Double difference regression results: The preliminary results of the previous study through the test of univariate double difference method show that after the introduction of the NEEQ reform policy, the innovation value of enterprises in the experimental group significantly decreases compared to the control group. Based on this; in order to more clearly identify the causal effect of policy shocks on enterprises' innovation, this paper introduces control variables as well as two-way fixed effects of individual enterprises and time for further analysis. The results show that the TD coefficients in column (1) and (5) of Table 3 are significantly negative at the 1% level without adding any control variables. In column (2) and (6), the TD coefficients are

still significantly negative after the introduction of control variables for enterprise characteristics, and the average effect results reveal a significant decline in the level of enterprise innovation as a result of the NEEQ reform policy shock.

In an effort to reveal the dynamic effects of policy shocks on enterprises' innovation, this article also introduces three variables Year2020, Year2021, Year2022 and Year2023 (taking the value of 1 in 2020, 2021, 2022 and 2023 respectively, and 0 in the other years), and generates the variables TD2020, TD2021, TD2022 and TD2023 as an interaction term with the grouping variable Treat. The results of the dynamic effects are shown in columns of Table 3 (3), (4), (7) and (8). The results of the dynamic analysis show that the inhibitory influence of policy shocks on enterprises' innovation first decreases and then increases.

In summary, after the introduction of the NEEQ reform policy, the innovation of enterprises in the experimental group decreased significantly compared to the control group, a result that supports hypothesis 1.

Mechanism analysis

So as to further explore the mechanism of the NEEQ policy on the innovation of CBEC enterprises, this article focuses on the analysis from the perspective of improving the efficiency of the use of exogenous funds. The mediating variables include Government Subsidies (*GS*), Tax Rebates (*TR*) and Credit Financing Amount (*CF*). The data of government subsidies come from the government subsidies part of non-operating income in the annual reports of the sample enterprises, and the data of tax rebates come from the column of "tax rebates received" in the consolidated statement of cash flows in the annual reports of the sample companies.

Table 4. Mechanism tests

Variant	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

	TR	*REI*	*Patent*	*GS*	*REI*	*Patent*	*CF*	*REI*	*Patent*
TD	3.248***	-0.712***	-0.223**	1.676**	-1.166***	-0.966***	-1.788***	-0.555***	-0.637***
	(2.881)	(-3.460)	(-1.994)	(1.991)	(-4.356)	(-3.795)	(-3.336)	(-4.371)	(-3.219)
TR		-0.114***	-0.437***						
		(-3.175)	(-2.440)						
GS					-0.063**	-0.049*			
					(-2.014)	(-1.855)			
CF								-0.172**	-0.238**
								(-2.108)	(-2.036)
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES
cons	-4.511	-2.226**	-3.512	-5.238***	-0.580***	-6.097**	-5.580***	2.345**	-4.366**
	(-0.988)	(-1.992)	(-0.782)	(-3.988)	(-3.077)	(-2.044)	(-2.906)	(2.241)	(-2.249)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.254	0.204	0.308	0.281	0.289	0.369	0.460	0.266	0.248
N	1120	1120	1120	1120	1120	1120	1120	1120	1120

Note: Tables *, ** and *** indicate 10%, 5% and 1% significance levels, respectively, with *t*-values in parentheses.

Therefore, this paper chooses government subsidies and tax rebates as the proxy variables for the policy incentive effect. The amount of credit financing reflects the bank's mastery of the enterprise's information, and this paper chooses the total amount of new bank credit financing (loans) of the enterprise in the present year as a proxy variable for the signaling effect. According to the research mechanism of Zhong et al (2021) and Ma et al (2025), this article constructs models (4) and (5) for empirical testing. The estimation results are detailed in Table 4.

$$M_{i,t} = \alpha + \beta \mathrm{TD}_{i,t} + \text{ Controls }_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (4)$$

$$GI_{i,t} = \alpha + \beta TD_{i,t} + M_{i,t} + \text{ Controls }_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (5)$$

So as to further examine the influence mechanism of NEEQ policy on the innovation of CBEC enterprises, this article verifies both the policy incentive effect and the signaling effect.

The policy incentive effect divides government financial support to enterprises into government subsidies (*Subsidy*) and tax rebates (*Tax Rebate*). The regression results, as shown in columns (1) and (4) of Table 4, show that the coefficients of the NEEQ reform policy are significantly positive, indicating that the implementation of this policy significantly increases tax rebates and government subsidies for enterprises.

Meanwhile, columns (2), (3), (5) and (6) of Table 4 show that the coefficients on tax rebates and government subsidies are significantly negative, indicating that enterprises that receive higher tax rebates and government subsidies tend to have less innovative output. This result suggests that due to information asymmetry, it is hard for the government to accurately identify enterprises that truly need policy incentives, leading CBEC enterprises to engage in opportunistic behavior to obtain policy incentives, which undermines the efficiency of resource allocation and hampers enterprises' innovation. At present, Chinese CBEC sellers mostly adopt a big store marketing strategy, with low product recognition, low core competitiveness and low added value. Most of the subsidized funds are used for on-site promotion, off-site promotion, single-serving, promotions, price wars and other activities to increase user penetration and expand the target market, and very little is invested in innovation.

The signaling effect is measured by the amount of bank credit financing. The regression results, as shown in column (7) of Table 4, show that the coefficient of the NEEQ reform policy is significantly negative, indicating that the implementation of this policy significantly reduces bank credit financing. Meanwhile, column (8) and (9) of Table 4 shows that the coefficients of the NEEQ reform policy and bank credit financing are significantly negative, indicating that the NEEQ reform reduces the amount of bank credit financing, which in turn reduces the innovation ability of CBEC enterprises. The NEEQ market provides more financing options, enabling listed SMEs to finance by issuing shares, directional issues, etc., which to a certain extent replaces the traditional bank credit financing and reduces the dependence on bank credit. And CBEC enterprises need a lot of financial support in the study and development of new products, expansion of new markets and improvement of supply chain efficiency. If the amount of bank credit financing is reduced, CBEC enterprises may face the problem of capital shortage, thus limiting the enhancement of their innovation ability.

To summarize, government subsidies, tax rebates and bank credit financing are important channels through which the NEEQ reform policy inhibits the innovation of CBEC enterprises. CBEC enterprises increase government subsidies and tax rebates or

reduce the amount of bank credit financing by listing on the NEEQ, which in turn reduces their innovation level. Therefore, hypotheses 2 and 3 are confirmed.

Regulatory effects analysis

Stock liquidity measurement

In this paper, we refer to Amihud and Mendelson (1986)'s research methodology and use *illiquidity* index to measure stock liquidity. As shown in model (6).

$$illiquidity = \frac{1}{D}\sum_{d=1}^{D_{it}}\left(\frac{|r_{itd}|}{V_{itd}}\right) \times 100 \quad (6)$$

In the above equation, *ritd* and *Vitd* are the return and turnover of a specific stock *i* on day *d* in year *t*, respectively. *D* is the total number of trading days in that year, $\frac{|r_{itd}|}{V_{itd}}$ is the change in stock price caused by turnover per million dollars, and its annual average is taken and multiplied by 100 as the illiquidity index. The greater the *illiquidity*, the greater the stock price fluctuation caused by each unit of turnover, indicating that the market trading depth is shallow, and the stock is illiquid, and vice versa. Therefore, the illiquidity index is an inverse indicator of stock liquidity.

Innovation disclosure measurement

In this paper, we use the keyword word set percentage method to measure the level of descriptive innovation disclosure, and the specific measurement steps are as follows. (1) Determine the seed word sets related to descriptive innovation disclosure. Referring to Han, Wu and Wei (2023), the seed word sets are "technology innovation", "R&D", "research", "development", "patent", "innovation" and "invention". (2) The annual reports were analysed to expand the seed words. By using Word2vec neural network model to analyse the corpus of annual reports, calculate the semantic similarity of words,

expand similar words to the seed word set, and finally identify 420 keyword word sets related to innovation information through screening. (3) Construct descriptive innovation information disclosure indicators. The ratio of the sum of the word frequency of the keyword word set to the total number of words in the full text of the annual report was used to measure the level of descriptive innovation disclosure (*ID*), and the higher its value, the higher the level of descriptive innovation disclosure.

Table 5. Regulatory effect tests

Variant	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RDI	*RDI*	*Patent*	*Patent*	*RDI*	*RDI*	*Patent*	*Patent*
TD	-0.786***	-0.904***	-1.322***	-0.926***	-0.590***	-0.785***	-1.170***	-0.667***
	(-3.533)	(-4.202)	(-4.550)	(-3.514)	(-3.766)	(-3.578)	(-2.954)	(-3.022)
IQ	0.687***	0.399***	0.564***	0.360***				
	(4.298)	(4.115)	(3.430)	(3.178)				
ID					0.131***	0.409***	0.357***	0.414***
					(3.010)	(4.467)	(2.878)	(2.891)
D_a		-2.762***		-0.835***				
		(-4.456)		(-2.833)				
D_b						-1.899***		-0.439***
						（-3.551）		（-2.870）
Control	YES	YES	YES	YES	YES	YES	YES	YES
cons	-2.091	0.280***	-5.437	-4.336***	-2.098	2.719***	-6.287***	-6.133***
	(-0.819)	(4.166)	(-1.234)	(-3.459)	(-1.135)	(4.590)	(-3.028)	(-3.565)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.178	0.340	0.223	0.241	0.224	0.265	0.189	0.175
N	1120	1120	1120	1120	1120	1120	1120	1120

Note: Tables *, ** and *** indicate 10%, 5% and 1% significance levels, respectively, with *t*-values in parentheses.

Regulatory effect test:

In equation (7) and (8), α is the constant term, β is the regression coefficient of the double difference variable. Illiquidity $_{i,t}$ is the regulatory variable, γ_1 is the coefficient of the regulatory variable, D_a and D_b is the cross term between the regulatory variable and the double difference variable, and the positive, negative and magnitude of its value reflects the direction and degree of the regulatory effect of the two on the NEEQ reform policy.

$$Patent_{i,t} = \alpha + \beta TD_{i,t} + \gamma_1 illiquidity_{i,t} + \gamma_2 D_a + Controls_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (7)$$

$$Patent_{i,t} = \alpha + \beta TD_{i,t} + \gamma_1 disclosure_{i,t} + \gamma_2 D_b + Controls_{i,t} + \rho_t + \mu_i + \varepsilon_{i,t} \quad (8)$$

As shown in Table 5, it can be seen that stock liquidity can affect the innovation effect of CBEC enterprises squeezed out by NEEQ reform policy. From column (1) and (3), it can be seen that in the case of high stock liquidity, the innovation of CBEC enterprises increases accordingly, and there is a positive effect of stock liquidity on the innovation of CBEC enterprises, which is consistent with the theoretical analysis above. The data in column (2) and (4) shows that the coefficient of the interaction term is negative at 1% significance level, which means that the variable of stock liquidity hinders the role of NEEQ reform policy in crowding out CBEC enterprises' innovation to a certain extent. The moderating effect test plot is shown in Figure 7. This is because for NEEQ enterprises, trading activities are extremely low, and stock liquidity is severely insufficient. Low liquidity hinders the entry of market investors and makes it difficult to attract institutions to increase their shareholdings in order to improve their corporate management model. However, many SMEs are illiquid and inactive trading limits growth. Therefore, improving stock liquidity can provide better entry opportunities for long-term strategic investors, which in turn can increase the focus of enterprises on long-term performance and play a critically important positive role in enhancing the level of technological innovation in enterprises. In addition, compared with low liquidity enterprises, highly liquid NEEQ further enhances their innovation capability by increasing stock liquidity. This suggests that only through a high degree of trading activity can SMEs further attract institutions to increase their shareholdings, optimize their corporate governance structure and reduce information asymmetry, thereby creating a continuous positive feedback mechanism and providing a strong guarantee for the enhancement of their level of technological innovation.

In addition, innovation disclosure affects the innovation effect of NEEQ reform policies crowding out CBEC enterprises. From column (5) and (7), it can be seen that innovation of CBEC enterprises increases accordingly under high innovation

disclosure, and innovation disclosure has a positive effect on innovation of CBEC enterprises, which is consistent with the theoretical analysis above. The data in column (6) and (8) shows that the coefficient of the interaction term is negative at 1% significance level, which means that the variable of innovation disclosure hinders the role of NEEQ reform policy in squeezing out CBEC enterprises' innovation to a certain extent. The moderating effect test plot is shown in Figure 8. This is due to the current poor state of information disclosure in the NEEQ market, where the disclosure standards are not sufficiently clear at the level of mechanism setting due to the large differentiation of the listed enterprises and the large span of regulation. For CBEC retail exports of a wide range of commodities, e-commerce sellers are unable to obtain input VAT invoices for each type and batch of goods sold, resulting in the risk of additional VAT levied on "sunshine" exports, which restricts the incentives of enterprises to sunshine. For some smaller CBEC enterprises or those with limited resources, innovation disclosure often involves the use of new technologies or new models, which requires enterprises to invest a large amount of human, material and financial resources, which may constitute greater cost pressure. Moreover, innovation disclosure may involve sensitive information such as an enterprise's core technology, business model, market strategy, etc., the disclosure of which may have a negative impact on an enterprise's commercial competitiveness, such as being imitated or surpassed by competitors. In addition, different countries and regions have different laws, regulations and regulatory requirements for the disclosure of information by CBEC enterprises. CBEC enterprises may need to invest a great deal of time and effort in understanding and complying with these regulations, which increases the difficulty and cost of innovation disclosure, thus crowding out R&D innovation by CBEC enterprises.

In summary, the test results of the regulatory effect validate hypothesis H4a and H4b and that stock liquidity and innovation information disclosure strengthen the negative impact of the NEEQ reform policy on the innovation of CBEC enterprises

with a positive moderating effect.

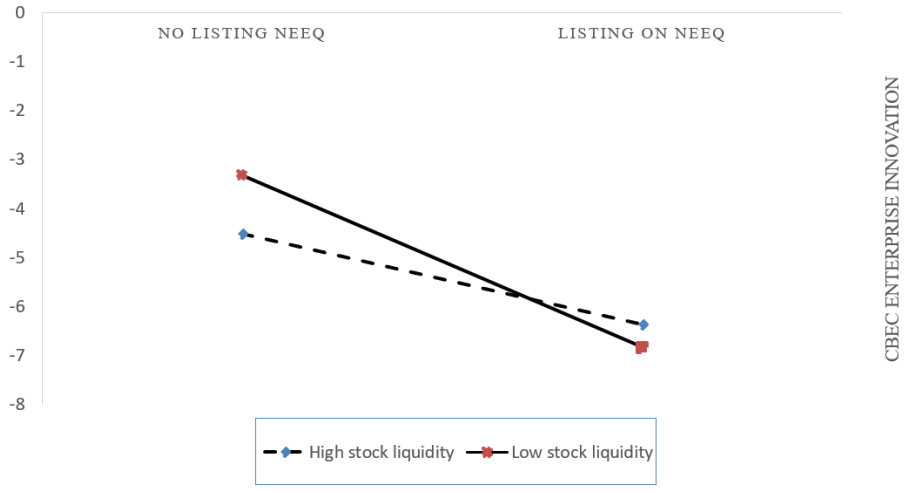

Figure 7. Stock liquidity test chart

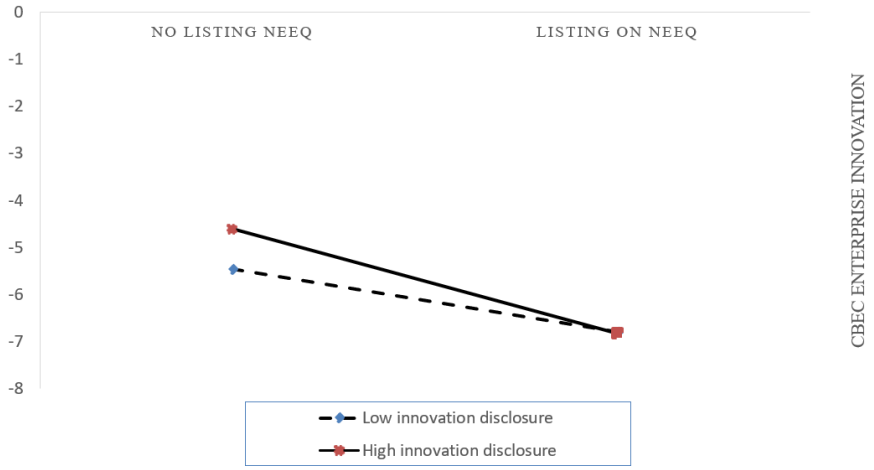

Figure 8. Innovation disclosure test chart

Heterogeneity checks

Table 6. Heterogeneity test

Panel A. *RDI*

Variant	(1) Central and the western	(2) Eastern	(3) High tech	(4) Non-high tech	(5) Low education	(6) Medium education	(7) High education	(4) Non-factor intensive	(5) Factor-intensive	(6) Low marketization	(7) High marketization
TD	-0.786***	-1.321	-2.067**	-1.835	-0.250**	-0.067**	-0.501***	-0.061	-0.311***	-0.554***	-0.082
	(-3.035)	(-0.939)	(-2.208)	(-1.320)	(-2.226)	(-2.159)	(-3.510)	(-0.981)	(-2.848)	(-4.215)-	(-0.946)
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
cons	-1.354***	3.288**	-0.491*	3.083	-4.157***	-3.122***	2.760***	-0.843	4.193**	-0.430	2.012
	(-3.678)	(2.233)	(-1.767)	(1.348)	(-4.090)	(-4.455)	(4.035)	(-1.304)	(2.189)	(-1.342)	(0.788)

Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.312	0.248	0.214	0.256	0.333	0.420	0.378	0.270	0.355	0.469	0.555
N	372	748	534	586	218	552	350	436	684	512	608
					Panel B. *Patent*						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(4)	(5)	(6)	(7)
Variant	Central and the western	Eastern	High tech	Non-high tech	Low education	Medium education	High education	Non-factor intensive	Factor-intensive	Low marketization	High marketization
TD	-0.452**	-0.676	-1.219**	-0.060	-0.468***	-0.433***	-0.672***	-0.454	-0.128***	-0.407***	-0.291
	(-1.987)	(-1.058)	(-2.161)	(-0.045)	(-4.203)	(-3.485)	(-2.873)	(-1.317)	(-3.150)	(-3.018)-	(-1.097)
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
cons	1.670*	-2.244	-1.714	1.178***	-2.022	-1.788	1.235**	1.444***	2.032**	2.211***	-0.624**
	(1.705)	(-0.760)	(-0.987)	(3.472)	(-1.012)	(-0.898)	(2.121)	(3.030)	(2.243)	(2.845)	(-2.034)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.219	0.127	0.298	0.341	0.420	0.195	0.237	0.255	0.178	0.210	0.225
N	372	748	534	586	218	552	350	436	684	512	608

Note: Tables *, ** and *** indicate significance levels of 10%, 5% and 1%, respectively, with t-values in parentheses.

Heterogeneity at the regional level:

There were significant differences in resource endowments, local policies, and market environments across different regions of China. By testing the heterogeneity of enterprises in various regions, it was possible to uncover the reasons behind differences in enterprise development and to formulate more precise policies for the innovative development of regional enterprises. In this article, the full sample was divided into two subsample sectors: eastern and central-western areas. The test findings are reported in column (1) and (2) of Panel A and Panel B of Table 6. The research indicated that the NEEQ policy significantly inhibited the innovation level of enterprises in the central and western areas, while the inhibitory impact on enterprise innovation in the eastern area did not pass the significance check.

The reason for this may lie in the fact that CBEC enterprises in the eastern region had entered a maturity stage and were actively creating a market and policy environment conducive to CBEC. These enterprises focused more on brand refinement operation strategies, advancing innovation in systems, management, and services, and promoting the liberalization, facilitation, and standardization of CBEC development. In

comparison, the central and western regions lacked soft power in their business environment and market mechanisms. The government's financial subsidies in these regions failed to enhance enterprises' willingness to conduct R&D, instead increasing innovation inertia and resulting in ineffective outcomes. Therefore, in the eastern region, the impact of the NEEQ policy on enterprise innovation was not apparent.

Heterogeneity at the industry level:

Enterprises in different industries have different characteristics and face different levels of market competition and environments, and these differences affect their market positioning, strategic choices, and operational effectiveness, which in turn have a profound impact on their organizational structures, business models, and innovation capabilities. In this article, we refer to the research of Dziurski and Sopińska (2020) to examine the heterogeneity of the innovation effect of the NEEQ among different industries. By employing the GB/T4754 industry classification standard from the National Bureau of Statistics, we categorized the equipment manufacturing industry and the cultural and office machinery industry within the manufacturing sector as high-tech industries, while classifying the remaining industries as non-high-tech[1]. The regression results are shown in column (3) and (4) of Panel A and Panel B of Table 6, where the regression parameters are insignificant in the regressions of non-high-tech industries, while the regression coefficients are significantly negative in the regressions of high-tech industries, suggesting that the impact of the NEEQ policy on inhibiting innovation is more pronounced in non-high-tech industries. The reason is that, with the expansion of subsidy scale, non-high-tech enterprises are more inclined to chase short-run profits and ignore long-run technological innovation, and the negative signals conveyed by government R&D subsidies are stronger than the positive signals, which affects the innovation decisions and inputs of enterprises. In the meantime, the continued operation of non-high-tech industries often does not rely on new product development, their willingness to innovate is low, and their business focuses on matching rich supply, good service and more interactive content. As a result, the NEEQ

[1]https://data.stats.gov.cn/english/tablequery.htm?code=AC0G

reform has a stronger disincentive to innovation for non-high-tech enterprises. In contrast, high-tech industries enjoy more government tax incentives, and most of their investment capital is used in R&D activities to ensure technological leadership and product innovation, which can resist external uncertainties and maintain competitive advantages. As a result, the reform of the NEEQ does not have a significant impact on inhibiting the innovation of high-tech firms.

Heterogeneity of human capital structure:

Human capital was essential to an enterprise's core competitiveness, and differences in its structure directly affected the enterprise's ability to innovate. Variations in human capital structures influenced the decision-making styles and strategic choices of enterprises. By examining the impact of different human capital structures on enterprises' innovation, a deeper understanding of the nature of these differences could be achieved. Research literature suggested that employees with education levels below university were usually excluded from human capital measures. Therefore, this paper drew on Liang et al. (2023) and Zhang et al (2025) and manually collected the proportion of employees with a bachelor's degree or higher in CBEC enterprises as a measurement variable for human capital structure. The entire sample was segregated into three distinct sub-sample groups: low, medium, and high education, using trichotomies based on the dimensions of year and employee education level.

The outcomes of the test are presented in columns (5), (6) and (7) of Panel A and Panel B of Table 6. The estimated coefficients of the interaction terms were significantly negative, indicating that enterprises with highly educated personnel experienced the least inhibition of innovation, while those with less educated personnel experienced the greatest inhibition. Low human capital implied that employees had more limited education, professional skills, and industry experience, directly affecting an enterprise's ability to explore new technologies and develop innovative products. Employees might lack the qualifications and confidence to undertake high-risk R&D activities, leading to lower investment in R&D and limiting the enterprise's competitiveness in areas of rapid technological development.

Currently, CBEC talent is scarce, and the cost of cultivation and trial and error was high, with a very low tolerance for mistakes. Non-compliance with operations could lead to a total collapse of the business. CBEC enterprises required more professional and technical talents in areas such as website design, payment systems, credit supervision, and technology research and development, which were often difficult for less educated employees to perform.

Heterogeneity in factor intensity:

Factor intensity was the foundation of enterprise production and innovation activities, as production relied on various inputs such as capital, labor, and technology. These inputs directly influenced the enterprise's production mode, market positioning, and development strategy. By comparing the differences in factor intensity across enterprises, it was possible to identify their strengths and weaknesses in factor utilization, providing insights for optimizing and upgrading industrial structures. Due to variations in production technologies and factor intensities, the capital-labor ratio varied significantly among different industries. Referring to the study by Timini et al. (2022), the industries represented by the sample companies were divided into labor-intensive and non-labor-intensive categories based on factor intensity. This division allowed for testing whether the impact of the NEEQ reform on innovation differed between enterprises with different factor intensities.

The results of the heterogeneity regression are presented in columns (4) and (5) of Panel A and Panel B of Table 6. The findings indicated that the estimated coefficients of the NEEQ reform on the innovation of labor-intensive enterprises were significantly negative. In contrast, the estimated coefficients for enterprises in non-labor-intensive industries were negative but not significant. This suggested that the NEEQ policy reform significantly inhibited innovation in labor-intensive enterprises. The reason might be that labor-intensive enterprises primarily relied on substantial labor inputs for production, faced intense market competition, and produced lower value-added products. Their innovation activities were often limited to optimizing production processes and improving management efficiency, making it challenging for them to

bear higher innovation risks.

On the other hand, non-labor-intensive enterprises typically had higher technological levels and product value-added. Their innovation activities involved the study, development, and application of new products and technologies. The NEEQ reform provided non-labor-intensive enterprises with more convenient and flexible financing channels, making it easier for them to get financial support, increase investment in innovation, and promote technological progress and product upgrading.

Heterogeneity in the degree of marketization:

The degree of marketisation reflected the intensity of market competition, the efficiency of resource allocation, and the extent of government intervention in the market. Examining the heterogeneity of enterprises under different levels of marketisation provided a more comprehensive understanding of enterprise characteristics and differences, which could help enterprises formulate more appropriate strategies based on their own characteristics and market environment. Referring to the study by Wang et al. (2024), the sample was divided into two sub-sample groups based on the annual mean of marketisation level: low and high marketisation levels. Group regression was conducted, and the findings are displayed in columns (6) and (7) of Panel A and Panel B of Table 6. The findings indicated that the estimated coefficients of the NEEQ reform on enterprises' innovation in low marketisation areas were significantly negative. In contrast, the estimated coefficients for high marketisation areas were negative but not significant. This suggested that the NEEQ reform had a stronger inhibiting effect on enterprises' innovation in regions with low marketisation levels. The reason might be that enterprises in low marketisation areas faced greater difficulties in financing, had deficiencies in their internal management and governance structures, and were not well known to a wide range of investors. These factors made it difficult for their performance on the NEEQ to attract market attention, thus affecting their innovation activities. Conversely, enterprises in high marketisation areas were usually more prone to attract the concern of investors. The NEEQ reform promoted the standardization of the capital market and provided

these enterprises with more financing channels, which helped them better connect with the capital market, attract more investors and partners, and obtain funds to support innovative activities.

To summarize, the NEEQ policy had a stronger inhibiting effect on the innovation of CBEC enterprises in the central and western regions, non-high-tech industries, low human capital levels, labor-intensive industries, and regions with low marketisation levels.

Further analysis: Quantile regression

Table 7. Quantile regression results

Variant	*RDI*				*Patent*			
	(1) Q5	(2) Q25	(3) Q50	(4) Q75	(5) Q10	(6) Q25	(7) Q75	(8) Q90
TD	-0.056**	-0.327***	-0.589***	-0.844***	-0.231*	-0.355**	-0.672***	-0.899***
	(-2.131)	(-3.015)	(-4.460)	(-5.269)	(-1.800)	(-2.274)	(-3.589)	(-4.976)
Control	YES	YES	YES	YES	YES	YES	YES	YES
cons	3.678	-1.477***	-0.653***	-2.545***	-2.659***	-0.715*	3.588***	-2.345**
	(0.851)	(-3.468)	(7.129)	(-6.307)	(-5.191)	(-1.754)	(3.125)	(-2.090)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.123	0.115	0.088	0.230	0.186	0.097	0.144	0.169
N	1120	1120	1120	1120	1120	1120	1120	1120

Note: In contrast to approaches that solely focus on reflecting the treatment effects of explanatory variables on the conditional mean of the dependent variable, the quantile regression method provides a description of the distribution of the dependent variable. This allows for the analysis of the influence of explanatory variables on different quantiles of the distribution.

Given that the innovation of CBEC enterprises is at varying levels, the impact of the NEEQ reform policies on CBEC innovation is likely to differ. Therefore, drawing upon the study by Abid et al. (2023), this research employs a quantile regression model to further investigate how the NEEQ reform policies influence CBEC innovation. Quantile regression fits the conditional quantiles of the dependent variable, thus enabling a detailed examination of the linear relationships at specific quantiles. The model is specified as follows:

$$Q_q[Y_{it} \mid G_{it}(TD)] = G_{it}(TD)\beta_q \quad (9)$$

The following components were considered: q represents the quantile; Y_{it} is the dependent variable, representing CBEC enterprise innovation (including RDI_{it} and $Patent_{it}$.) $G_{it}(TD)$ represents the influencing factors of CBEC enterprise innovation. $Q_q[Y_{it} \mid G_{it}(TD)]$ is the value of Y_{it} at the q-th quantile, and β_q represents the regression coefficient of other variables at the q-th quantile. Research and development (R&D) intensity, defined as the ratio of R&D investment to total revenue, reflects the degree to which enterprises invest in R&D and the emphasis they place on technological innovation. It is commonly believed that an ideal R&D intensity should reach 10% or more (Moncada-Paternò-Castello, 2022), or that an enterprise is considered technology-driven if the proportion of invention patents exceeds 50% (Caviggioli, 2016). Therefore, this study selected 5%, 25%, 50% and 75% quantiles of RDI_{it} and the 10%, 25%, 75% and 90% quantiles of $Patent_{it}$ for estimation and testing. The estimated value of β_a needs to minimise the following objective function:

$$Q(\beta_q) = \sum_{Y_{ik} > G_{ik}(TD)\beta_q}^{n} q\left|Y_{it} - G_{it}(TD)\beta_q\right| + \sum_{Y_{it} < G_{ik}(TD)\beta_q}^{n} (1-q)\left|Y_{it} - G_{it}(TD)\beta_q\right| \quad (10)$$

The quantile regression results are shown in Table 7. In the quantile regression for RDI_{it}, *TD* passed the 5% significance test at the 5th percentile, and the 1% significance test at all other percentiles. The corresponding regression coefficients were -0.056, -0.327, -0.589, and -0.844. In the quantile regression for $Patent_{it}$, *TD* passed the 10% significance test at the 10th percentile, the 5% significance test at the 25th percentile, and the 1% significance test at all other percentiles. The regression coefficients were -0.231, -0.355, -0.672, and -0.899. These results suggest that the NEEQ reform had a progressively larger negative impact on the innovative performance of technology-driven CBEC firms, indicating significant variation in the effects of the NEEQ reform across firms with different technological capabilities.

For technology-driven CBEC enterprises, the intensity of the inhibitory effect of the NEEQ reform policy on innovation was found to vary to some extent with changes in the firm's technological innovation intensity and industry characteristics. Although

the reform provided support from the capital market and financing channels, it also presented challenges in areas such as information disclosure, regulatory compliance, shareholder returns, and market short-termism. Specifically, when a firm's technological innovation involves high risks and requires long-term investment, the inhibitory effect of the NEEQ reform was more pronounced, particularly in terms of capital market pressures and compliance challenges. In such cases, firms were likely to allocate more resources to market expansion and business model optimization that could yield short-term returns, rather than focusing on high-risk technological innovation. This shift towards prioritizing short-term returns and market expansion could potentially limit the firm's ability to maintain a competitive edge in the long term, which is crucial for CBEC firms to be reliant on technological innovation.

Discussion

The development of CBEC in China has unleashed new momentum for foreign trade and has become a significant engine for economic growth. The sustainability of this engine is closely tied to the innovation capacity of enterprises. This study, focusing on CBEC, not only deepens the understanding of the relationship between listing and innovation but also explores the intrinsic mechanisms of the NEEQ policy reform on enterprise innovation. Unlike previous research, which often relied on subjectively influenced data, this study employed authentic enterprise data for examinations. Through a series of empirical tests, it yielded valuable insights. This paper, drawing on practical experience from the Chinese market, provides useful references for enterprises planning to list on the NEEQ in the future.

In this study, we empirically investigated the policy influence of the NEEQ reform on CBEC enterprises' innovation and its system of action, applying data on the listings of CBEC enterprises in China from 2017 to 2023, employing the DID model. The study

drew several conclusions. First, descriptive statistics illustrated that the NEEQ board reform policy had an inhibitory effect on CBEC enterprises' innovation. Second, the univariate difference-in-differences method confirmed that the innovation value of NEEQ-listed CBEC enterprises significantly decreased after the introduction of the NEEQ reform policy. Further analysis of both average and dynamic effects indicated that the NEEQ reform policy significantly reduced the innovation level of enterprises initially, followed by a subsequent enhancement. Mechanism analysis revealed that policy incentives and signaling effects were crucial channels through which the NEEQ reform inhibited CBEC enterprises' innovation. The reform reduced corporate innovation by increasing government subsidies and tax rebates for CBEC enterprises and decreasing credit financing. The inhibitory effect of the NEEQ reform policy was stronger among CBEC enterprises in central and western regions, non-high-tech industries, low human capital levels, labor-intensive sectors, and regions with low marketisation levels. Robust tests, including placebo tests, reduced-tail method tests, endogeneity problem tests, timing changes of policy shocks, zero-inflated Poisson tests, sample selection bias tests, and econometric model setting replacements, confirmed the reliability of these conclusions.

Theoretical implications

To strengthen the theoretical contributions of this study, the following points can be emphasized to articulate how the findings advance our understanding of innovation theory and build upon or contrast with existing research.

First, this study challenges the conventional assumption that financial market

reforms, particularly those focused on capital access (e.g., the NEEQ reform), inherently drive innovation. While traditional theories posit that reforms such as improved capital access, entrepreneurship incentives, and enhanced resource allocation promote innovation, this study provides empirical evidence that the NEEQ reform may actually suppress innovation, counteracting the traditional belief that financial support automatically spurs innovation. By demonstrating that increased access to capital does not always translate into more innovation, this paper contributes to the evolving discourse on financial market reforms by showing that other contextual factors, such as regulatory burdens and strategic firm behavior, can mediate this relationship.

Second, the study identifies policy incentives and signaling effects as key mechanisms through which regulatory reforms influence innovation. Existing literature has extensively discussed how policy incentives affect firm behavior by altering resource allocation, strategic priorities, and market confidence. However, this study introduces a nuanced perspective by showing that such incentives can also unintentionally hinder innovation, especially when firms prioritize regulatory compliance over innovation. The study also builds on signaling theory, which posits that market and investor expectations can shape firm behavior. The paper extends this theory by illustrating how positive or negative signals from regulatory reforms can either foster or deter innovation, depending on how businesses interpret these signals. This dual mechanism adds complexity to the current understanding of innovation policy, highlighting that signals are not universally positive or negative, but are contingent on firms' perceptions.

Third, this research extends innovation theory by applying it to the rapidly growing and emerging sector of cross-border e-commerce (CBEC), which has received limited attention in traditional innovation research. While previous studies have predominantly focused on innovation in established industries or large enterprises, this study broadens the theoretical framework to include new industries characterized by unique challenges and opportunities. It highlights how innovation in CBEC firms is influenced not only by internal factors such as firm resources and capabilities, but also by external factors like regulatory changes and market signals, thus expanding the scope of innovation theories to better address the dynamics of emerging industries.

Finally, the study's contribution lies in its emphasis on the unintended negative consequences of regulatory reforms, particularly in stifling innovation. While much of the existing literature focuses on the positive impacts of reform, this paper calls attention to the complexity of reform outcomes, urging policymakers to adopt a more comprehensive, context-sensitive approach. It stresses the need to consider not only capital access but also regional disparities, industry-specific needs, and human capital when designing innovative policies. This critique of current policy frameworks challenges the simplistic notion that financial support alone is sufficient for fostering innovation, offering a more holistic perspective on innovation policy design.

By offering these insights, this study advances innovation theory by bridging the gap between traditional industry-focused research and the emerging dynamics in new sectors like CBEC. It also encourages a deeper exploration of the complex relationship between policy interventions and innovation outcomes, thus providing a valuable

contribution to both theoretical discourse and practical policy development.

Practical implications:

This study emphasizes the need for policymakers to recognize the varying challenges faced by different types of enterprises, especially in the context of cross-border e-commerce (CBEC) companies, many of which are under significant pressure during the innovation process. The research suggests that targeted support measures should be implemented to address these challenges. These measures could include enhancing stock liquidity, improving the disclosure of innovation-related information, and addressing the specific needs of enterprises. Such policy interventions can effectively mitigate the potential negative effects of regulatory reforms and foster growth and development in the innovation sector.

The study also points out that policymakers should design customized policies based on the characteristics of enterprises, industry specifics, and regional differences. For companies in underdeveloped areas or non-high-tech industries, more targeted support may be necessary to reduce the negative impact that reforms could have on innovation. By adjusting policy incentives and disclosure requirements, policymakers can better support various industries, especially within the cross-border e-commerce sector, thereby enhancing the effectiveness of reforms.

From the enterprise perspective, understanding the specific impacts of regulatory reforms on their innovation processes and adjusting strategies and practices accordingly is crucial. Enterprises need to proactively adopt strategies to navigate regulatory changes by understanding the details of policy shifts, allowing them to better achieve

innovation goals within the context of the reforms. Innovation within enterprises should not solely rely on external policy drivers but should also involve self-adjustment, innovative practices, and resource optimization to further enhance competitiveness in the cross-border e-commerce sector.

Overall, this study provides valuable guidance for policymakers, enabling them to develop more targeted reform measures that support innovation and growth in the cross-border e-commerce industry while mitigating potential negative effects on innovation for certain enterprises. By refining the policy framework, policymakers can more effectively promote the sustainable development of the industry.

Conclusions

This paper first investigated the impact of Chinese NEEQ policy reform on enterprises' innovation from the view of Chinese CBEC enterprises. Assuming parallel trends and following a series of robustness checks, the empirical findings showed that the reform of the NEEQ policy significantly inhibited the innovation of CBEC enterprises in terms of average and dynamic effects. Specifically, CBEC enterprises were able to obtain government subsidies and tax rebates by presenting themselves as entities in need of policy incentives to meet policy requirements. This phenomenon suggested that the NEEQ policy might induce adverse selection behavior among enterprises, which in turn inhibited their enthusiasm for R&D and innovation.

Additionally, although listing on the NEEQ provided positive signals to commercial banks and other institutions, CBEC enterprises were prone to lose credit financing opportunities due to their unique nature and the lack of trust in their

operations and supervision. Stock liquidity strengthens the negative impact of the NEEQ reform policy on CBEC enterprises' innovation with a positive moderating effect. In addition, stock liquidity and innovation disclosure strengthen the crowding-out effect of the NEEQ reform policy on innovation in CBEC enterprises. Further analysis revealed heterogeneity in the impact of NEEQ policy reforms on enterprise innovation. Among CBEC firms in the central and western areas, non-high-tech industries, low human capital levels, labor-intensive industries, and regions with low marketisation levels, the inhibitory effect of policy reforms on enterprise innovation was stronger.

Limitations and recommendations

This study provides valuable insights, but also has some limitations, while providing recommendations for all parties. Firstly, the research data only covered the period from 2017 to 2023, which may not fully capture the long-term or future impacts of the NEEQ reform. Secondly, the use of unbalanced panel data could introduce bias or affect the robustness of the results.

Finally, the potential limitations arising from missing and delayed data in CBEC primarily include the following aspects: (1) The data related to transaction volumes, buyer and seller activities, logistics information, and other aspects of CBEC often suffer from missing or inconsistent entries due to differences in legal regulations, platform rules, or technical standards across countries or regions. This incomplete data can affect the reliability and representativeness of the research findings. (2) As CBEC transactions involve multiple stages, such as payments, logistics, and customs, data may be delayed. Particularly in international trade, factors such as time differences, time zone issues,

and government approval processes can cause delays in data updates and feedback, making it difficult for research analyses to promptly reflect market changes and corporate innovation dynamics. (3) CBEC not only involves traditional business operation data but also factors such as international exchange rate fluctuations, international logistics costs, and policy changes. These factors can cause data to lag or become unstable, thereby affecting the accurate understanding of CBEC market dynamics.

Studying the influence of NEEQ policies on enterprises' innovation holds significant importance, and the following recommendations are put forth in this paper.

For CBEC enterprises, below are some more specific suggestions.

(1) CBEC firms should integrate regulatory compliance and innovation into a unified strategy, creating innovation roadmaps that align with market trends and regulatory changes. This includes exploring alternatives like product diversification or digital transformation to stay competitive. Investing in digital tools for efficient cross-border operations will provide a competitive edge.

(2) Enterprises must optimize resources to achieve innovative goals. CBEC firms can leverage big data, AI-powered customer service, and blockchain for better supply chain and marketing strategies. Collaborating with universities, research institutes, and international partners will enhance innovation capacity, offering access to new technologies, market insights, and cross-border opportunities.

(3) For non-high-tech CBEC firms, innovation can focus on improving business processes, customer experience, or marketing strategies. Firms should invest in incremental innovation to boost efficiency and optimize products. Training in data-

driven marketing, logistics, and global customer relations will enhance competitiveness in the global market.

(4) Building an innovative-driven culture is crucial for enterprises. They should prioritize attracting, training, and retain talent skilled in new technologies and global market strategies. Promoting creative thinking, risk-taking, and collaboration within the organization is key. Continuous investment in employee development, especially in areas like AI, blockchain, and data analytics, will support long-term innovation.

For the government, the government should enhance policy incentives for CBEC enterprises, particularly by offering targeted tax breaks in areas such as R&D investment, international market expansion, and technological innovation. Special tax reductions could promote investment in R&D and support market expansion abroad. Additionally, an innovation fund could be established to assist enterprises with breakthrough technologies, addressing financial challenges in the innovation process. Policies should also favor SMEs in this sector, providing subsidies, low-interest loans, and other support to reduce innovation barriers and encourage technological and business model advancements.

Furthermore, the government could establish an information disclosure platform, publishing regular industry reports on trends, technological innovations, and policy changes. These reports would provide timely feedback to businesses on market prospects and policy shifts, aiding in the adjustment of innovative strategies. Collaboration and resource-sharing platforms could be created by the government and industry associations to facilitate technology development, market expansion, and reduce redundant investments. The NEEQ should also encourage enterprises to disclose

operational, innovation, and R&D information, improving transparency and aiding investor decision-making. Clearer explanations of CBEC business models would help investors better understand strategies and innovation pathways.

The reform of the NEEQ aimed to provide Chinese SMEs with more flexible and diversified financing channels and to promote innovation and development. To bolster the trust of financial lending institutions, regulators should have further reinforced the information disclosure standards for listed companies. Concurrently, to diversify financing tools in the NEEQ market, it was crucial to standardize the NEEQ trading framework, improve the grading system, and upgrade the market-making trading mechanism. Based on the quality, scale, and operational status of listed enterprises, the NEEQ market should have been divided into different tiers, with corresponding trading rules and regulatory requirements formulated to improve the overall quality and transparency of the market.

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Appendix

Robustness checks

Placebo test

In this paper, based on a quasi-natural experiment view, the test results are to some extent affected by omitted variables, random factors, etc. To deal with this potential problem, we refer to the methodology of Zhang et al. (2023). Taking the NEEQ policy revised and released by the National Small and Medium Enterprises Stock Transfer System Limited Liability Company in 2017 as the starting point of the study[2]. Firstly, the experimental group and the control group were set by chance. Pilot CBEC enterprises listed on the NEEQ were randomly assigned to the experimental group that received the pilot policy and the control group that received a placebo. Before the NEEQ reform policy, the experimental and control groups should tend to be similar in characteristics. After the reform time in 2019, the experimental group receives the pilot policy while the control group receives the placebo. Then, time dummy variables are set according to the time when CBEC enterprises are listed on the NEEQ market. Finally, the randomly selected experimental and control groups are analyzed, and the results of the placebo test are plotted.

[2]https://english.www.gov.cn/news/topnews/202109/07/content_WS6136bfdac6d0df57f98dfcca.html

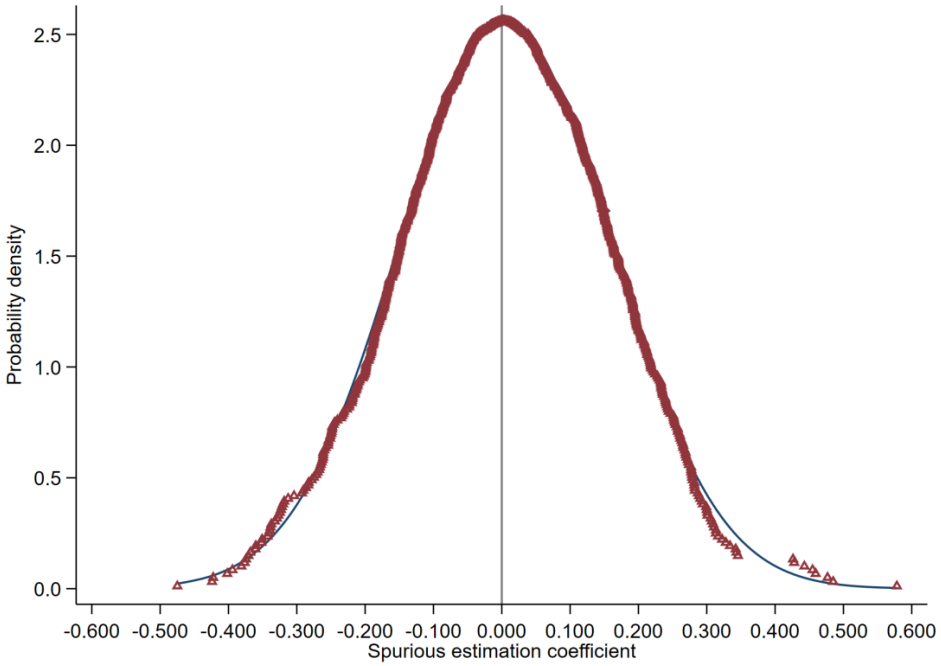

Figure A. Placebo test (*Patent*)

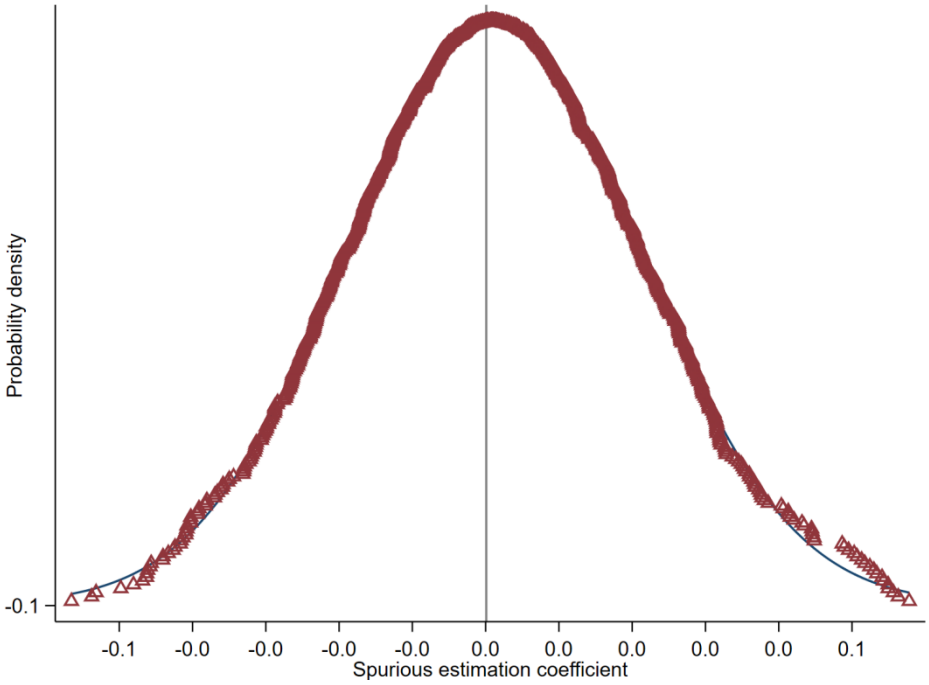

Figure B. Placebo test (*RDI*)

To judge the reliability of the conclusions, the probabilities of the estimated coefficients of the baseline regression were obtained using a sham experiment based on the regression results in column (2) and (6) of Table A. With a view to further enhancing the validity of the placebo test, the above process is repeated 500 times, and finally the distribution of the estimated coefficients of the coefficient *TD* is plotted. Based on this,

it is verified whether CBEC enterprises are significantly affected by factors other than the NEEQ policy. If the distribution of the estimated coefficients of *TD* is close to 0 under the randomized treatment, it indicates that the impact effect in the benchmark analysis is indeed due to the results caused by the policies concerned in this paper. The estimated coefficients depicted in Figure A and Figure B reveal a clustering around 0 for the spurious double-difference term, suggesting the absence of a significant omitted variable issue in the modeling process, thereby confirming the robustness of the core conclusions.

Reduced-tail test

Winsorization is a common data preprocessing technique used to cope with extreme values in data. It is based on the principle of determining a specific percentile for each variable and replacing values below that percentile with that percentile and values above that percentile with that percentile. The main purpose of using this method is to reduce the influence of extreme values on the results of the analysis. This is because in empirical analysis, when the sample size is small, extreme values may significantly affect the results. The reduced tail test improves the stability and reliability of data analysis by replacing extreme values with more moderate values.

Column (1) of Panel A and Panel B of Table A showcases the regression outcomes following the application of a 1% shrinkage tail adjustment to each continuous variable in the paper. The findings reveal that the *TD* coefficients maintain their statistical significance at a 1% significance level, thereby confirming the robustness of the results.

Endogeneity problem test

One-period lagged variables are particularly suitable as instrumental variables for analyzing the dynamic effects of economic variables. There is often time dependence and continuity among economic variables, and one-period lagged variables are correlated with endogenous explanatory variables in the current period. Error terms, on the other hand, represent unobserved random disturbances in the current period, which usually do not affect the past variables, and thus lagged one-period variables are usually uncorrelated with the current period's error terms. Since lagged one-period variables satisfy the exogeneity condition for instrumental variables, the endogeneity problem can be avoided, resulting in more accurate estimates.

This paper introduces one period lag of the explanatory variable (*Patent*) as an instrumental variable based on Deng and Zhao (2022). Column (2) of Panel A and Panel B of Table A shows the regression results using two-stage least squares (2SLS) with an F-statistic greater than 10 (F=1343.25), and thus it cannot be considered as a weak instrumental variable (Sanderson and Windmeijer, 2016). The regression results indicate that the effect of *TD* on firm innovation remains significantly negative. We further validate this through limited information maximum likelihood (LIML) regressions (see column (3) of Panel A and Panel B of Table A). Comparing the results in columns (2) and (3), the regression coefficients and significance remain unchanged except for the standard errors (Ullah et al., 2021).

Changing the timing of policy shocks

The Counterfactual test is a methodology used to assess the robustness of an outcome. The rationale is to create a counterfactual scenario that does not correspond

to the actual time of policy implementation, in order to test whether the results would have been consistent with the DID estimates if the policy had been implemented at an earlier time than it actually was. Assuming that a significant policy effect can still be observed by advancing the time of policy implementation, this could mean that our DID estimates are affected by other unobserved factors or modeling errors. If the DID estimation results are insensitive to the assumption of policy implementation time, i.e., similar results are obtained regardless of how we change the setting of policy implementation time, then we can consider the DID estimation results to be robust.

In this paper, we use a counterfactual test that assumes an earlier point in time for the implementation of the NEEQ reform policy. This is done by replacing the interaction term (*Treat*×*After*) with the cross-multiplier term at the point of the hypothesized earlier release as the main explanatory variable and examining whether the core explanatory variables remain significant. If significant, it suggests that there may be other unobserved factors influencing enterprise innovation. If it is not significant, it indicates that the inhibitory effect of the NEEQ policy on enterprise innovation is stable and reliable. The results, as shown in column (1) and (4) of Panel A and Panel B of Table A, the interaction term is not significant, so the model can be judged to be consistent with the counterfactual hypothesis.

Zero expansion poisson test

The basic principle of the Zero-Inflated Poisson Model (ZIP) is to solve the problem that the frequency of occurrence of zero values in real observational data is too high, exceeding the predictive ability of the traditional poisson distribution. The

model is particularly suitable for describing datasets that contain a large number of zero-count events. In this paper, the explanatory variable is enterprise patents, and there are numerous zero values in the data, so the zero-inflated poisson regression is used for testing on the basis of the benchmark regression. Column (6) of Panel A and Panel B of Table A shows that the estimated coefficients on the cross terms are significantly negative and significant at the 1% significance level after controlling for fixed effects.

Sample selectivity bias

Although the DID method can isolate the net effect of the NEEQ reform policy on the innovation of CBEC enterprises, it inevitably generated errors in its sample selection process considering the differences in the individual characteristics of enterprises. In order to effectively avoid selection bias, this article adopts the Propensity Score Matching (PSM) method, which draws on the research method of Luo et al. (2023), and which is able to effectively reduce the effects of data bias and confounding variables when dealing with observational research data, so as to more reasonably compare the experimental and control groups.

Specifically, PSM eliminates the interference of non-treatment factors by selecting the control group samples that are most similar to the treatment group characteristics based on the treatment group characteristics. In this article, the samples are screened and selected utilizing the methods of one-to-one nearest-neighbor matching and radius matching, and the matched samples are used to estimate the parameters of model (1). The PSM-DID regression results are shown in columns (7) and (8) of Panel A and Panel B of Table A, where the estimated coefficients of the cross-over terms are significantly

negative, which is in line with the results of this paper's benchmarking test and sufficiently demonstrates that the sample-selective bias does not have an impact on the research conclusions.

Replacement of measurement modeling

Abadie and Imbens (2006) pointed out that even though the PSM-DID method is used in some cases to remove differences in the characteristics of the samples of the experimental and control groups, this method leads to inconsistencies in the estimated standard errors before and after the matching. The PSM needs to ensure that the matching is accurate and reasonable by removing some of the samples that do not satisfy the conditions for the matching, which will reduce the sample size, which directly affects the estimated standard error. In addition, in PSM, the choice of different covariates, matching methods, or matching proportions may lead to differences in matching results and estimated standard errors.

Therefore, this paper used the differences in enterprise patents before and after the policy implementation as explanatory variables. The methodology involved several steps: first, the panel data was divided into two periods, 2017-2019 and 2020-2023. Next, the average values of both the explanatory and control variables were calculated for each period. Finally, the differences between the two periods were computed by subtracting the values from the first period from those of the second, creating cross-sectional data. Following this data processing, the explanatory variable represented the change in patents between the two periods, while the explanatory variable was the policy grouping dummy variable, Treat. The results from the OLS regression model,

presented in column (9) of Panel A and Panel B of Table A, indicated that the estimated coefficient of *Treat* was significantly negative, consistent with the prior benchmark findings.

To assess the robustness of the study's conclusions, this article constructs a non-existent placebo policy or intervention and examines its impact on the results to verify that the conclusions are truly due to the policy or intervention under study rather than other unobserved factors or time trends. Tailoring to deal with extreme values removes the effect of outliers in the data on the results and assesses the sensitivity of the findings to the distribution of the data by comparing the change in results before and after tailing. Endogeneity problems (e.g., omitted variables, reverse causation, etc.) may lead to biased estimation results, so appropriate measures are taken to correct them so as to improve the reliability of the research conclusions. The robustness of the research findings can be tested by changing the timing of the implementation of the policy or intervention and reassessing its impact on the results. The zero-inflated poisson test is applicable when the dependent variable is counting data and there are a large number of zero values, and the robustness of the research conclusions can be assessed by testing whether the zero values disproportionately affect the results. The PSM eliminates differences between the two groups by matching samples with similar characteristics in the experimental and control groups and provides a more accurate evaluation of the influence of the policy or intervention. The robustness of the study's conclusions can be assessed by replacing different econometric model settings and comparing the results under different models.

Changing the sample interval

The COVID-19 pandemic, which emerged at the end of 2019, significantly disrupted the global economy and had a markedly negative effect on CBEC enterprises. To mitigate the potential distortion caused by the pandemic on these enterprises, this paper excluded the 2020 sample and re-evaluated the impact of the NEEQ reform policy on the innovation of CBEC enterprises. The regression results are presented in column (10) of Panel A and Panel B of Table A. After excluding the 2020 sample, the regression coefficients are significant at the 1% level, indicating that the NEEQ reform policy indeed inhibited the innovation of CBEC enterprises.

In this paper, robust tests were conducted through the use of placebo test, reduced-tail treatment, endogeneity problem test, varying the timing of policy shocks, zero-inflated poisson test, propensity score matching method, replacing the econometric model setup and changing the sample interval, and the results of all of them show that the results of the research are robust. Overall, these robust tests provide a comprehensive assessment of the study from different perspectives, which helps to reveal possible problems and limitations of the research and improve the reliability and consistency of the findings. When conducting robust tests, the characteristics and conditions of applicability of various methods should be considered comprehensively and appropriate methods should be selected for the tests.

Table A. Robustness test results

Panel A. *RDI*										
Variable	(1) Shrinkage 1%	(2) 2SLS	(3) LIML	(4) 2 years in advance	(5) 1 year in advance	(6) Poisson	(7) Nearest neighbor matching	(8) Radius match	(9) OLS	（10） Exclude 2020

TD	-1.650***	-0.787**	-2.233**	-2.190	-3.456	-3.215***	-0.070***	-0.044***		-2.981***
	(-3.156)	(-2.239)	(-2.108)	(-1.121)	(-1.047)	(-5.067)	(-3.121)	(-3.128)		(-5.232)
Treat									-0.760***	
									(-3.921)	
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
cons	1.678***	3.701***	-2.540***	0.134	1.988*	-2.766	-3.774***	-4.200	-3.125***	0.342***
	(4.589)	(4.283)	(-4.437)	(1.231)	(1.799)	(-1.039)	(-4.176)	(-1.303)	(-2.971)	(4.019)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
F-value		2067.70								
R^2	0.246	0.345	0.278	0.410	0.105	0.189	0.290	0.323	0.305	0.238
N	1120	876	876	1120	1120	1120	876	521	1120	876
					Panel B. *Patent*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	（10）
Variable	Shrinkage 1%	2SLS	LIML	2 years in advance	1 year in advance	Poisson	Nearest neighbor matching	Radius match	OLS	Exclude 2020
TD	-0.934***	-0.505**	-0.505**	-0.560	-0.331	-0.985***	-0.619***	-1.138***		-0.716***
	(-5.676)	(-2.127)	(-2.234)	(-1.434)	(-1.358)	(-3.221)	(-4.023)	(-5.177)		(-2.908)
Treat									-0.421***	
									(-4.921)	
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
cons	2.620***	0.891	0.672	0.065*	-0.498	-2.766***	-0.652	-2.389	-5.349	0.578
	(3.762)	(1.021)	(0.899)	(1.740)	(-0.675)	(-2.981)	(-0.776)	(-1.276)	(-1.458)	(1.072)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
F-value		1343.25								
R^2	0.123	0.210	0.139	0.245	0.098	0.152	0.147	0.218	0.325	0.266
N	1120	876	876	1120	1120	1120	876	521	1120	876

1 Note: Tables *, ** and *** indicate significance levels of 10%, 5% and 1%, respectively,

2 with *t*-statistics in parentheses.