



# Research on the Impact of U.S. Technology Export Controls on Green Innovation in Chinese Manufacturing Enterprises

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**Abstract.** Currently, ecological and environmental issues are becoming increasingly significant, and environmental protection has become a global focus. China is actively promoting green innovation in enterprises to tackle global climate change. However, for a long time, the United States has been implementing technology export control policies against China, which has had a substantial impact on the green innovation of Chinese enterprises. Therefore, this study explores the impact of U.S. technology export control on the green innovation of the manufacturing enterprises by constructing a multi-period DID model and selecting the panel data of Chinese manufacturing listed companies from 2014 to 2022. This study finds that the U.S. technology export control has a significant negative impact on the green innovation of Chinese enterprises. Meanwhile, the risk-taking ability of enterprises can effectively alleviate the negative effect of U.S. technology export controls on green innovation.

**Keywords:** export control, green innovation, enterprise risk-taking ability

## 1 Introduction

Currently, ecological crises are becoming increasingly prominent, profoundly affecting the international order and global governance patterns. Green innovation, as a key pathway to resolving environmental challenges, addressing climate change, and promoting sustainable development, has already become a focal topic in the international community. China has consistently engaged in global environmental and climate governance, aligning with the international trend of green and low-carbon development and demonstrating its responsibility as a major country in addressing climate change. As a pillar of the economy, the manufacturing sector is crucial for national economic growth and a key driver of industrial green transformation. Enhancing its green innovation capabilities is essential for addressing environmental challenges and achieving China's carbon peaking and neutrality goals.

The U.S. has long implemented technology export controls against China, significantly impacting the green innovation of Chinese manufacturing firms. In recent years, as China's high-tech manufacturing competitiveness has grown, the U.S., concerned

about the erosion of its technological advantage, has further escalated export controls against China in an attempt to hinder China's innovation and development. In 2018 alone, it added 44 Chinese companies to the Entity List of export controls<sup>[1]</sup>. U.S. technology export controls have directly blocked Chinese manufacturing firms from getting green technologies, raising their operating and time costs. Furthermore, corporate management may tend to suspend innovation R&D activities or reduce the scale of innovation investment to mitigate the risks posed by escalating trade tensions<sup>[2]</sup>.

Current research on the impact of technology export controls on green innovation is limited, especially quantitative studies at the micro-enterprise level. Therefore, this study adopts a micro-enterprise perspective and addresses the following questions: (1) What are the specific impacts of U.S. technology export controls on the green innovation of Chinese manufacturing enterprises? (2) How should China's manufacturing enterprises actively respond to the effects of U.S. technology export controls, and can risk-taking ability play a moderating role? This study not only enriches green innovation research but also provides reference strategies and suggestions for both the Chinese government and enterprises to counter U.S. export controls.

## **2 Literature review and research hypothesis**

### **2.1 The Impact of U.S. Technology Export Controls on the Green Innovation of Chinese Enterprises**

International sanctions may significantly constrain the innovation activities of Chinese enterprises. For instance, the U.S. has included certain Chinese enterprises in its Entity List, restricting their ability to directly acquire critical technologies in key fields<sup>[3]</sup>. In such a context, it may be difficult for Chinese enterprises to make breakthroughs in green technology innovation, thus affecting their ability to innovate in environmentally friendly products, cleaner production technologies, etc., and making it more challenging for them to develop and innovate green technologies. Moreover, technological blockades could exacerbate market instability, making it harder for Chinese enterprises to secure external financing<sup>[4]</sup>. The lack of funds may cause enterprises to be unable to adapt to market changes in the short term. This situation will threaten their operations, potentially endanger their survival, and make them incapable of innovation. Notably, green projects typically require substantial investments, involve long payback periods, and carry high risks<sup>[5]</sup>. Faced with increased uncertainty from U.S. technological blockades, enterprises may reduce their commitment to green innovation to mitigate losses<sup>[6]</sup>. Therefore, the following hypothesis is formulated:

H1: U.S. technology export controls are negatively related to the green innovation of Chinese firms.

### **2.2 Moderating effects of Risk-taking ability**

When facing the sanctions imposed by the U.S. Entity List, enterprises with different risk-taking abilities may be affected differently in their innovation activities. Firstly, green innovation has dual externalities. It includes not only the spillover effects

common to general innovation but also the external environmental costs [7]. Secondly, enterprises with higher risk-taking abilities are more likely to actively meet green market demands, acquire new technologies and resources, and absorb new knowledge, effectively mitigating external risks. From the perspective of market competition and collaboration, enterprises with high risk-taking abilities are more likely to adopt proactive strategies, such as developing new green products or services to gain market share [8]. They are also more inclined to collaborate with others, sharing risks and resources to jointly drive green innovation. In addition, due to the uncertainties in external economic policies caused by U.S. technology export controls, enterprises with high risk-taking abilities can alleviate financial burdens through diversified means [9], providing the necessary financial support to sustain green innovation activities. Therefore, the following hypothesis is proposed:

H2: Risk-taking ability promotes the impact of U.S. technology export controls on the green innovation performance of Chinese firms.

The theoretical model diagram of this study is shown in Figure 1.

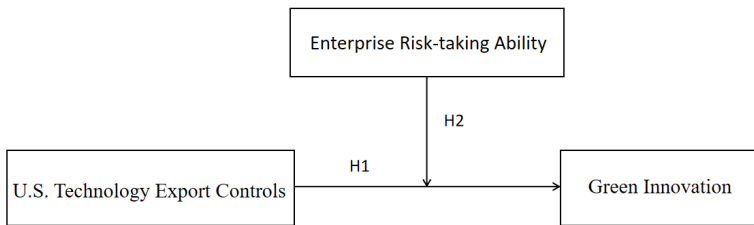


Fig. 1. Diagram of the theoretical model

### 3 Research Methodology

#### 3.1 Sample and data sources

This study focuses on China's A-share manufacturing companies from 2014 to 2022, excluding firms with incomplete data. Data sources include: (1) Data on U.S. Entity List sanction recipients come from the Bureau of Industry and Security of the U.S. Department of Commerce. (2) The data on green innovation comes from Chinese Research Data Services (CRDS). (3) All other data were obtained from the China Stock Market & Accounting Research Database (CSMAR).

#### 3.2 Measurement of variables

Green Innovation. Following Fang X. M. and Na J. L. (2020), and considering that the approval of patent authorisation generally takes a long time and has a relatively serious lag, this study uses the sum of the number of invention patents and utility model patents obtained to measure the green innovation performance of enterprises, and takes logarithmic treatment.

U.S. Technology Export Controls. Drawing on Song H. T. (2024) and Li Z. W. (2024), data is manually compiled from the Entity List issued by the U.S. Department of Commerce's Bureau of Industry and Security. Listed companies sanctioned by the U.S. Entity List are designated as the treatment group (1), while others serve as the control group (0).

**Risk-taking ability.** This study measures risk-taking using the volatility of a firm's earnings (Roa), following John (2008) and Yu M. G. (2013). Roa is calculated as pre-tax profit divided by year-end total assets. To control for industry and cyclical effects, we derive Adj\_Roa by subtracting the annual industry average Roa from the firm's Roa, as in John et al. (2008). Using a five-year window (t-2 to t+2), we calculate the standard deviation of Adj\_Roa to measure volatility.

**Control Variables.** Referring to the studies of Cheng Z. M. (2023), Ji J. Y. (2024), and Li Z. W. (2024), the following variables are controlled: Firm Age, Employ, Size, Board, TobinQ, Cash Flow, and Adj\_Roa.

## 4 Empirical analysis

### 4.1 Descriptive statistical analysis

Table 1 presents the descriptive statistics of the variables. “Green” has a maximum value of 574, a minimum value of 0, and a standard deviation of 11.65, which indicates that there is a large variation in green innovation among different firms.

**Table 1.** Descriptive statistics

|           | Mean     | Std. dev. | Min    | Max       |
|-----------|----------|-----------|--------|-----------|
| DID       | 0.003    | 0.055     | 0.000  | 1.000     |
| Green     | 1.665    | 11.648    | 0.000  | 574.000   |
| Firm Age  | 2.933    | 0.291     | 1.946  | 3.611     |
| Employ    | 4414.944 | 7862.599  | 77.000 | 71736.000 |
| Size      | 22.079   | 1.157     | 19.703 | 26.430    |
| Board     | 2.095    | 0.188     | 1.609  | 2.708     |
| TobinQ    | 2.141    | 1.287     | 0.802  | 13.527    |
| Cash flow | 0.056    | 0.064     | -0.172 | 0.266     |
| Adj_Roa   | 0.036    | 0.041     | 0.002  | 0.536     |

### 4.2 Baseline regression results

Table 2 presents the results. Column (1) displays the estimates without control variables, where the DID coefficient is -0.176, significant at the 5% level. Column (2) adds control variables, with the DID coefficient at -0.171, also significant at the 5% level. The negative DID coefficients remain consistent in significance regardless of control variables, proving that U.S. technology export controls significantly inhibit green innovation in Chinese enterprises ( $\beta_1 = -0.71, P < 0.05$ ), supporting Hypothesis 1.

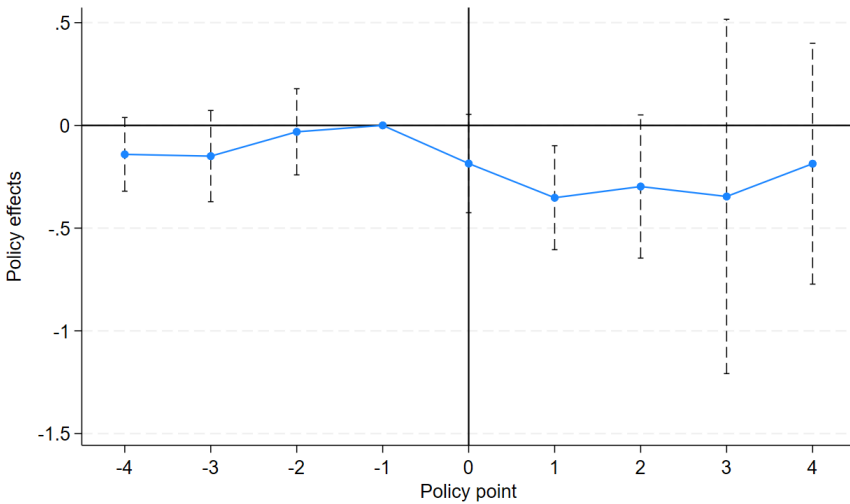
**Table 2.** Impact of US technology export controls on green innovation in China's manufacturing firms

| Variables         | lnGreen             | lnGreen              |
|-------------------|---------------------|----------------------|
| DID               | -0.176**<br>(0.425) | -0.171**<br>(0.0788) |
| Control Variables | No                  | Yes                  |
| Constant          | 0.352***<br>(0.003) | -0.789**<br>(0.377)  |
| R-squared         | 0.735               | 0.733                |
| Individual effect | Yes                 | Yes                  |
| Year effect       | Yes                 | Yes                  |

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

### 4.3 Parallel trend test

Figure 2 shows that there was no significant difference in green innovation performance between the treatment group and the control group before the sanctions. One year after the sanctions, the green innovation performance of the treatment group significantly declined. The results indicate that the sample passed the parallel trend test, and U.S. export controls significantly reduced the green innovation performance of Chinese enterprises, with the impact being lagged and short-term in nature.



**Fig. 2.** Parallel trend test

### 4.4 Placebo test

To test the extent to which the baseline regression results are affected by unobservable firm characteristic factors, a further placebo test is conducted. In this paper, the simple advance method is used, assuming that the U.S. export control policy is advanced by one, two, and three years. Table 3 reports the results, which show that the estimated

coefficients of DID are not significant after the policy time is advanced, so the influence of other exogenous variables on firms' green innovation can be excluded.

**Table 3.** Placebo test

| Variables | 1                  | 2                | 3                |
|-----------|--------------------|------------------|------------------|
| DID1      | -0.024<br>(-0.363) |                  |                  |
| DID2      |                    | 0.038<br>(0.616) |                  |
| DID3      |                    |                  | 0.026<br>(0.412) |
| R-squared | 0.734              | 0.734            | 0.734            |

Note: t-values in parentheses, \*\*\*:  $p < 0.01$ , \*\*:  $p < 0.05$ , \*:  $p < 0.1$

### 4.5 Moderating effect test

The results are shown in Table 4. The coefficient of the interaction term DID\*Adj\_Roa is 6.058, which passes the significance test at the 5% level. So when the level of firm risk-taking is high, it can mitigate the adverse effects of U.S. technology export control on green innovation, and thus Hypothesis 2 is confirmed.

**Table 4.** Moderating effects of corporate risk-taking capacity

| Variables         | Green              |
|-------------------|--------------------|
| DID               | -0.263*<br>(0.136) |
| DID*Adj_Roa       | 6.058**<br>(3.060) |
| Constant          | -0.076<br>(0.483)  |
| R-squared         | 0.751              |
| Individual effect | Yes                |
| Year effect       | Yes                |

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

## 5 Conclusions

This study examines the impact of U.S. technology export controls on green innovation in China's manufacturing enterprises by constructing a multi-period DID model, with a sample of A-share listed manufacturing companies from 2014 to 2022. The main findings are as follows:

First, U.S. technology export controls significantly inhibit corporate green innovation. This negative effect operates through multiple channels: (1) U.S. technology export controls directly hinder Chinese enterprises' access to external technologies; (2) The controls increase uncertainty in external markets, which constrains affected enterprises' ability to secure external financing; (3) Given the inherent risks and long-term

payback periods of green projects, firms under external pressures are more likely to deprioritize such initiatives in favor of short-term, low-risk alternatives.

Second, the risk-taking ability of enterprises can mitigate the negative impact of U.S. technology export controls on corporate green innovation. This mitigation effect operates through the following factors: (1) Enterprises with strong risk-taking abilities tolerate failure better, enabling them to manage external uncertainties <sup>[8]</sup>; (2) They can actively meet green market demands by acquiring new technologies, integrating resources, and absorbing knowledge. (3) High-risk-taking firms not only adopt proactive strategies but also exhibit stronger collaboration propensity to drive green innovation; (4) These enterprises can alleviate financial constraints through diversification mechanisms.

## 6 Management Insights

First, this study reveals that U.S. technology export controls negatively impact corporate green innovation. Second, when facing U.S. export control policies, enterprises should adopt a proactive approach to enhance their independent innovation capabilities, striving to break through key core technologies and reduce reliance on external technologies. On the other hand, enterprises should strengthen their risk-bearing capacity, establish robust risk management mechanisms, and improve production efficiency and quality.

Second, governments should assist enterprises in effectively conducting risk assessments and establish dedicated information platforms to ensure that businesses can promptly access the latest policy information. They should provide enterprises with risk assessment methods and tools to help them identify, evaluate, and manage potential risks. Additionally, governments should deepen trade relations with alternative import source countries and actively diversify market access. Furthermore, they should set up special funds to support green innovation initiatives.

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