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Environmental Regulation and Structural Employment Imbalances

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Abstract: As China pursues the goal of "dual-carbon" together with implementing an employment-first strategy, labor reallocation across industries has become a key structural challenge and tendency. Using panel data from 31 Chinese provinces during 2008–2020, this study measures structural employment imbalance by constructing the Lilien index and testing environmental regulation through environmental keyword frequency in provincial government reports. The results show that lagged environmental regulation significantly reduces the Lilien index. The finding highlights the positive conditional employment effects of green transition and provides theoretical guidance for coordinating carbon reduction with employment stability.

Keywords: Environmental regulation; Structural employment imbalances; Lilien index; High-carbon industries

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1. Introduction

Employment has always been a critical part of the policy trade-off between economic transformation and social stability. As the Chinese economy develops toward carbon neutrality, stricter environmental regulation accelerates the transformation of high-carbon industries and the release of labor from shrinking sectors, while it is possible that emerging industries may not be able to fully absorb these workers immediately. Differences in employment growth across industries can therefore create reallocation friction even when total employment changes remain small.

Existing studies mainly focus on environmental regulations' effects on aggregate employment. While the compliance-cost view suggests that regulation raises production costs, reduces output, and destroys jobs [1-4], the Porter hypothesis argues that appropriate regulation stimulates innovation and may generate new employment [5-7]. Empirical evidence remains mixed. One reason is that aggregate employment indicators conceal substantial cross-industry reallocation. Stable total employment can coexist with massive unemployment in individual industries [8-14].

This paper addresses these gaps by constructing provincial panel data of 31 Chinese regions from 2008 to 2020. It focuses on structural reallocation friction and explores the mechanism between environmental regulation, high-carbon employment, and sectoral employment dispersion.

2. Literature review

Research on the employment effects of environmental regulation has developed around two competing arguments. Compliance-cost theory reckons that regulations tend to lead to the rise of firms' costs, the reduction of production, and the decline of labor demand [1-4]. The Porter hypothesis suggests that regulations are able to encourage technological innovation and improve productivity, which will at least partly offset compliance costs [5-7]. Existing studies find complex outcomes consisting of negative, positive, nonlinear, and sector-specific effects [15-18]. Chinese evidence similarly reports threshold effects, double dividends, and substantial industrial heterogeneity [19-21].

Aggregate employment measures, however, do not reveal the reallocation process for the time being. The Lilien index, brought forward by Lilien (1982), captures the weighted dispersion of employment growth across industries [22]. A higher value of the Lilien index indicates greater sectoral divergence and potentially stronger structural unemployment risk.

Employment reallocation often happens among manufacturing as well as industries experiencing technological and structural change [23-24]. Environmental regulation can affect such reallocation through changing firms' production decisions, industry employment demand, and the speed of capacity adjustment [25-29].

3. Research design

3.1. Data

The study uses panel data from 31 provincial-level administrative units (excluding Hong Kong, Macao, Taiwan, and Xizang due to data availability) over 2008–2020, yielding 403 provincial-year observations.

Three considerations should be noted. First, China's industry classification standards (GB/T 4754-2002, -2011, -2017) were revised repeatedly; around 2006–2007 the industry employment statistics changed abruptly, causing abnormal early Lilien values, so we start in 2008 (2007 serves only as the growth-rate base year and is excluded from regression). Second, by 2008 the Eleventh Five-Year Plan had made major pollutant reduction a mandatory local performance target, making provincial regulation comparable. Third, the 2020 COVID-19 shock and the advent of the "dual carbon" goals changed the institutional environment, so the sample ends in 2020.

The data on urban-unit employment by industry comes from provincial statistical yearbooks; the regulation indicator is built by manual word segmentation of provincial government work reports; other controls are from the China Statistical Yearbook and provincial yearbooks. Following the NBS crosswalk, industry categories across versions are consolidated into 19 comparable groups to ensure time consistency of employment data.

3.2. Model specification

To identify the baseline effect of one-period lagged environmental regulations on structural employment imbalances, a province-level fixed-effects panel model is constructed:

$$\text{Lilien}_{it} = \alpha + \beta \cdot \text{envRegLag}_{it} + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where X_{it} is the vector of control variables, μ_i is the province-specific fixed effect, and ε_{it} is the random error term; standard errors are clustered at the provincial level to address within-group serial correlation.

3.3. Variable definition

The Lilien index of Lilien (1982) measures inter-industry reallocation friction and is widely used in research on regional labor reallocation. It is computed as follows:

$$\text{Lilien}_{it} = \sqrt{\sum_j s_{ijt} \times \left(g_{ijt} - g_{it}\right)^2}$$

In the formula, s_{ijt} represents the share of employment in a particular industry within urban units of a province in year t relative to the total urban unit employment in that province; g_{ijt} is the employment growth rate of the industry, and g_{it} is the overall employment growth rate across all industries in the province.

The Lilien index captures only the dispersion of sectoral employment growth, and its labor-market effect is state-dependent: equally large reallocation shocks can imply different unemployment outcomes under different macro conditions[8]. We therefore complement the index with heterogeneity analysis. Crucially, whether narrower dispersion actually eases friction depends on whether displaced workers are absorbed elsewhere; the heterogeneity analysis below directly examines this conditionality.

Following Chen Shiyi and Chen Dengke (2018) [30], we measure regulation by the relative frequency of environmental keywords, including “environmental protection”, “pollution control”, “energy conservation and emissions reduction”, “green development”, “ecological construction” and “low-carbon”—in provincial government reports, expressed as keyword occurrences per total word count. As a pre-policy signal, this measure is distinct from ex post input indicators such as pollution-control investment and is unaffected by local fiscal capacity.

Government reports are issued at the start of the year, while firm adjustment and labor reallocation take time; lagging the explanatory variable also eases reverse causality. The baseline therefore uses one-period lagged regulation.

Following Li Mengjie and Du Weijian (2014) [31], Wang Feng and Ge Xing (2022) [32], we include seven controls:

(1) lnGdp, the log of regional GDP per resident;
(2) edu, average years of schooling for those aged six and above, weighted by educational attainment;
(3) indStr, secondary-industry value added as a share of GDP;
(4) open, total trade as a share of GDP;
(5) urban, urban share of resident population;
(6) fiscal, local general public budget expenditure as a share of GDP;
(7) rd, internal R&D expenditure as a share of GDP.

4. Empirical results and analysis

4.1. Benchmark regression

To test H1, we estimate a province fixed-effects model with province-clustered standard errors. Results appear in **Table 1**.

Table 1. Benchmark regression results

Variable	(1) Current period effect	(2) One-period lag effect
envReg	-0.700 (0.469)	
envRegLag		-0.958** (0.459)
lnGdp	0.046* (0.026)	0.038 (0.031)
edu	0.030** (0.015)	0.034** (0.016)
indStr	0.030 (0.112)	0.052 (0.123)
open	0.099*** (0.027)	0.108** (0.040)
urban	-0.325**(0.143)	-0.271 (0.162)
fiscal	0.005 (0.081)	-0.022 (0.087)
rd	0.683 (1.261)	0.389 (1.299)
Observation	403	372
R^2	0.069	0.061

Note: Standard errors in parentheses are cluster-robust at the provincial level; *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. All regressions control for provincial fixed effects.

In model (1), current regulation is insignificant; in model (2), one-period lagged envRegLag is -0.958, significantly negative at the 5% level. The insignificant contemporaneous but significant lagged effect reflects the policy-transmission lag: annual announcements take time to reach firm cost assessment, output adjustment, and cross-sector reallocation; lagging also mitigates reverse pressure from structural employment on local policy. Economically, a one-standard-deviation rise in regulation lowers the Lilien index by about 7.1% of its mean. Given that the index captures short-run sectoral fluctuations and low within-group R^2 is typical in such studies, we focus on the sign and significance of the key coefficient.

Lag-structure tests concentrate the effect at the one-period lag: envRegLag2 falls to -0.730 and becomes insignificant, and envRegLag3 to -0.398, also insignificant—a monotonic decay consistent with the annual release of work reports and within-year firm adjustment, suggesting the baseline picks up genuine policy effects rather than persistent omitted-variable bias.

4.2. Robustness check

Robustness checks use proxy substitution, added confounders, excluded alternatives, and sample adjustments.

Table 2. Robustness test results

Test Type	envRegLag coefficient	Standard error	Observation	Conclusion
Replace X with the intensity of pollution control investment	-4.365***	1.284	368	Stable
Control for the advanced industrial structure index	-0.978**	0.459	372	Stable
Control for interprovincial population mobility	-0.950**	0.465	372	Stable
Exclude the total unemployment channel	-0.958**	0.459	372	Stable
Exclude western provinces	-1.791***	0.555	228	Stable
Exclude the three northeastern provinces	-0.839	0.497	336	Not significant
Exclude years of financial crisis	-1.478**	0.580	341	Stable
Expand the sample range	-0.397	0.352	496	Not significant

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. All regressions control for provincial fixed effects and covariates. Western provinces are excluded based on the standard 12-province definition (including Chongqing, Sichuan, and

Shaanxi). Sensitivity analyses of fixed effects—including two-way fixed effects and region-year trends are not included in the robustness assessment presented here.

First, replacing the keyword-frequency indicator with lagged pollution-control investment intensity produces a significantly negative coefficient of -4.365. The result is therefore not driven solely by the measurement of policy attention.

Second, adding an industrial-structure-upgrading index and interprovincial population-mobility variables leaves the core coefficient close to -0.958 and statistically significant. Controlling for regional unemployment also does not change the result, suggesting that the finding is not merely a mechanical consequence of lower aggregate unemployment.

Third, excluding western provinces produces a stronger negative coefficient of -1.791. Excluding the three northeastern provinces reduces the coefficient to -0.839, which is no longer significant, indicating weaker adjustment capacity in regions heavily dependent on high-carbon industries. Excluding the financial-crisis years also preserves the negative effect.

Extending the sample through 2024 leaves the coefficient negative but insignificant. This result is consistent with the institutional change after 2021 and the compression of cross-province policy variation under nationally synchronized carbon policies. The baseline sample is therefore retained.

5. Conclusion

Using provincial panel data for 2008–2020, this paper examines the effect of environmental regulation on structural employment imbalance from the perspective of high-carbon industry reconfiguration. First, environmental regulation reduces the Lilien index with a one-year lag. The contemporaneous effect is insignificant, while the one-period-lagged coefficient is significantly negative. The result survives alternative measures, sample adjustments, placebo tests, instrumental variables, and trend controls. Second, high-carbon employment growth is the principal transmission channel. Environmental regulation reduces employment growth in high-carbon industries, narrows the dispersion of sectoral employment growth, and thereby lowers the Lilien index. Manufacturing accounts for most of this mechanism. Third, the effect is conditional. It is concentrated in eastern provinces, regions with higher human capital, and provinces with higher marketization. The results do not imply that environmental regulation always improves employment outcomes. A lower Lilien index does not directly establish higher employment, lower unemployment, or improved worker welfare. Several limitations remain. The Lilien index measures dispersion rather than actual labor flows. Keyword frequency reflects policy attention and may not perfectly measure enforcement intensity. Urban-unit employment data exclude some private and self-employed workers. Future research should combine sectoral flows, individual employment histories, unemployment, wages, and firm-level emissions data.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Gray WB, 1987, The Cost of Regulation: OSHA, EPA and the Productivity Slowdown. American Economic Review, 77(5): 998–1006.

[2] Jorgenson DW, Wilcoxen PJ, 1990, Environmental Regulation and U.S. Economic Growth. RAND Journal of Economics, 21(2): 314–340.

[3] Walker W R, 2011, Environmental Regulation and Labor Reallocation: Evidence from the Clean Air Act. American Economic Review, 101(3): 442–447.

[4] Hafstead MAC, Williams RC, 2018, Unemployment and Environmental Regulation in General Equilibrium. Journal of Public Economics, 160: 50–65.

[5] Porter ME, 1991, America's Green Strategy. Scientific American, 264(4): 168.

[6] Porter ME, van der Linde C, 1995, Toward a New Conception of the Environment-Competitiveness Relationship. Journal of Economic Perspectives, 9(4): 97–118.

[7] Dechezleprêtre A, Glachant M, Haščič I, et al., 2011, Invention and Transfer of Climate Change-Mitigation Technologies: A Global Analysis. Review of Environmental Economics and Policy, 5(1): 109–130.

[8] Bakas D, Panagiotidis T, Pelloni G, 2024, Labour Reallocation and Unemployment Fluctuations: A Tale of Two Tails. International Journal of Finance & Economics, 29(3): 3444–3468.

[9] Becker GS, 1962, Investment in Human Capital: A Theoretical Analysis. Journal of Political Economy, 70(5): 9–49.

[10] Berman E, Bui LTM, 2001, Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin. Journal of Public Economics, 79(2): 265–295.

[11] Bezdek RH, Wendling RM, DiPerna P, 2008, Environmental Protection, the Economy, and Jobs: National and Regional Analyses. Journal of Environmental Management, 86(1): 63–79.

[12] Davis SJ, Haltiwanger J, 1992, Gross Job Creation, Gross Job Destruction, and Employment Reallocation. Quarterly Journal of Economics, 107(3): 819–863.

[13] Goldsmith-Pinkham P, Sorkin I, Swift H, 2020, Bartik Instruments: What, When, Why, and How. American Economic Review, 110(8): 2586–2624.

[14] Greenstone M, 2002, The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures. Journal of Political Economy, 110(6): 1175–1219.

[15] Dechezleprêtre A, Sato M, 2017, The Impacts of Environmental Regulations on Competitiveness. Review of Environmental Economics and Policy, 11(2): 183–206.

[16] Gray WB, Shadbegian RJ, 2013, Do the Job Effects of Regulation Differ with the Competitive Environment? Economics, 116.

[17] Hille E, Möbius P, 2019, Environmental Policy, Innovation, and Productivity Growth: Controlling the Effects of Regulation and Endogeneity. Environmental and Resource Economics, 73(4): 1315–1355.

[18] Coglianese C, Finkel AM, Carrigan C, eds., 2014, Does Regulation Kill Jobs? University of Pennsylvania Press.

[19] Liu M, Shadbegian R, Zhang B, 2017, Does Environmental Regulation Affect Labor Demand in China? Evidence from the Textile Printing and Dyeing Industry. Journal of Environmental Economics and Management, 86: 277–294.

[20] Sheng J, Zhou W, Zhang S, 2019, The Role of the Intensity of Environmental Regulation in the Employment Effect of Chinese Industrial Enterprises. Journal of Cleaner Production, 232: 1230–1240.

[21] Wang Y, Shen N, 2016, Environmental Regulation and Environmental Productivity: The Case of China.

Renewable and Sustainable Energy Reviews, 62: 758–766.

[22] Lilien DM, 1982, Sectoral Shifts and Cyclical Unemployment. Journal of Political Economy, 90(4): 777–793.

[23] Walker WR, 2013, The Transitional Costs of Sectoral Reallocation: Evidence from the Clean Air Act and the Workforce. Quarterly Journal of Economics, 128(4): 1787–1835.

[24] Curtis EM, 2018, Who Loses Under Cap-and-Trade Programs? The Labor Market Effects of the NOx Budget Trading Program. Review of Economics and Statistics, 100(1): 151–166.

[25] Morgenstern RD, Pizer WA, Shih JS, 2002, Jobs versus the Environment: An Industry-Level Perspective. Journal of Environmental Economics and Management, 43(3): 412–436.

[26] Acemoglu D, Aghion P, Bursztyn L, Hemous D, 2012, The Environment and Directed Technical Change. American Economic Review, 102(1): 131–166.

[27] Aghion P, Dechezleprêtre A, Hemous D, et al., 2016, Carbon Taxes, Path Dependency, and Directed Technical Change: Evidence from the Auto Industry. Journal of Political Economy, 124(1): 1–51.

[28] Dechezleprêtre A, Nachtigall D, Venmans F, 2023, The Joint Impact of the European Union Emissions Trading System on Carbon Emissions and Economic Performance. Journal of Environmental Economics and Management, 118: 102758.

[29] Martin R, de Preux LB, Wagner UJ, 2014, The Impact of a Carbon Tax on Manufacturing: Evidence from Microdata. Journal of Public Economics, 117: 1–14.

[30] Chen SY, Chen DK, 2018, Haze Pollution, Government Governance, and High-Quality Economic Development. Economic Research, 53(2): 20–34.

[31] Li MJ, Du WJ, 2014, Does the Dual Dividend of Environmental Regulation and Employment Apply to China at Its Current Stage? An Empirical Analysis Based on Provincial Panel Data. Economic Science, (4): 14–26.

[32] Wang F, Ge X, 2022, Does Low-Carbon Transition Impact Employment? Empirical Evidence from Pilot Cities of Low-Carbon Development. China Industrial Economics, (5): 81–99.

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