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# *Environmental Regulations and Left-behind Children*

**Qirui Wang**[1,a,*]

[1]*Department of Economics, Henan University, Kaifeng, China*
*a. wqruby@henu.edu.cn*
**corresponding author*

***Abstract:*** Environmental regulation is the enactment of a series of laws and regulations by the government that require companies or individuals to reduce emissions of hazardous substances and greenhouse gases. This study finds that strong implementation of environmental regulatory policies may increase the number of children left behind. The intrinsic mechanism may be that the policy forces enterprises to adjust in their business strategies, which increases the uncertainty of the life and employment of migrant workers and leads to their tendency to keep their children in their hometowns. This study utilizes data from the China Industrial Enterprise Database, China Urban Statistical Yearbook, China Family Tracking Survey (CFPS), China Migrant Population Dynamics Survey (CMDS), and China Labor Dynamics Survey (CLDS). The study employs regression models to conduct econometric analyses, illustrating the positive correlation between the effectiveness of urban environmental regulation policies and the prevalence of left-behind children. It is hoped that more thoughts will be brought to the left-behind children issue.

***Keywords:*** Environmental regulations, left-behind children, migrant worker.

## 1. Introduction

Environmental regulation generally encompasses a range of government-implemented laws and policies aimed at reducing emissions of hazardous substances and greenhouse gases, addressing issues of environmental pollution and climate change [1]. For instance, the United States' Inflation Reduction Act offers significant financial incentives for investments in clean energy and green technologies [2]. Similarly, Canada's Climate Action Plan introduces a new carbon pricing policy to further support green energy initiatives, while China's carbon emissions trading market seeks to manage and reduce greenhouse gas emissions through market-based mechanisms.

In response to these regulatory changes, firms and individuals often adjust their practices, which can influence the labor market as well [3]. The most immediate effect is on production costs for companies. Some researchers suggest that environmental regulations increase production costs, which may lead to reduced profits and fewer job opportunities as firms cut back on hiring to manage expenses [4]. Conversely, other studies propose that such policies can have a positive effect on employment [5]. Firms may require additional skilled workers to adapt and enhance their production processes, and improved environmental conditions in certain regions could attract labor inflows. The impact of these regulations on the labor market varies depending on the region and the intensity of policy enforcement, leading individuals to weigh their options and make migration and residence decisions based on the relative costs and benefits in different areas.

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The literature on the impact of environmental regulatory policies on labor mobility across regions has focused on the following perspectives: Firstly, strict policies make urban environments more livable. People do not want to live in cities with high levels of environmental pollution, which is detrimental to physical and mental health and increases health costs [6]. Secondly, firms are pressured by the policy to innovate more environmentally friendly production techniques, which attracts technicians to join them [7]. Thirdly, firms move to cities with less stringent policies to reduce environmental costs, which in turn leads to the relocation of some of their employees [8]. This literature focuses mainly on the mechanism of the impact of environmental regulatory policies on labor mobility, focusing on the spatial and inter-industry flow of labor, but lacks in-depth exploration of the impact on specific groups of migrants, as well as on their family members, especially their offspring. Specifically, there is a complete lack of literature on migrant workers, who make up a large proportion of those employed in the manufacturing and construction industries, and their related groups of left-behind children.

This paper seeks to address the existing gap in research by investigating how environmental regulatory policies impact the issue of children being left behind. It aims to provide a thorough analysis of how these policies affect different groups, offering a detailed view of the varying influences on diverse populations. In addition, the study will explore the underlying mechanisms through which environmental regulations impact left-behind children. This includes examining how these policies might alter migration patterns, household structures, and economic conditions, thereby contributing to the increased number of children left behind. By uncovering these processes, the research intends to offer insights into the broader consequences of environmental regulations. The goal is to provide actionable recommendations for policymakers, helping them to design environmental policies that not only achieve ecological objectives but also address potential negative effects on vulnerable groups. This approach aims to support the development of more nuanced and effective policies that balance environmental goals with the well-being of affected communities.

## 2. Background and Model Design

The Chinese government classifies migrant workers as individuals with rural household registrations who have been employed in non-agricultural sectors or away from home for six months or more within a year [9]. The primary environmental regulations, which impose specific pollution emission limits, have a significant impact on industries with high energy consumption during production, such as manufacturing and construction [10]. These sectors generally do not require high educational qualifications for employment, making them a major source of job opportunities for workers with lower skill levels. Consequently, many migrant workers with rural household registrations find employment in these fields. Data from the National Bureau of Statistics of China's Migrant Worker Monitoring Survey Report for 2013-2023, as shown in Table 1, indicates that manufacturing and construction have consistently had the highest proportion of migrant workers, with their share remaining relatively stable over time.

Table 1: Mean value and average rate of change of the share of employment of migrant workers in various industries(2014-2023.

| | Mean | Average rate of change of the share |
|---|---|---|
| Agriculture | 0.47 | -0.22 |
| Manufacturing | 28.74 | -0.21 |
| Construction | 18.97 | 0.12 |
| Wholesale and retail trade | 12.2 | 0.71 |
| Transportation, storage and postal services | 6.71 | 0.98 |

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Table 1: (continued).

| | | |
|---|---|---|
| Accommodation and catering | 6.32 | -0.18 |
| Residential services repair and other services | 11.65 | -0.21 |

Data source: the National Bureau of Statistics of China, Migrant Worker Monitoring Survey Report.

In 2023, the total number of migrant workers in this demographic was 29,753,000, with an average age of 43.1 years. Among this group, 44.6% were 40 years old or younger, 24.8% were between 41 and 50 years old, and 30.6% were over 50 years old. The demanding nature of their work, characterized by long hours and relatively lower incomes compared to the national average, poses significant challenges for balancing their work and family responsibilities. This economic strain, coupled with the geographical distance from their home regions, often results in difficulties in providing adequate care and support for their families. Consequently, many migrant workers are compelled to leave their children and elderly parents behind in their places of origin. This situation contributes to a substantial number of children being left behind, as their parents work away from home to sustain their livelihoods [11]. The combination of long working hours, lower wages, and the physical separation from their families underscores the need for targeted policies to address the welfare of both migrant workers and the children left behind.

Left-behind children typically refer to those in rural areas who are separated from both parents simultaneously. This issue has deep roots in China's history, becoming particularly pronounced during the last century when the country underwent extensive urban construction efforts. Many individuals who previously lived in rural or peri-urban areas relocated to cities in search of better job opportunities, higher wages, and improved living conditions [12]. However, the instability of income and living conditions in the cities often prevents these migrants from bringing their children along, leading them to leave their children behind in their hometowns. This problem has been exacerbated by the growing disparity between urban and rural development, resulting in an increasing number of left-behind children. The consequences of this phenomenon are profound and multifaceted. As of 2018, 51% of school-age children with rural household registrations were left-behind, highlighting the scale of the issue. These children often miss out on parental guidance and are typically cared for by elderly grandparents. This lack of parental involvement can impact their mental and physical health, as well as their educational attainment, causing them to fall behind their peers in various aspects. In the long term, the presence of left-behind children can undermine societal stability and security. It also has implications for China's economic development and income distribution. On one hand, these children's future contributions to the labor force may be diminished, affecting the nation's human capital accumulation. On the other hand, the growing human capital divide between urban and rural areas may further impede their opportunities to realize their potential and improve their socioeconomic status.

## 2.1. Data

The data used in this research are drawn from a range of important sources: the China Industrial Enterprises Database (CIED), which provides detailed information on industrial enterprises; the China Urban Statistical Yearbook, offering comprehensive urban statistics; the China Household Tracking Survey (CFPS), which tracks household dynamics and economic conditions; the China National Migrant Population Dynamics Surveillance (CMDS), which monitors migration patterns and their effects; and the China Labor Force Dynamics Survey Data (CLDS), which details labor force trends and employment issues. By integrating these diverse datasets, the study aims to present a nuanced analysis of the implementation strength of environmental regulation policies, examining how these policies are enforced and their effects across various economic sectors and geographic

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regions. This approach allows for a thorough evaluation of policy impacts and effectiveness in different contexts.

### 2.1.1. Strength of Environmental Regulation Policy Implementation

This study follows the general approach outlined for constructing environmental regulation indicators, utilizing two specific metrics: the industrial sulfur dioxide removal rate and the industrial fume (dust) removal rate [9]. The underlying data for these indicators, including industrial sulfur dioxide emissions, industrial smoke (dust) emissions, as well as the removal rates for sulfur dioxide and smoke (dust), are sourced from the China Urban Statistical Yearbook published by the National Bureau of Statistics of China. This dataset, compiled by Chinese city governments, provides a reliable and precise account of industrial emissions and regulatory performance.

### 2.1.2. Industrial Sulfur Dioxide Removal and Industrial Smoke Dust Removal

Because the government statistics of industrial sulfur dioxide removal and industrial smoke (powder) dust removal after 2010 data are missing, while industrial sulfur dioxide emissions and industrial smoke (powder) dust emissions data are relatively complete, this paper uses industrial sulfur dioxide emissions and industrial smoke (powder) dust emissions data to calculate the removal rate, i.e., using the emissions of class m pollutants in city j in year t (t>1) minus the emissions of class m pollutants in city j in year t+1, and then divide by the emissions of class m pollutants in city j in year t+1. emissions, and then divided by the emissions of city j category m pollutants in year t. The formula in this paper is as follows.

$$Pollutant_{jm} = \frac{Pollutant_{jm}^{t} - Pollutant_{jm}^{t-1}}{Pollutant_{jm}^{t-1}} \tag{1}$$

### 2.1.3. Standardized indexes

The standardized indexes are calculated according to the general method [9]. $Pollutant_{jm}$ denotes the original value of the indicator of the removal rate of m pollutants in city j, $max(Pollutant_m)$ and $min(Pollutant_m)$ denote the maximum and minimum values of each indicator in all cities respectively, and $Pollutant_{jm}^{s}$ is the standardized indicator of the removal rate of industrial sulfur dioxide and industrial smoke (dust).

$$Pollutant_{jm}^{s} = \frac{Pollutant_{jm} - min(Pollutant_m)}{max(Pollutant_m) - min(Pollutant_m)} \tag{2}$$

The variables related to the strength of environmental regulation policy implementation in this paper after treatment are presented in Table 2.

Table 2: Summary of strength variables.

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| city | 1533 | 149.406 | 85.259 | 1 | 296 |
| year | 1533 | 3.877 | 2.153 | 1 | 8 |
| ln $so^2$ | 1533 | 7.24 | .631 | 3.434 | 8.582 |
| ln smoke | 1533 | 7.003 | .929 | 1.099 | 7.976 |
| change percent $so^2$ | 1533 | 1.672 | 3.111 | -7.514 | 11.475 |
| change percent smoke | 1533 | -2.274 | 28.69 | -620.02 | 100 |
| standardized $so^2$ | 1527 | .43 | .377 | 0 | 1 |
| Standardized smoke | 1527 | .55 | .362 | 0 | 1 |

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#### 2.1.4. Left-behind Children

The data concerning left-behind children used in this study are sourced from China's National Migrant Population Dynamics Survey (CMDS). This survey provides comprehensive information on the personal and household circumstances of interviewed migrant workers. For this analysis, the study selected samples based on specific criteria: individuals whose household registration is in a rural area, who are eighteen years old, and who currently reside in their place of household registration. The paper then matched these samples with data on the strength of environmental regulation policy implementation across various cities from 2011 to 2018. Additionally, the study paid particular attention to information about the parents of these left-behind children due to the significant impact parental circumstances have on the children's well-being. The distribution of the samples used in this analysis is detailed in Table 3.

Table 3: The distribution of samples in CMD.

| Type of household | Freq. | Percent | Cum. |
|---|---|---|---|
| Rural household | 104504 | 68.75 | 68.75 |
| Non-Rural household | 20736 | 13.64 | 82.39 |
| From rural household to residential | 20283 | 13.34 | 95.74 |
| From non-rural household to residential | 3335 | 2.19 | 97.93 |
| Residential household | 3088 | 2.03 | 99.96 |
| Others | 54 | 0.04 | 100.00 |
| Total | 152000 | 100.00 | |

### 2.2. Variable Description

In this paper, the data has been processed to remove invalid data. The following are some important variables in this paper. The year of migrant workers' migration is taken as the main time variable, labeled as mig_1, to filter out people who have migrated during 2011-2018. Grouped by cities, the number of left-behind children in each city for the corresponding year is labeled chn_left, and the total number of children of migrants is labeled total count. their ratio is labeled proportion_left, which is the main dependent variable in this paper. In this paper, the product of standardized sulfur dioxide and dust removal rates is used as an interaction term to combine their effects.

### 2.3. Control Variable

Because of the complexity of the factors affecting left-behind children, this paper lists several variables that may affect the results. The first is the level of economic development of the migrant workers' inflow area. A higher level of economic development means more job opportunities, better educational resources, and a better living environment, which may affect the family’s decision of whether to accompany the left-behind children. This is followed by the children's attributes, such as age and gender. Older children may be left behind in their hometowns as they are perceived to have better survival ability, while girls tend to be neglected or even forgotten by their parents due to the patriarchal attitudes common in rural areas. This paper labels these two variables as ch_age and ch_gender and calculate the corresponding values using principal component analysis to produce the variable Z_1.

Also, there are parental and family factors. The study take parents' education level, age, whether they are ethnic minorities, whether they join political parties, their willingness to stay in their current residence, and their marital status. The reason is very simple, these factors can greatly affect the

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parents' perceptions and thus the status of the children left behind. At the same time, the paper add family income, whether the parents are employed, the number of children in the family, and the number of hours the parents work. the family's economic income is an important reference for the family's decision-making. Parents' working hours also determine whether they have time to spend with their children. This study took the above variables and used principal component analysis to generate a covariate Z_2. Main variables are listed in Table 4.

Table 4: Main Variables.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Province | 715 | 17.176 | 7.516 | 1 | 32 |
| City | 715 | 159.649 | 97.152 | 2 | 345 |
| mig_1 | 715 | 2014.404 | 2.247 | 2011 | 2018 |
| proportion_left | 715 | .489 | .337 | 0 | 1 |
| multiply | 715 | .255 | .306 | 0 | 1 |
| Z1 | 715 | 0 | 1.007 | -1.773 | 2.072 |
| Z2 | 715 | 0 | 1.261 | -4.158 | 4.236 |
| ezone | 715 | .34 | .474 | 0 | 1 |

## 3. Analysis

### 3.1. Fixed Effect Analysis

This study first utilizes a fixed-effects model to control for provincial-level differences. This method helps to manage various influencing factors by accounting for the covariate Z1, which pertains to individual child characteristics, and the covariate Z2, which relates to individual parent characteristics. Additionally, the model adjusts for the economic development level of each region. By incorporating these controls, the fixed-effects model allows us to isolate the impact of the primary variables of interest more precisely, reducing potential confounding effects and ensuring that the results reflect the true relationships between the variables under investigation. This approach enhances the robustness and accuracy of the findings.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_{1it} + \beta_3 Z_{2it} + \beta_4 ezone_{it} + \alpha_i + \epsilon_{ijk} \quad (3)$$

Since the effects of the policy are observed with a time lag, the study adjust y to reflect the lagged value of the proportion of children left behind by one period. This adjustment accounts for the delayed impact of environmental regulation policies. The model analysis indicates that the results are notably significant, showing a positive association between the stringency of environmental regulation policy implementation and the number of children left behind. This finding supports the study's initial hypothesis. The detailed results from the model are outlined in Table 5, which provides a thorough presentation of the analyzed data and its implications.

Table 5: Results of fixed effects model analysis.

| y_lag1 | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| multiply | .1 | .049 | 2.06 | .04 | .005 | .196 | ** |
| z1 | .023 | .016 | 1.39 | .166 | -.009 | .055 | |
| z2 | .007 | .013 | 0.55 | .581 | -.018 | .033 | |
| ezone | 0 | . | . | . | . | . | |
| Constant | .485 | .018 | 26.64 | 0 | .449 | .521 | *** |

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Table 5: (continued).

| | | | |
|---|---|---|---|
| Mean dependent var | 0.509 | SD dependent var | 0.312 |
| R-squared | 0.325 | Number of obs. | 363 |
| F-test | 2.059 | Prob > F | 0.105 |
| Akaike crit. (AIC) | 47.728 | Bayesian crit. (BIC) | 63.306 |

*** p<.01, ** p<.05, * p<.1

## 3.2. Mixed-Effect Analysis

To ensure greater reliability of the results, the paper implemented a mixed-effects modeling approach. This involved adjusting y to reflect the value of one period lagged, thus accounting for the delayed effects of the policy. The study also controlled for various covariates, including Z1 (individual child characteristics), Z2 (individual parent characteristics), and ezone (regional economic conditions) simultaneously.

Our analysis was conducted at both provincial and city levels. This multi-level approach allows us to capture potential variations and detailed impacts of environmental regulation policies across different geographic contexts. By employing mixed effects modeling, the study were able to address both fixed and random effects, thereby providing a more comprehensive and accurate understanding of how policy implementation influences the number of children left behind.

$$Y_{ijk} = \beta_0 + \beta_1 X_{ijk} + \beta_2 Z_{1ijk} + \beta_3 Z_{2ijk} + \beta_4 ezone_{ijk} + \mu_{proince(i)} + \mu_{city(i,j)} + \epsilon_{ijk} \quad (4)$$

The analysis revealed highly significant findings, confirming the hypothesis that more intense environmental regulation correlates with an increase in the number of children left behind. This suggests that stricter environmental policies may contribute to higher numbers of children being left behind, potentially due to factors like increased migration or shifts in family dynamics.

The mixed effects model used in this study provides a thorough examination of these relationships by accounting for both fixed and random effects. This approach offers a nuanced understanding of how variations in environmental regulation impact the number of children left behind. For a comprehensive view of the findings and their implications, in Table 6, which details the results of the mixed effects analysis.

Table 6: Results of mixed effects model analysis.

| y_lag1 | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| multiply | .107 | .039 | 2.78 | .005 | .032 | .183 | *** |
| z1 | .016 | .013 | 1.29 | .197 | -.009 | .041 | |
| z2 | -.006 | .01 | -0.62 | .537 | -.026 | .014 | |
| ezone_develop | .141 | .074 | 1.90 | .058 | -.005 | .286 | * |
| Constant | .391 | .042 | 9.37 | 0 | .309 | .472 | *** |
| Constant | .016 | .009 | .b | .b | .005 | .047 | |
| Constant | .053 | .01 | .b | .b | .036 | .078 | |
| Constant | .036 | .003 | .b | .b | .03 | .043 | |
| Mean dependent var | | 0.509 | | SD dependent var | | 0.312 | |
| Number of obs | | 363 | | Chi-square | | 14.565 | |
| Prob > chi2 | | 0.006 | | Akaike crit. (AIC) | | 60.271 | |

*** p<.01, ** p<.05, * p<.1

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## 4. Conclusion

The intensified enforcement of environmental regulatory policies may result in a rise in the number of children left behind. When policies are implemented rigorously, many businesses face challenges in quickly adopting cleaner production technologies, leading them to relocate operations to reduce production costs. Companies struggling to remain competitive are often compelled to move, and employees, driven by risk aversion, may choose to follow their employers to new locations. This increased labor mobility can disrupt family structures, as the uncertainty surrounding parental employment and career stability influences family decision-making.

In such scenarios, parents are more likely to leave their children behind in their original homes under the care of elderly relatives. This tendency stems from the difficulties associated with relocating children and maintaining stable family care amidst the upheaval caused by job changes. Consequently, the number of left-behind children may increase as families adjust to the new realities imposed by environmental regulations.

Conversely, firms that successfully implement technological upgrades to meet regulatory standards might reduce their dependence on human labor. This shift can lead to job losses among certain segments of the labor force, particularly for workers who are less adaptable or who lack the skills to transition into new roles. Thus, while technological advancements might enhance environmental performance, they can also contribute to higher unemployment rates among displaced workers, further impacting family dynamics and potentially increasing the number of children left behind.

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