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# *Industrial Relocation and Firm Green Innovation: Evidence from National Industrial Transfer Demonstration Zones*

**Yue Wang**

*Department of Economics, Southeast University, Nanjing, China*
*213230790@seu.edu.cn*

***Abstract.*** Against the backdrop of the global green transition, this study examines how regional development strategies influence corporate green innovation. Using the establishment of National Industrial Transfer Demonstration Zones (NIRDZs) between 2010 and 2014 as a quasi-natural experiment, this study employs a multi-period difference-in-differences (DID) model to investigate the impact of industrial transfer policies on green innovation among firms in pollution-intensive industries, along with their underlying mechanisms and heterogeneity. The results show that the policy significantly promotes green innovation among firms in host-regions. Mechanism analysis indicates that the policy promotes green innovation through facilitating the cross-regional mobility of advanced production factors and improving firm specialization. Heterogeneity analysis further reveals that the policy effect is stronger in labor-intensive and technology-intensive firms and in competitive industries, while it is insignificant for capital-intensive firms constrained by high-carbon lock-in. Overall, upgrading industrial transfer from "capacity relocation" to "factor and capability relocation," while promoting firm specialization and differentiated policy support, can better align industrial transfer with green innovation and support coordinated regional green development.

***Keywords:*** industrial transfer, green innovation, factor mobility, specialized division of labor

## 1. Introduction

Amid increasing pressures from climate change and environmental degradation, advancing green transformation has become a key concern for global policymakers. As the world's second-largest economy and a major manufacturing center, China's progress in industrial greening is crucial not only for its own high-quality development but also for global sustainable development. Within this context, firm-level green innovation is widely regarded as a critical pathway to resolving the long-standing tension between economic growth and ecological protection. However, green innovation is often associated with high risk, substantial upfront investment, long payback periods, and strong positive externalities, all of which give rise to market failures. As a result, effective policy intervention is often required to provide incentives for green innovation. Identifying and evaluating macro-level policy instruments that can stimulate firms' green innovation has therefore become an important research issue.

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Industrial relocation has been a central policy tool in China's effort to promote regional coordinated development and optimize the spatial allocation of productive forces. In the past decade, this strategy has been implemented through the establishment of NIRDZs. While this policy has stimulated economic growth in central and western regions, it has also generated complex environmental consequences. Policy implementation areas attract advanced production factors such as capital, technology and skilled labor, but may also undertake more polluting activities, thus putting pressure on governance. This dual effect highlights the need for firms in policy implementation areas to strengthen green innovation to meet emerging challenges. Although extensive research has been done on industrial transfer, most studies have focused on its economic performance or adverse consequences. Whether and how such a major regional development policy can actively induce firm-level green innovation remains insufficiently explored, both theoretically and empirically.

At the same time, although the drivers of green innovation have been extensively studied, existing studies mainly focus on micro-level drivers, and few studies incorporate large-scale structural policies such as industrial transfers into their analytical frameworks. As a result, we know little about the linkage mechanism between regional strategy and micro-firm green behavior, and also make the formulation of relevant policies lack precise evidence support. To address this gap, this study exploits the establishment of NIRDZs in 2010 as a quasi-natural experiment and focuses on firms in pollution-intensive industries. Specifically, this study examines whether the establishment of NIRDZs promotes firms' green innovation, through what mechanisms this effect operates, and whether the policy impact varies across firms with different factor intensities and industries with different levels of market competitions. Answering these questions contributes to the literature on industrial transfer and green innovation and provides policy insights for optimizing industrial transfer policies and promoting coordinated regional green development.

## 2. Literature review

Industrial transfer has been regarded as an important mechanism of regional coordination since then. According to the theory of gradient transfer, the difference of regional economic and technological levels drives the transfer of production factors from high-gradient areas to low-gradient areas. This process is not only the result of the role of market rules, but also an important policy tool for China to promote regional coordination strategy.

From 2010 to 2014, the state successively established 10 national-level industrial transfer demonstration zones, covering the central, western and northeastern regions, aiming to optimize the national industrial layout and promote regional coordination by undertaking industrial transfers from the east. This policy background stems from multiple practical motivations: on the one hand, the eastern region is facing pressures such as rising labor costs, tight land resources, and tightening constraints. "Rising labor costs have become an important driving force for the upgrading of the manufacturing structure" [1]; On the other hand, the central and western regions have gradually become a new choice for firm layout by virtue of their lower factor costs, abundant natural resources and expanding domestic demand market. The strategy of "expanding domestic demand" and "domestic and international dual circulation" has further strengthened the strategic value of the inland market [2]. Meanwhile, the green concept of "lucid waters and lush mountains are golden mountains and silver mountains" is deeply rooted in the hearts of the people, and the differences in the intensity of regulation between regions also provide institutional space for the cross-regional transfer of related industries [3].

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It is worth noting that industrial transfer has two sides. On the one hand, the origin regions can reduce pressure by transferring out pollution-intensive and low value-added industries. On the other hand, the host regions will face the problem of pollution transfer, even if they can attract capital and technology. The pollution haven hypothesis proposed by Copeland and Taylor believes that differences in environmental regulations will induce pollution-intensive industries to move to areas with loose regulations [4]. Evidence from China also shows that some local governments, in order to attract industrial transfer, may lower environmental standards [5]. This behavior may reduce the technology spillover effect and intensify the transfer of pollution. In this context, enterprises in the host regions may face increasing pressure on environmental governance. Therefore, green innovation has become an important way for enterprises to achieve sustainable development.

However, existing literature mostly focuses on the economic effects or environmental externalities of industrial transfer. There are few studies on the impact of industrial transfer on green innovation at the firm level. At the same time, although there are many studies on green innovation, they mainly focus on external institutional factors. For example, ESG disclosure requirements, tax policies [6],and carbon neutrality goals. Besides, they also look at internal governance structures, such as mixed ownership reform and internal control systems [7]. Few studies have included industrial transfer, which is a dynamic and cross-regional structural policy, into the analysis framework.

To fill this gap, this paper uses the establishment of National Industrial Relocation Demonstration Zones (NIRDZs) in 2010 as a quasi-natural experiment. We empirically examine the impact of industrial relocation policies on firms' green innovation and its mechanism. The research results are expected to provide theoretical support for optimizing industrial relocation strategies and promoting green coordinated development.

## 3. Empirical results and analysis

### 3.1. Impact of industrial relocation demonstration zones on firms' green innovation

This study uses the DID method to identify the policy effect. We use green patent applications to measure firm-level green innovation. The baseline model is set as equation (1):

$$Y_{it} = \alpha + \beta(Treat_i \times Post_t) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{1}$$

In this model, $Treat_i$ shows if the firm i is in a demonstration zone. $Post_t$ shows the time after the policy. The coefficient $\beta$ is used to capture the net effect of the policy.

Table 1 shows the baseline regression results. We find that the coefficient of the policy interaction term is significantly positive at the 1% level in all models. This means that industrial relocation can significantly promote green innovation in firms. Model (1) does not include control variables. Models (2) to (4) add firm-level control variables step by step. The estimated effect remains positive and significant in all models.

Table 1. Impact of industrial relocation demonstration zones on firms' green innovation

| Variables | (1)<br>Green innovation | (1)<br>Green innovation | (1)<br>Green innovation |
|---|---|---|---|
| Policy Shock | 0.104*** | 0.098*** | 0.114*** |
| | (0.002) | (0.009) | (0.003) |

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Table 1. (continued)

| | | | |
|---|---|---|---|
| Control variable | NO | NO | YES |
| Constant | 1.165*** | 2.566*** | 2.186*** |
| | (0.018) | (0.201) | (0.433) |
| Fixed Effects | NO | Yes | Yes |
| Observations | 31715 | 31715 | 31487 |
| adj. $R^2$ | 0.567 | 0.414 | 0.429 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

## 3.2. Robustness tests

To make sure the baseline results are reliable, we do robustness tests from two parts: the parallel trend assumption and the estimation method.

First, we use an event-study method to test the parallel trend assumption. We use the year before the policy as the reference. The results show that the coefficients before the policy are not significant. This means the treatment group and the control group have parallel trends in green innovation before the policy. After the policy, the coefficient is significantly positive. And this effect increases with time. This shows the policy effect appears gradually.

Second, to solve the potential bias of the two-way fixed effects estimator when treatment times are different, we use the Callaway and Sant'Anna (2021) CS-DID estimator [8]. As shown in Table 2, the estimated dynamic ATT is 0.292. It is still significant at the 1% level. This result is highly consistent with the baseline results. It further supports the robustness of the core findings.

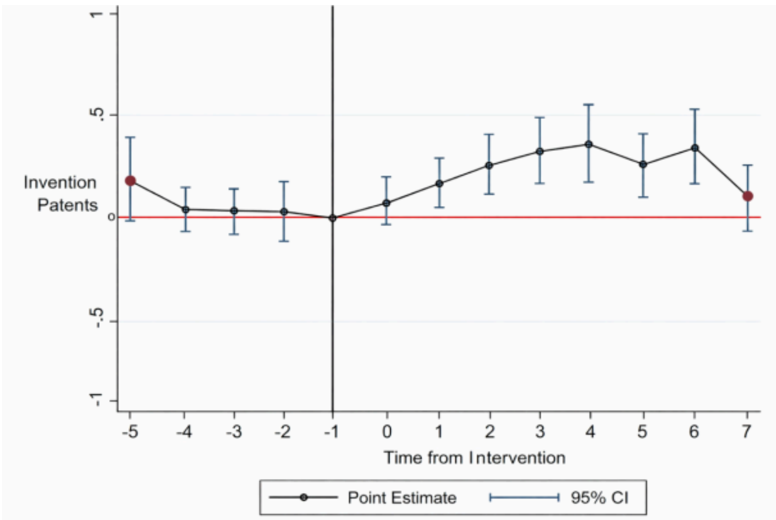


Figure 1. Parallel trend test

Table 2. Heterogeneous treatment effects

| | (1) | (1) |
|---|---|---|
| | Stacked DID | CS-DID |
| Variables | Patent Count | Patent Count |

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Table 2. (continued)

| | | |
|---|---|---|
| Policy Shock | 4.970*** | |
| | (0.083) | |
| ATT | | 0.292*** |
| | | (0.087) |
| Observatios | 153,238 | 5710 |
| adj. $R^2$ | 0.327 | |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

### 3.3. Mechanism analysis

The baseline results prove that the NIRDZs have promoted green innovation significantly. To reveal the internal mechanism, based on the theory of industrial organization and innovation economics, this study tests two paths: factor flow and the promotion of firm specialization.

#### 3.3.1. Factor mobility mechanism

Industrial transfer includes not only the spatial transfer of production capacity, but also the reallocation of advanced factors like capital, technology, and human resources. Demonstration zones promote factor flow and technology spillover by removing institutional barriers and improving infrastructure.

To test this mechanism, we construct a proxy variable for firm-level technology factor liquidity and interact it with policy variables. As shown in column (1) of Table 3, the interaction term is significantly negative at the 5% level. This means the policy has accelerated the inflow of technological elements to host country firms. After controlling the direct effects of technology flow, part of the policy effects are absorbed. This causes the interaction coefficient to be negative.

Besides, we use the reciprocal of labor allocation efficiency (labor distortion) as a proxy for firm specialization. A lower value means higher specialization. Column (2) of Table 3 shows that the interaction term between labor distortion and the policy shock is significantly positive at the 1% level. But the main effect of labor distortion is significantly negative. This means that under the demonstration zone policy, improvements in labor allocation efficiency generate a positive marginal effect on green innovation.

#### 3.3.2. Specialization and vertical integration mechanism

According to the division of labor theory, higher specialization allows firms to internalize the R&D and production of green technologies. This reduces market failures and increases returns on innovation. In industrial transfer, leading firms often relocate with their partners to form clusters.

This study measures the degree of vertical division of labor to capture vertical integration. As shown in column (3) of Table 3, policy shocks have significantly enhanced the vertical integration of firms. Combined with theory, this structure is good for planning the green production process and integrating innovation resources. It provides a solid organizational foundation for green innovation.

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Table 3. Mechanism tests

| | (1) | (2) | (3) |
|---|---|---|---|
| | Patent Count | Patent Count | Specialization |
| Technology Flow*Policy Shock | -0.125** | | |
| | (0.044) | | |
| Technology | 0.004 | | |
| | (0.013) | | |
| Labor Distortion*Policy Shock | | 0.286** | |
| | | (0.105) | |
| Labor Distortion | | -0.080* | |
| | | (0.034) | |
| Policy Shock | 1.897 | -1.507** | 0.210** |
| | (1.144) | (0.552) | (0.074) |
| Controls | Yes | Yes | Yes |
| Fixed Effects | Yes | Yes | Yes |
| Constants | 0.337** | 0.794*** | 1.280*** |
| | (0.130) | (0.225) | (0.166) |
| Observations | 31487 | 31487 | 42372 |
| adj. $R^2$ | 0.235 | 0.342 | 0.599 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

### 3.4. Heterogeneity analysis

The effect of the policy may be different across firms. So, we do heterogeneity analysis from two dimensions: factor intensity and industry competition.

#### 3.4.1. Factor intensity

Firms with different factor intensities are different in resource endowment and innovation constraints. Table 4, columns (1) and (2) show that the policy promotes green innovation in labor-intensive and technology-intensive firms significantly. Both are significant at the 5% level or higher. But the impact on capital-intensive firms is not significant.

For labor-intensive firms, although they have thin profit margins, the technology spillover from industrial transfer forms a strong reverse force. This forces them to improve green processes. Technology-intensive firms have strong R&D capabilities. The collaborative innovation ecology in the demonstration area is highly compatible with their needs. This realizes the multiplier effect of a strong alliance.

In contrast, capital-intensive firms often fall into the high carbon lock-in. Due to their huge sunk costs and production inertia, green transformation faces significant resistance. This weakens the policy incentive effect.

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### 3.4.2. Industry competition

Market competition plays a crucial role in corporate behavior. We divide the sample into competitive and non-competitive industries [9]. The results in Table 4 columns (3) and (4) show that the policy promotes green innovation in competitive industries at the 5% level. But the effect is not significant in non-competitive industriesa.

This contrast highlights the role of market discipline. For firms in competitive pressure, the need to survive drives them to innovate. In non-competitive settings, the absence of pressure dampens motivation. These firms rely more on administrative requirements and are less capable of responding to market-based policy signals.

Table 4. Heterogeneity analysis

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Capital-intensive | Labor-intensive | Competitive Industries | Non-competitive Industries |
| Policy Shock | 0.265 | 0.100* | 0.311* | 0.662 |
| | (0.239) | (0.040) | (0.129) | (0.790) |
| Controls | Yes | Yes | Yes | Yes |
| Fixed Effects | Yes | Yes | Yes | Yes |
| Constant | 0.907*** | 1.288*** | 3.199*** | 1.230*** |
| | (0.107) | (0.203) | (0.440) | (0.333) |
| Observations | 15851 | 15864 | 24518 | 7336 |
| adj. $R^2$ | 0.274 | 0.248 | 0.021 | 0.026 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

## 4. Conclusion and policy implications

### 4.1. Conclusion

Since this study deals with pollution-intensive industries and treats the NIRDZs established since 2010 as a quasi-natural experiment, it is able to systematically analyze the impact, mechanisms, and heterogeneous effects of industrial transfer policies on firm green innovation, and hence it arrives at clear, well-supported conclusions.

First, the establishment of NIRDZs has clearly and convincingly promoted green innovation in host regions, and since the main result has survived all the relevant robustness tests, it is reasonable to conclude that industrial transfer is both a means of optimizing the spatial allocation of productivity and a powerful tool for inducing host firms to go green.

Second, the policy can naturally and clearly be analyzed through the twin mechanisms of cross-regional factor flow and firm specialization: the demonstration zones offered preferential policies and made infrastructural improvements that reduced the institutional costs of the cross-regional flow of high-level production factors such as technology and talent, hence accelerating technology spillovers and knowledge diffusion, and giving local green innovation activities a strong, favorable impetus. More importantly, the cluster migration of the industrial chain improves labor allocation efficiency and vertical integration, enabling firms to internalize green R&D and application processes directly, thus neatly addressing market failures.

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The third point made is very clear and well organized: the effects of the industrial transfer policy are manifestly heterogeneous, with the positive effects accruing mainly to labor-intensive and technology-intensive firms, whereas the impact on capital-intensive firms is effectively zero because of the high carbon lock-in effect. Moreover, the policy strongly encourages green innovation in competitive industries, but in non-competitive industries, lack of market pressure undermines the endogenous incentives of firms and thus limits their policy responsiveness.

## 4.2. Policy implications

Based on these findings, we propose the following policy recommendations:

First, actively promote the upgrading of industrial transfer from "capacity undertaking" to "factor and capacity undertaking." Therefore, future construction of demonstration areas should go beyond simple factory relocation and instead aim at building an ecosystem capable of attracting, integrating, and utilizing advanced factors such as green technology, high-end talent, and innovative capital. Local governments should accordingly optimize the business environment, strengthen intellectual property protection, and construct industry - university - research cooperation platforms, so that the inflow of factors can truly be converted into green innovation capabilities for local firms.

The second point is very clear: to improve the level of specialization and integration in order to lay a solid organizational foundation for green innovation, therefore policies should encourage firms to optimize resource allocation and concentrate on their core competitiveness, while actively supporting leading firms in coordinating the relocation of upstream and downstream partners to form integrated green industrial clusters that combine R&D, manufacturing, and application. Such a division of labor and integrated layout naturally becomes the best guarantee for firms to invest in green innovation and achieve commercialization.

Carry out precise, differentiated support measures, because a "one-size-fits-all" approach is not to be adopted. For labor-intensive firms, subsidies for green skills training and process transformation can be provided; for technology-intensive firms, support for basic research and development should be strengthened; for capital-intensive firms facing transformation difficulties, market-oriented instruments such as stricter regulations and carbon pricing should be employed. More importantly, it is necessary to deepen market-oriented reforms, break administrative monopolies, and introduce effective competition, especially in non-competitive sectors, so as to fully stimulate the endogenous motivation for green innovation among all market players.

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