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Does the Inflow of Rural-to-Urban Migration Increase Firms' Productivity?

Mengzhen Wang [1], Zhennan Xie [1], Zihao Huang [1], Jiang Hu [1,*] and Baekryul Choi [2,*]

[1] School of Digital Economics, Hubei University of Automotive Technology, Shiyan 442002, China; 20230022@huat.edu.cn (M.W.)
[2] Department of International Trade, Jeonbuk National University, Jeonju 54896, Republic of Korea
* Correspondence: 20150007@huat.edu.cn (J.H.); brchoi@jbnu.ac.kr (B.C.)

Abstract

Our study examines whether the inflow of rural-to-urban migration increases the productivity of manufacturing firms in China, using cross-sectional data from the 2005 China 1% Population Survey and the Annual Survey of Industrial Firms. The analysis accounts for firm heterogeneity—including ownership, export orientation, and industry type—and explores the moderating role of regional minimum wage policies. The results indicate that the inflow of rural-to-urban migration significantly enhances firm productivity through agglomeration effects, technological efficiency, and cost advantages, and the findings remain robust under alternative specifications. Productivity gains are most pronounced among private, non-exporting, and technology-intensive firms, while the effects are weaker or insignificant for state-owned and exporting firms due to higher skill requirements and labor mismatches. At the regional level, moderate minimum wage standards amplify the productivity benefits of migration, whereas higher wage levels reduce cost advantages. These results highlight that the productivity effects of rural-to-urban migration are context-dependent—shaped by firm characteristics and regional wage settings. The study contributes new empirical evidence to the international literature on labor mobility and sustainable industrial productivity and provides policy insights aligned with the United Nations Sustainable Development Goals, emphasizing differentiated regional and sectoral strategies for inclusive and sustainable growth.

Keywords: rural migrant workers; total factor productivity; firm type; minimum wage standard

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Academic Editor: Michael L. Lahr

Received: 6 September 2025
Revised: 19 October 2025
Accepted: 21 October 2025
Published: 23 October 2025

Citation: Wang, M.; Xie, Z.; Huang, Z.; Hu, J.; Choi, B. Does the Inflow of Rural-to-Urban Migration Increase Firms' Productivity? *Sustainability* **2025**, *17*, 9414. https://doi.org/10.3390/su17219414

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1. Introduction

In the context of globalization and economic integration, rural-to-urban migration has become a major driver of inclusive and sustainable growth. Across both developed and emerging economies, the movement of people from rural to urban areas reshapes industrial structures, productivity patterns, and social welfare outcomes [1–3]. According to the International Labour Organization, more than 700 million individuals worldwide participate in internal or cross-regional migration, contributing significantly to productivity, innovation, and social inclusion—key priorities under the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 10 (Reduced Inequalities) [4,5].

China provides a compelling case within this global trend. Since the initiation of economic reforms and the gradual relaxation of its rural–urban dual system, rural-to-urban migrants have grown into a vital labor force, exceeding 290 million people by 2020

and representing nearly 40 percent of the total labor force [6]. The large-scale inflow of rural-to-urban migration has profoundly reshaped urban economies, enhanced industrial competitiveness, and transformed the employment structure [7,8]. Comparable evidence from OECD and emerging economies suggests that internal migration boosts firm productivity through knowledge diffusion, efficient resource reallocation, and enhanced firm-level competitiveness [9–12]. These dynamics align with global commitments to inclusive and sustainable growth under the SDGs framework [5].

The existing literature identifies two principal mechanisms through which rural-to-urban migration influences firm productivity. First, drawing on the new economic geography framework [13–15], migration-induced agglomeration generates economies of scale, knowledge spillovers, and cost-saving advantages through more efficient labor allocation. Second, from a cost-effectiveness perspective, access to lower-cost migrant labor can initially enhance productivity by reducing input costs [16,17]. Yet excessive dependence on cheap labor may deter firms from investing in R&D or technology upgrading, leading to a "low-end lock-in trap" that constrains long-term sustainability [18]. These dynamics are not unique to China but are also observed in other developing and developed economies striving to balance labor efficiency with innovation-driven growth [19–22].

Despite these insights, several research gaps persist. Previous studies have primarily examined wage or employment effects in specific sectors such as agriculture or manufacturing [7,8,23]. Little attention has been paid to how firm heterogeneity—ownership (state-owned vs. private), export orientation (exporting vs. non-exporting), and industry type (labor-, capital-, or technology-intensive)—conditions the impact of rural-to-urban migration on productivity. Moreover, the moderating role of regional institutional factors, especially minimum wage standards, remains underexplored despite their potential to shape both distributional and efficiency outcomes.

Our study contributes to the growing discourse on sustainable labor and productivity by examining how the inflow of rural-to-urban migration affects firm-level productivity in China, using microdata from the 2005 China 1% Population Survey and matched firm-level datasets. Our contributions are threefold. First, we empirically identify the heterogeneous productivity effects of labor inflows across firms with different ownership structures, export orientations, and industrial intensities. Second, we assess how regional minimum wage standards moderate these effects, thereby illuminating the institutional determinants of sustainable productivity. Third, we provide policy insights relevant not only to China but also to other emerging economies facing similar challenges in balancing migration, wage regulation, and productivity growth. By integrating a sustainability perspective, this research aligns with global efforts to promote inclusive industrial upgrading and contributes to achieving the UN SDGs [24,25].

2. Hypothesis Development

2.1. Agglomeration Effect

According to the new economic geography framework, rural-to-urban migration and industrial agglomeration are closely intertwined. Increasing returns to scale, transport costs, and knowledge spillovers jointly promote the concentration of industries in urban centers and the inflow of migrants from peripheral regions [11,13–15]. This inflow expands the local labor supply, encouraging firms to enlarge production and exploit economies of scale. Evidence also shows that low-skilled labor inflows stimulate the entry of new manufacturers—an "entry effect" that can exceed the expansion of incumbent firms [8]. In this sense, migration inflows foster agglomeration and generate externalities such as knowledge sharing, specialization, and technological diffusion. Firms within the same industry benefit from intra-industry knowledge flows that enhance innovation, while

inter-industry linkages enable the exchange of diverse know-how and the joint use of intermediate inputs and public infrastructure [7,26,27]. These mechanisms collectively enhance firm-level productivity and contribute to sustainable industrial development.

However, prior studies often treat agglomeration effects as homogeneous and overlook firm heterogeneity. The extent to which low-skilled migrant inflows lead to sustained productivity growth remains uncertain. Firm-level evidence is therefore required to clarify under what conditions agglomeration linked to rural-to-urban migration enhances—or weakens—productivity.

2.2. Technology Efficiency

The inflow of rural-to-urban migrants may alter the skill composition of local labor through both substitution and complementarity channels. Because migrants generally have a wage advantage, their arrival increases competition among similarly skilled local workers. Duranton and Puga [19] argue that, instead of exiting the labor market, local workers often respond by upgrading their skills, pursuing further education, or shifting occupations to preserve income. This competition-induced upgrading improves the overall efficiency of the labor force and enhances productivity.

At the same time, migrants complement local high-skilled workers by performing routine or physically demanding tasks, allowing skilled employees to focus on higher-value activities. Such complementarity strengthens division of labor and raises total factor productivity. Nevertheless, in some sectors migrants may simply replace locals without affecting average skill or efficiency. Prior evidence remains mixed: some studies highlight substitution-driven improvement, while others find no significant productivity change. These inconsistencies indicate a need to explore when substitution or complementarity dominates and how firm characteristics shape these effects.

2.3. Cost Effectiveness

Under China's household registration (hukou) system [28–31], rural-to-urban migrants often occupy a disadvantaged position in the labor market, facing limited bargaining power [30,31]. This creates a dual labor structure in which migrants receive lower wages than equally skilled locals. Assuming firms combine only labor and capital—two substitutable inputs—the demand for the cheaper factor rises. Manufacturers adjust input mixes to exploit this comparative advantage, reducing unit costs and capturing the demographic dividend. Lower costs strengthen competitiveness in global value chains (GVCs), enable resource reallocation toward technology upgrading, and ultimately enhance productivity [24,32–34].

However, abundant cheap labor can also discourage firms from investing in R&D or training, undermining creative destruction [18,35]. This reliance on low-cost inputs may trap firms in a "low-end lock-in", limiting innovation and long-term productivity growth. Empirical studies find that firms abundant in low-skilled labor are less likely to adopt automation [36]. Similarly, Saracoğlu and Roe [23] show that although rural–urban migration contributes to growth, intra-regional labor reallocation can depress productivity. Therefore, migrant inflows can either raise or reduce productivity depending on how firms respond.

Thus, we propose the following:

Hypothesis 1. *The inflow of rural-to-urban migrants may either improve or reduce firms' productivity.*

Firm ownership plays a decisive role in conditioning how rural-to-urban migration influences firm productivity. Compared with private enterprises, state-owned enterprises (SOEs) often pursue both economic and social objectives—profit generation, employment

stability, and social responsibility. Employees in SOEs generally hold long-term contracts, and dismissal costs are relatively high. As a result, rural-to-urban migrants, who are mostly informal employees, have limited interaction with permanent staff and exert weaker competitive pressure. Consequently, SOE employees have fewer incentives to engage in self-improvement or skill upgrading, resulting in limited productivity gains from technological efficiency.

In contrast, private firms prioritize profit maximization and demonstrate greater flexibility in labor management. The inflow of rural-to-urban migrants increases competitive pressure among local workers with similar skills, heightening their awareness of job insecurity. This competition motivates incumbent employees to upgrade their skills and improve performance, thereby contributing to firm-level productivity enhancement. Moreover, private firms are more sensitive to labor-cost fluctuations and respond swiftly to changing factor prices. When faced with an abundant supply of low-cost migrant labor, private firms tend to reallocate resources efficiently—reducing labor costs, expanding production, and redirecting savings toward R&D or skill development programs. Such flexibility enables private firms to convert migrant inflows into tangible productivity improvements [37,38].

Based on this context, we propose the following:

Hypothesis 2a. *Compared with state-owned firms, the inflow of rural-to-urban migrants more significantly enhances the productivity of private firms.*

Non-exporting firms may be more likely to benefit from the influx of rural-to-urban migrants due to their greater reliance on low-cost labor within domestic markets. Unlike exporting firms, which often require higher-skilled labor to meet international standards and compete globally, non-exporting firms typically engage in less complex production processes that can accommodate lower-skilled workers more effectively. The availability of cheap migrant labor enables non-exporting firms to meet their labor demands without incurring significant investments in advanced technology or skilled labor, which in turn helps reduce production costs and enhance productivity [39].

In contrast, exporting firms often face stricter competition in the international market, necessitating higher levels of innovation, management, and operational efficiency. These firms may not be able to fully capitalize on the low-skilled labor provided by rural-to-urban migrants due to skill mismatches. Exporting firms typically require a workforce with specialized skills to handle sophisticated production processes and technologies. As a result, the inflow of rural-to-urban migrants may have a limited impact on their productivity, as they would need to invest additional resources in training and upskilling their workforce to align with the demands of international markets [40].

Moreover, non-exporting firms, which operate in less competitive domestic markets, may face fewer barriers to integrating rural-to-urban migrants into their production processes. The lower competitive pressure allows them to maintain relatively lower levels of technological and managerial sophistication while still benefiting from the cost advantages provided by low-skilled labor. Exporting firms, however, must continuously invest in management and organizational improvements to stay competitive, which may dilute the potential productivity gains from the inflow of lower-skilled migrant workers.

Thus, the inflow of rural-to-urban migrants may lead to a more significant productivity increase for non-exporting firms, which can more easily adapt their operations to the availability of low-cost labor, compared to exporting firms, which face greater challenges due to skill mismatches and the need for higher technological standards.

Thus, we propose the following:

Hypothesis 2b. *Compared to exporting firms, the inflow of rural migrant workers would more significantly promote the productivity of non-exporting firms.*

The heterogeneous nature of firms also plays a crucial role in shaping how rural-to-urban migration influences productivity. Compared with labor-intensive firms, capital- or technology-intensive firms may benefit more significantly from the inflow of rural-to-urban migrants. Capital- or technology-intensive firms, while relying on advanced machinery and production technologies, often possess the financial and organizational resources to invest in worker training and technological upskilling, including programs for migrant employees. Although a skill mismatch may initially exist between low-skilled migrants and the specialized requirements of capital-intensive industries, these firms are better equipped to bridge this gap through training and incremental learning. Over time, the upskilling of migrant workers enables them to operate complex equipment and contribute to high-value-added production processes, which enhances overall firm productivity [22,40].

In contrast, labor-intensive firms, which typically rely on repetitive and low-skill tasks, may receive smaller marginal benefits from the inflow of rural-to-urban migrants [25]. These firms are already optimized for low-skilled labor, meaning that the additional influx of migrants may produce limited improvements in efficiency or output. The production processes in labor-intensive firms are less likely to evolve through technological upgrading or process innovation, as these firms depend primarily on maintaining a large workforce to meet production targets. Consequently, the potential for productivity gains in such firms may be capped, as their dependence on low-cost, low-skilled labor leaves little room for substantial efficiency improvements [26].

Furthermore, capital- and technology-intensive firms are more likely to invest in advanced management systems and production optimization strategies, which enable them to fully utilize the complementarities between high- and low-skilled labor. The integration of rural-to-urban migrants into these firms can enhance operational efficiency, as migrants often undertake routine or manual tasks that complement the work of more skilled employees. This division of labor allows skilled workers to focus on innovation, process optimization, and technological advancement. In turn, the dynamic fosters productivity growth and sustainable competitiveness.

As a result, capital- and technology-intensive firms are better positioned to leverage migrant labor inflows for long-term productivity improvements, whereas labor-intensive firms—whose operations already rely heavily on low-skilled workers—face diminishing marginal returns from additional labor inputs.

Thus, we propose the following:

Hypothesis 2c. *Compared with labor-intensive firms, the inflow of rural-to-urban migrants more significantly enhances the productivity of capital- or technology-intensive firms.*

The role of government intervention—particularly through minimum wage regulations—is critical in moderating the relationship between the inflow of rural-to-urban migrants and firm productivity. China promulgated the Minimum Wage Regulations in 2004 and implemented them nationwide, creating an exogenous policy shock to labor cost structures. Theoretically, minimum wage policies increase the reservation wage, thereby eroding the relative "price advantage" of migrant labor. As labor costs rise, firms lose part of their incentive to absorb low-skilled migrants, which constrains the cost-effectiveness channel through which migrant inflows typically enhance productivity [26]. This mechanism weakens firms' willingness to adjust factor allocations in favor of cheaper labor and may shift production strategies toward capital substitution or even the downsizing of labor-intensive operations.

At the same time, excessively high minimum wages may erode regional comparative advantages in low-cost labor, discouraging the entry or expansion of labor-intensive and cost-sensitive industries. In such contexts, the agglomeration effects generated by migration are undermined, as firms become reluctant to expand or relocate to higher-cost regions. However, moderate increases in minimum wages can produce the opposite effect—encouraging firms to pursue efficiency gains, adopt new technologies, and engage in process innovation. This aligns with evidence from both developed and emerging economies that wage floors, when set at moderate levels, can incentivize firms to upgrade production systems and enhance productivity, whereas overly rigid wage policies reduce employment and innovation incentives [11,27,39].

This duality implies that the productivity effects of rural-to-urban migration are highly sensitive to the intensity of wage regulation. In regions with lower or moderately increasing minimum wage standards, firms retain the ability to leverage migrant inflows for cost reduction and expansion. Conversely, in regions with high wage standards, productivity-enhancing effects are substantially diminished.

Regional heterogeneity in minimum wage enforcement across provinces further amplifies these dynamics. Developed eastern provinces generally set higher wage floors, narrowing the wage gap between migrants and local workers. In contrast, central and western regions maintain relatively lower minimum wage standards, sustaining their attractiveness to labor-intensive industries and maximizing the productivity contribution of rural migrant inflows [39,40]. Consequently, minimum wage regulation functions as a key institutional moderator that determines whether rural-to-urban migration translates into long-term productivity gains or merely short-lived cost advantages.

Thus, we propose the following:

Hypothesis 3. *As the minimum wage standard increases, the positive impact of rural-to-urban migration on firms' productivity decreases.*

3. Model Specification and Data Description

3.1. Firm-Level Productivity Measurement

We use firm-level data from Chinese manufacturing enterprises to measure total factor productivity (TFP), a widely accepted indicator of firm efficiency and competitiveness [38]. TFP is typically defined as the difference between observed output and that predicted by a standard Cobb–Douglas production function, capturing the portion of output growth not explained by measurable inputs [39]. The estimation of TFP is based on the following production function framework:

$$Y = AL^{\alpha}K^{\beta}M^{\gamma} \quad (1)$$

where Y represents total output, A denotes total factor productivity; K represents capital input, L denotes labor input, and M is the intermediate factor input. Parameters $\alpha, \beta,$ and γ correspond to the output elasticities of labor, capital, and intermediate inputs, respectively. The residual term derived from this estimation is interpreted as firm-level TFP, which serves as the dependent variable in subsequent analyses.

To measure the productivity of manufacturing firms, we follow the method proposed by Levinsohn and Petrin [39], known as the LP method, which is an improvement on the earlier method by Olley and Pakes [40], known as the OP method. The latter assumes a strict monotonic relationship between investment and output, implying that sample firms with zero investment in a given year cannot be included in the estimation. The LP method is an improvement of the OP method. The OP method assumes that the investment and

total output need to maintain a monotonic relationship at all times, so sample firms with zero investment cannot be estimated. In practice, however, many Chinese manufacturing firms do not report positive investment every year, which leads to a substantial sample loss if OP is applied.

The improvement offered by the LP method is to use the intermediate goods input to replace investment as the proxy variable, which can avoid the problem that the total factor productivity of the firm cannot be estimated due to zero investment [41]. This substitution avoids the zero-investment problem and allows us to obtain more reliable estimates of firm-level total factor productivity.

In our study, we apply the LP method to measure TFP. Based on Petrin et al. [42] and Tang et al. [38], the following equation estimates the TFP:

$$\ln Y_i = \beta_0 + \beta_1 \ln L_i + \beta_2 \ln K_i + \beta_3 \ln M_i + \varepsilon \quad (2)$$

where Y represents total output, which is measured by value added in the manufacturing firms; K represents capital input, which is measured by total fixed assets; and L represents labor input proxied by the total number of employees. In addition, in the LP method measurement, the intermediate factor input M is represented by total intermediate input [43]. Following Levinsohn and Petrin [40], we estimate total factor productivity using the semi-parametric LP method, which corrects for simultaneity bias between unobserved productivity shocks and input choices. Specifically, the LP method uses intermediate inputs M_i as a proxy variable for the unobserved productivity component ω_i, which allows for a consistent estimation of the production function parameters. The resulting firm-level TFP is obtained as the fitted residual:

$$TFP_i^{LP} = lnY_i - \hat{\beta}_1 \ln L_i - \hat{\beta}_2 \ln K_i - \hat{\beta}_3 \ln M_i \quad (3)$$

All continuous variables are expressed in natural logarithms to stabilize variance and allow elasticity-based interpretation. The estimated residual TFP_i^{LP} represents firm efficiency in transforming inputs into outputs. For robustness, we also compute TFP_OLS, derived from the ordinary least squares (OLS) estimation of Equation (2), to serve as a benchmark.

The firm data for our study comes from the Annual Survey of Industrial Enterprises (ASIF). The database provides detailed information on all state-owned enterprises and non-state-owned enterprises with annual sales of more than 5 million yuan from 1998 to 2011. It includes variables such as the enterprise's location, industry, year of establishment, total output value, total sales, intermediate factor inputs, total fixed assets, and total number of employees. The basic data for calculating TFP is reported in Table 1.

Table 1. Basic Data for Calculating TFP.

	Variable	Definition	Obs.	Mean	Std.	Min	Max
Output	lnY	Log (Value added) Unit: thousand yuan	194,800	8.727	1.343	0	18.715
Input	lnL	Log (Total number of employees) Unit: person	194,801	4.713	1.087	2.079	20.794
	lnK	Log (Total fixed assets) Unit: thousand yuan	194,800	9.823	1.271	0	20.794
	lnM	Log (Total intermediate factor input) Unit: thousand yuan	194,801	8.339	1.676	0	18.716

3.2. Model Specification

The purpose of our study is to test the impact of rural migrant workers on productivity. Thus, the following regression model by using a cross-sectional dataset was constructed:

$$TFP_{ic} = \beta_0 + \beta_1 migrants_c + \gamma\chi_c + \tau\chi_i + \delta_j + \mu_d + \rho_o + \varepsilon_{ic} \quad (4)$$

where TFP_{ic} is the proxy variable of the manufacturing firm i's productivity in the city c, measured by the total factor productivity calculated by the LP method; $migrants_c$ denotes the number of migrant workers flowing into the city c; χ_c represents a vector of control variables for the city c, which include GDP per capita of each city and total population at the end of the year; χ_i represents a vector of control variables for the industrial firm i, which include the firm age and subsidy income; and ρ_o, μ_d, and δ_j represent firm, province, and industry fixed effects, respectively. Our study includes multiple fixed effects to mitigate unobserved heterogeneity. These absorb time-invariant unobservable characteristics across firms, regions, and industries, thereby alleviating potential omitted-variable bias. ε_{ic} represents the error terms.

The specification allows us to identify the average effect that rural-to-urban migrations have on firm productivity, which is conditional on observable firm and city characteristics. The inclusion of fixed effects controls for unobservable factors such as province-level policy differences, industry-specific technological trends, and firm-level managerial practices. However, a potential concern is the endogeneity of rural migrant workers' inflows: more productive cities may attract more migrants, which may bias the estimates. To address this challenge, we later employ an instrumental variable (IV) estimation, using road density per capita and the Engel coefficient as instrumental variables, which affect migration patterns but are plausibly exogenous to firm-level productivity.

Our study relies on the 2005 China 1% Population Survey and the Annual Survey of Industrial Firms. Both datasets are authoritative and widely used in the literature. The 2005 population survey is one of the few official sources that allow precise identification of rural migrant workers [44,45]. Zhao [46] uses the 2005 mini-census to identify rural migrants and quantify their wage impacts on urban workers, which has established a widely accepted precedent for using this year as the unique migration dataset. Similarly, the 2005 industrial firm database has been extensively employed to measure firm productivity [47–49].

Although the data are cross-sectional and somewhat dated, 2005 represents a unique period during China's WTO accession era characterized by large-scale rural–urban migration. Previous influential studies show that analyses based on earlier censuses or firm surveys provide enduring insights into migration and productivity mechanisms [50,51]. Therefore, while we acknowledge the limitation of using data from a single year, our approach is consistent with established practice and allows us to uncover structural mechanisms of long-term relevance.

3.3. Data Description

Data on the rural migrant workers come from the 2005 China 1% Population Survey. Since the mid-1980s, the National Bureau of Statistics of China (NBS) has conducted large-scale population surveys, usually in the fifth year after the census. The survey uses a lengthy questionnaire to elicit detailed demographic, geographic, economic, and housing information about household members. The survey collects information about a person's current place of residence but also about the location of her household and whether she has been away from it for more than six months. This information allows us to identify mobile populations. Specifically, if a person has a rural hukou but is currently living and working in the city, they are classified as a migrant worker [47]. The last survey before the 2005 survey was in 2000.

Our study uses data from the 2005 China 1% Population Survey to capture the number of rural migrants. The data processing steps were as follows. First, based on the respondents' birthdates, we selected individuals aged 16–65 whose employment status is shown as an employee. We then retained samples with a rural household registration status and a migrant status. Next, we removed individuals who had not sought employment within the past three months. Finally, we removed individuals who responded that they have not worked in the past week for one of the following reasons: not in the labor force, studying, out of the labor force, retired, or performing housework. The individual samples retained after these treatments were then aggregated to form the city-level rural migration data used in the empirical analysis. To address distributional skewness and to facilitate elasticity-based interpretations, we take the logarithm of the inflow of rural migrant workers.

At the city level, we include variables that capture the broader economic environment. GDP per capita is introduced as the logarithm of per capita output, which reflects regional development disparities that may affect both labor allocation and firm productivity. Total population at the end of the year, measured in units of 10,000 persons, controls for potential agglomeration effects as well as urban congestion. In addition, two structural dummy variables are incorporated: east, which equals 1 if the city is located in the eastern region of China and 0 otherwise, following the official classification of the National Bureau of Statistics; and sh, which equals 1 if the city is a provincial capital and 0 otherwise. These variables capture the institutional and locational heterogeneity across Chinese cities. The city data comes from the China City Yearbook.

At the firm level, several control variables are included. First, foreign investment status is captured by a dummy variable equal to 1 if the firm is foreign-invested and 0 otherwise. This aspect accounts for the well-documented productivity differentials between foreign-invested and domestic firms [52]. Second, subsidy income is measured as the logarithm of government subsidies plus one, which reflects the role of policy support in enhancing firm performance [47]. Third, financial leverage is represented by the ratio of total liabilities to total assets, in line with studies emphasizing the role of capital structure in investment and productivity dynamics. Finally, firm age is measured as 2005 minus the firm's establishment year, given that firm age may capture accumulated learning effects as well as potential organizational rigidities [53,54]. The firm data for our study comes from the ASIF. The descriptive statistics are reported in Table 2.

Table 2. Descriptive Statistics.

	Variable	Definition	Obs.	Mean	Std.	Min	Max
Dependent Variable	Firm productivity (TFP_LP)	Total factor productivity calculated by the LP method	194,801	6.440	1.091	−7.134	21.506
Core Independent Variable	Rural Migrant inflows(migrant)	Log (the number of migrant workers flowing into the city c) Unit: person	194,801	5.799	2.337	0	363.062
Firm-level Control Variables	Foreign Investment (fdi)	Foreign Capital: 1; Not foreign capital: 0	194,792	0.119	0.324	0	1
	Subsidy Income (subsidy)	Log (subsidy income + 1) Unit: thousand yuan	194,787	0.700	1.933	0	13.695
	Firm age (age)	2005-establishment year	194,792	8.152	9.333	0	405
	Leverage (lev)	Total liabilities/total assets	194,792	0.572	0.312	0	22.897
City-level Control Variables	GDP per capita (pergdp)	Log (GDP per capita) Unit: yuan	193,693	10.41	0.542	4.867	11.625
	Population (pop)	Total population at the end of the year Unit: ten thousand persons	194,763	5.241	0.927	1.963	7.163
	Eastern Region (east)	Eastern region: 1 not the eastern region: 0	194,792	0.802	0.398	0	1
	Capital City (sh)	Capital City: 1; Not capital city: 0	194,792	0.259	0.438	0	1

4. Empirical Results

4.1. Baseline Results

The baseline results examining the impact of rural-to-urban migrations on the productivity of local firms are presented in Table 3. Columns (1)–(3) report the specifications without additional control variables but with progressively richer sets of fixed effects. The estimates consistently show that the inflow of rural-to-urban migrations enhances local firm productivity, whether controlling for province-level, industry-level, or firm-level fixed effects, or all three. This finding indicates that the productivity-enhancing effect is not attributable to cross-province institutional differences, sectoral composition, or time-invariant firm characteristics.

Table 3. Baseline Results.

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP_LP	**TFP_LP**	**TFP_LP**	**TFP_LP**	**TFP_LP**	**TFP_LP**
migrant	0.049 **	0.048 **	0.049 ***	0.018 ***	0.022 ***	0.018 ***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
fdi				0.411 ***	0.396 ***	0.411 ***
				(0.008)	(0.007)	(0.008)
subsidy				0.094 ***	0.087 ***	0.094 ***
				(0.001)	(0.001)	(0.001)
lev				−0.164 ***	−0.186 ***	−0.164 ***
				(0.008)	(0.008)	(0.010)
pergdp				0.078 ***	0.057 ***	0.078 ***
				(0.008)	(0.008)	(0.009)
pop				0.001	0.002	0.001
				(0.006)	(0.006)	(0.006)
east				−0.437	−0.509	−0.437
				(0.737)	(0.720)	(1.158)
sh				−0.018 *	−0.010	−0.018 *
				(0.009)	(0.009)	(0.010)
age				0.004 ***	0.005 ***	0.004 ***
				(0.000)	(0.000)	(0.000)
cons	5.752 ***	5.724 ***	6.154 ***	5.525 ***	5.800 ***	5.815 ***
	(0.023)	(0.031)	(0.012)	(0.741)	(0.724)	(0.938)
Firm FE	No	No	Yes	No	No	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	Yes	No	Yes	Yes
Obs.	194,471	194,471	194,471	193,375	193,375	193,375
R-sq	0.040	0.091	0.040	0.087	0.133	0.087

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Columns (4)–(6) present the results after incorporating firm- and city-level control variables under the same sequence of fixed effects. The coefficients remain positive and statistically significant, demonstrating that the inflow of rural-to-urban migrations continues to raise firm productivity once observable firm and city heterogeneity is accounted for. Taken together, the evidence across all six specifications strongly supports Hypothesis 1. These findings are consistent with previous studies that highlight the productivity gains from internal migration and agglomeration [8,13,41,42]. Importantly, the result also echoes global evidence linking labor mobility and productivity growth emphasized in the OECD [55] and ILO [56] reports, and aligns with the broader objectives of UN SDG 8 (Decent Work and Economic Growth), which encourages inclusive labor participation as a path toward sustainable productivity improvements.

Regarding the control variables, we did not provide a detailed interpretation of the city-level variables that were statistically insignificant. The estimates show that being a provincial capital and being located in the eastern region are negatively associated with firm productivity, while the size of the population is positively associated with productivity. Although these results are not statistically significant, they may reflect certain tendencies. For instance, provincial capitals and eastern cities may face fiercer competition, higher living costs, and tighter regulatory constraints, which could offset their potential productivity advantages. By contrast, a larger population size may increase labor supply and market potential, thereby displaying a positive, though insignificant, correlation with productivity.

At the firm level, our results reveal that firm age, subsidy income, and foreign capital participation are positively associated with productivity, while leverage exhibits a negative association. These findings are consistent with the existing literature that emphasizes that firm fundamentals—such as financial structure, external support, and experience—are critical determinants of productivity outcomes. Wang [57] stresses that firm productivity reflects the efficiency of transforming inputs into outputs, depending on labor structure, equipment quality, and innovation. Rural migrant workers can alter the composition of local labor forces, thereby shaping firm productivity through specialization and human capital channels. Empirical evidence from Combes et al. [8], Imbert et al. [12], and Zhao et al. [3] further suggests that rural migrant workers' inflows complement urban labor, foster agglomeration, expand labor supply, and lower labor costs, which collectively contribute to local productivity gains. Such findings are not only relevant to China but also resonate with global experiences of developing and emerging economies where migration acts as a catalyst for industrial dynamism and inclusive growth.

Overall, our findings confirm that the inflow of rural-to-urban migrations is positively related to firm productivity, but the precise mechanisms—whether through agglomeration, technological efficiency, or cost-effectiveness—cannot be fully disentangled within the current empirical framework. This limitation underscores the need for future research based on more granular and dynamic data to clarify the channels through which the inflow of rural migrant workers affects firm productivity [57–59].

4.2. Heterogeneity Analysis

In the current research, we find that most studies focus on the different productivity or wage impacts brought about by the heterogeneous skill levels of rural migrant workers [13,14,44]. Some studies have observed the impact of rural migrant workers on the productivity of agriculture or specific industries, such as manufacturing and construction [14,44,45]. Moreover, the impact may vary among different types or characteristics of firms. Thus, we conduct a heterogeneous analysis by classifying the firms based on their type and characteristics. This approach also aligns with international practices in productivity research (e.g., OECD [55]; UNIDO [60], emphasizing how firm heterogeneity mediates the link between labor mobility and productivity—a key aspect of sustainable industrial policy under SDG 9 (Industry, Innovation and Infrastructure).

4.2.1. State-Owned and Private Firms

First, to test whether the firm's nature regulates the productivity impact of the rural-to-urban migrations, according to the registration type, we classify firm types into private and state-owned firms. Based on the registration type code in the database of the "Chinese Annual Survey of Industrial Firms," private firms include private proprietorships, private partnerships, private limited liability companies, and private joint stock firms. State-owned firms include state-owned firms, collective firms, state-owned joint ventures, collective joint ventures, state-owned and collective joint ventures, and wholly state-owned firms.

The empirical results reported in Columns (1)–(2) of Table 4 confirm that the inflow of rural-to-urban migrations could promote the local firms' productivity of the state-owned and private firms. At the same time, we find that the inflow has a slightly more significant impact on the productivity of state-owned industrial firms than that of private industrial firms, which rejects Hypothesis 2a. Although the mean value of productivity of state-owned industrial firms was slightly lower than that of private industrial firms in 2005, the action to deepen the reform of state-owned firms was in full swing and some achievements were achieved. Some scholars indicate that the profits of state-owned firms are growing rapidly, but a careful analysis of the composition of profits in the state-owned firms at the industry level indicates that a considerable part of the profits of state-owned and state-controlled firms comes from industries that have not yet been fully liberalized, such as petroleum, petrochemicals, telecommunications, and tobacco. The inflow of rural-to-urban migrations provides state-owned industrial firms with more low-cost labor resources, thus increasing the productivity of the firms.

Table 4. Heterogeneity Analysis.

	(1) Private	(2) State-Owned	(3) Non-Exporting	(4) Exporting	(5) Capital	(6) Labor	(7) Technology	(8) Lower Minimum Wage	(9) Higher Minimum Wage
migrant	0.021 ***	0.033 **	0.010 **	0.006	0.009	−0.004	0.053 ***	0.005	−0.041 ***
	(0.004)	(0.015)	(0.004)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.010)
fdi	0.487 ***	1.152 ***	0.401 ***	0.235 ***	0.423 ***	0.262 ***	0.513 ***	0.284 ***	0.509 ***
	(0.061)	(0.131)	(0.014)	(0.011)	(0.017)	(0.013)	(0.013)	(0.013)	(0.011)
subsidy	0.081 ***	0.085 ***	0.076 ***	0.120 ***	0.086 ***	0.091 ***	0.105 ***	0.086 ***	0.102 ***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
lev	−0.102 ***	−0.354 ***	−0.176 ***	−0.122 ***	−0.163 ***	−0.133 ***	−0.181 ***	−0.170 ***	−0.143 ***
	(0.012)	(0.051)	(0.013)	(0.015)	(0.018)	(0.016)	(0.018)	(0.013)	(0.017)
pergdp	0.012	0.207 ***	0.084 ***	0.075 ***	0.089 ***	0.118 ***	0.019	0.142 ***	0.051 ***
	(0.011)	(0.032)	(0.010)	(0.016)	(0.015)	(0.015)	(0.014)	(0.011)	(0.017)
pop	0.006	0.015	0.046 ***	−0.064 ***	0.035 ***	0.005	−0.050 ***	0.049 ***	−0.051 ***
	(0.008)	(0.025)	(0.007)	(0.010)	(0.010)	(0.010)	(0.010)	(0.008)	(0.010)
east	−1.996 ***	0.000	−0.525	0.000	1.045 ***	0.000	−2.084 ***	1.096 ***	0.000
	(0.214)	(0.000)	(1.085)	(0.000)	(0.029)	(0.000.)	(0.214)	(0.022)	(0.000)
sh	−0.026 **	−0.188 ***	−0.073 ***	0.141 ***	−0.097 ***	0.047 **	0.018	−0.038 ***	−0.019
	(0.013)	(0.038)	(0.012)	(0.017)	(0.016)	(0.019)	(0.016)	(0.014)	(0.016)
age	0.010 ***	0.001	−0.001 *	0.012 ***	0.002 ***	0.006 ***	0.006 ***	0.003 ***	0.007 ***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
cons	7.607 ***	4.062 ***	5.639 ***	5.937 ***	4.501 ***	5.126 ***	7.863 ***	4.102 ***	6.289 ***
	(0.204)	(0.322)	(0.852)	(0.155)	(0.135)	(0.152)	(0.234)	(0.110)	(0.143)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	92,080	16,732	132,499	60,876	63,796	55,631	73,948	104,240	89,134
R-sq	0.091	0.137	0.076	0.121	0.088	0.080	0.104	0.061	0.119

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2.2. Non-Exporting Firms and Exporting Firms

To test whether firm characteristics influence the productivity impact of r rural-to-urban migrations, we distinguish whether a firm is an export-oriented firm based on whether an export delivery value is listed in the China Industrial Enterprise Yearbook Survey database. The estimated results of exporting firms and non-exporting firms are shown in Columns (3)–(4) of Table 4, which illustrates that the non-exporting firms' productivity is positively associated with rural migrant workers. Non-exporting firms, generally facing a more limited labor market and higher labor costs, can benefit more from the influx of low-cost labor provided by rural migrant workers. The reduction in labor costs improves operational efficiency, which allows these firms to boost their productivity. However, the productivity of rural-to-urban migrations flowing to exporting firms has no significant effect. As discussed, the firms' output and profits do not improve in the presence of an abundant endowment of low-cost labor.

Furthermore, the insignificant effect observed for exporting firms might be attributed to the specific demands of the global market. Exporting firms, often capital- or technology-

intensive, require a workforce with higher technical skills to operate complex machinery and technologies, as emphasized by Duranton and Puga [19]. Rural migrant workers, generally low-skilled, may not meet the specialized skill requirements of these firms, which leads to a skill mismatch [38,49]. Such a mismatch could result in a negligible impact on productivity, as these firms may need to invest in additional training to bring the rural migrant workers up to the required skill levels, which would temporarily lower productivity in the short term, as noted by Fortier and Lewis [22]. This finding suggests that labor mobility's benefits depend strongly on the nature of firms and the skill compatibility of migrant workers—an observation also emphasized in international analyses of labor markets and productivity differentials (e.g., OECD [55]).

4.2.3. Capital, Technology-Intensive Firms, and Labor-Intensive Firms

In line with the Standard Industrial Classification (SIC) codes provided in the China Industrial Enterprise Yearbook Survey database, firms are categorized into three groups: labor-intensive, capital-intensive, and technology-intensive industries. The classification is consistent with international standards and is widely adopted in prior studies on industrial heterogeneity [44,46].

The estimated results of capital, technology-intensive firms, and labor-intensive firms are shown in Columns (5)–(7) of Table 4, which illustrates that the technology-intensive firms' productivity is positively associated with rural migrant workers. However, the productivity of rural-to-urban migrations flowing to labor-intensive firms has no significant effect. The result is in line with the findings of Liu and Zhang [27], who emphasize that the productivity gains in technology-intensive firms are likely driven by the ability of these firms to integrate advanced technologies and efficiently utilize labor inputs, including rural migrants. The higher productivity can be attributed to the complementarity between technology-intensive operations and migrant workers, where rural migrant workers contribute to the more routine or manual tasks, freeing up higher-skilled workers to focus on specialized functions that enhance productivity [18].

In contrast, for labor-intensive firms, the influx of rural-to-urban migrations does not significantly affect productivity. This context could be due to the saturation of low-skilled labor in these industries, where firms have already optimized production processes to rely heavily on manual labor. As noted by Fortier and Lewis [22], firms with an abundant supply of low-skilled labor tend to be less incentivized to introduce automation or advanced technology. Such inflow could lead to a lack of "creative destruction," as described by Imbert et al. [12], where firms may fall into a low-end production trap, failing to upgrade their production capacity or adopt new technologies that would otherwise drive productivity improvements. These findings provide further support for Hypothesis 2c, which posits that an inflow of rural migrant workers has a heterogeneous impact on productivity based on whether the firm is capital- or labor-intensive. Capital- or technology-intensive firms are better positioned to leverage the inflow of rural migrant workers for productivity gains, while labor- or natural resource-intensive firms show no significant productivity effect due to the saturation of low-skilled labor and potential skill mismatches.

4.2.4. High Minimum Wage and Low Minimum Wage Level

The findings in Columns (8)–(9) of Table 4 further support Hypothesis 3, revealing a significant moderating effect of the minimum wage standard on the relationship between rural migrant workers' inflow and firm productivity. Specifically, areas with a higher minimum wage standard exhibit a negative association between the inflow of rural migrant workers and productivity, as these regions face increased labor costs, which diminishes the cost-effectiveness initially expected from the influx of rural migrant workers [26]. The

higher labor cost leads firms to reduce their reliance on migrant workers, which thereby limits the potential for productivity improvements through agglomeration effects and cost advantages. As a result, firms in these regions may face challenges in achieving economies of scale and specialization [9,16].

Conversely, areas with lower minimum wage standards exhibit a positive association. In these regions, firms can better capitalize on the "demographic dividend," utilizing lower-cost labor inputs to optimize production strategies and benefit from cost-saving measures, which align with the cost-effectiveness hypothesis discussed earlier [7,21]. Moreover, the availability of cheaper labor in these regions may enhance firms' capacity to adjust their production methods and factor allocation, thereby fostering innovation and promoting higher productivity levels [7].

These findings align with the dual labor market theory and support the notion that minimum wage policies play a critical role in shaping the relationship between rural migrant workers and firm productivity. As hypothesized, the results suggest that the comparative advantage of rural migrant workers diminishes in regions where wage policies increase labor costs, which limits firms' ability to benefit from agglomeration effects, specialization, and labor cost reductions [11]. Furthermore, higher wage standards appear to hinder potential productivity gains linked to the inflow of rural migrant workers as higher wages discourage firms from investing in skill training or technological upgrades [12,22]. At a global level, this evidence complements international discussions on "inclusive wage policy" under UN SDG 10 (Reduced Inequalities), illustrating that wage regulation must balance fairness with productivity incentives.

4.3. Robustness Check

4.3.1. Change the Measurement Methods of Total Factor Productivity

In addition to the measurement methods of total factor productivity mentioned above (LP or OP method), many other methods can be applied [47], such as using data envelopment analysis (DEA) or calculating the residual value from the Cobb–Douglas production function in the Solow Model [14,33,48–50]. Nadiri [59] concludes that the growth accounting or residual method of TFP measurement originates in Solow's 1956 and 1957 articles [61,62]. A production function is used to relate measured inputs to measured output. Since the dataset in our study is cross-sectional, total factor productivity calculated from the Solow model is both convenient and accurate. Thus, we replace the explained variable in the baseline regression results with TFP measured by the OLS residual method and then re-estimate the model.

The results, reported in Table 5, show that the influx of rural migrant workers continues to have a significantly positive effect on firms' total factor productivity, confirming that our baseline findings are robust to alternative measures of productivity. This robustness suggests that the productivity-enhancing role of rural migrant inflows is not dependent on a specific estimation technique but reflects a broader empirical regularity consistent with prior research.

Table 5. Robustness Check by Changing Explained Variables.

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP_OLS	**TFP_OLS**	**TFP_OLS**	**TFP_OLS**	**TFP_OLS**	**TFP_OLS**
migrant	0.061 ***	0.062 ***	0.061 ***	0.024 ***	0.027 ***	0.024 ***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
fdi				0.615 ***	0.598 ***	0.615 ***
				(0.008)	(0.008)	(0.009)
subsidy				0.137 ***	0.124 ***	0.137 ***
				(0.001)	(0.001)	(0.002)

Table 5. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP_OLS	**TFP_OLS**	**TFP_OLS**	**TFP_OLS**	**TFP_OLS**	**TFP_OLS**
lev				0.034 ***	−0.014 *	0.034 ***
				(0.008)	(0.008)	(0.010)
pergdp				0.069 ***	0.051 ***	0.069 ***
				(0.009)	(0.008)	(0.009)
pop				0.018 ***	0.021 ***	0.018 ***
				(0.006)	(0.006)	(0.006)
sh				−0.062 ***	−0.049 ***	−0.062 ***
				(0.010)	(0.009)	(0.010)
age				0.014 ***	0.015 ***	0.014 ***
				(0.000)	(0.000)	(0.000)
east				−0.526	−0.613	−0.526
				(0.756)	(0.726)	(1.208)
cons	7.939 ***	7.756 ***	8.373 ***	7.600 ***	7.752 ***	7.920 ***
	(0.024)	(0.032)	(0.012)	(0.761)	(0.730)	(0.978)
Firm FE	No	No	Yes	No	No	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	Yes	No	Yes	Yes
Obs.	194,471	194,471	194,471	193,375	193,375	193,375
R-sq	0.023	0.107	0.023	0.122	0.194	0.122

Notes: Standard errors in parentheses. * $p < 0.1$, *** $p < 0.01$.

4.3.2. Change the Core Explanatory Variable to the Rural Migrants in 2000

In our study, the baseline model uses the rural migration data of 2005 to capture its impact on firms' productivity. We use the rural migration data of 2000 as a substitute proxy variable for robustness testing; due to the high correlation between the rural migration data of 2000 and 2005 (correlation coefficient is 0.94), the inclusion of both variables in the regression model will introduce serious multicollinearity problems. Therefore, to reduce the risk of biased and imprecise estimates, we choose to use the rural migration data of 2000 as a substitute variable in the robustness test instead of simultaneously merging the migration data of 2000 and 2005 into the regression model.

This approach is based on established practice in the literature on labor economics and immigration. For example, Borjas [50] and Card [63] have recognized the importance of considering immigration data with time lags to capture the long-term impact on the labor market and productivity. Specifically, the impact of early migration flows tends to emerge gradually. Therefore, using 2000 data also allows us to study long-term and potential cumulative effects in the labor market.

The robustness test results are shown in Columns (1)–(2) of Table 6, which are consistent with our baseline results and verify the validity of the conclusions of the baseline model. The findings also show that the observed positive effects are not sensitive to the exact timing of immigration data but to the overall trend of migration flows over time. Consistent with McMillan and Rodrik [64], who emphasize that structural change and labor reallocation are key drivers of productivity growth in developing economies, the impact of migration on productivity may not be limited to one year but may reflect broader and longer-term demographic adjustments.

Table 6. Robustness Check.

	(1)	(2)	(3) IV Method		(4) IV Method	
	TFP_LP	**TFP_LP**	**First Stage (Migrant)**	**Second Stage (TFP_LP)**	**First Stage (Migrant)**	**Second Stage (TFP_LP)**
per capita road area			0.003 **		0.002 **	
			(0.001)		(0.001)	
rural Engel coefficient			2.593 **		2.528 **	
			(1.217)		(1.216)	

Table 6. *Cont.*

	(1)	(2)	(3) IV Method		(4) IV Method	
	TFP_LP	TFP_LP	First Stage (Migrant)	Second Stage (TFP_LP)	First Stage (Migrant)	Second Stage (TFP_LP)
migrant				0.059 *** (0.010)		0.060 ** (0.027)
migrant_2000	0.052 *** (0.002)	0.012 *** (0.004)				
fdi		0.412 *** (0.008)			0.120 *** (0.009)	0.406 *** (0.031)
subsidy		0.095 *** (0.001)			−0.002 (0.001)	0.095 *** (0.005)
lev		−0.164 *** (0.010)			−0.026 ** (0.010)	−0.163 *** (0.018)
pergdp		0.094 *** (0.008)			1.685 *** (0.026)	0.008 (0.047)
pop		0.006 (0.006)			0.857 *** (0.012)	−0.035 (0.029)
sh		−0.024 ** (0.010)			−0.636 *** (0.049)	0.008 (0.028)
age		0.004 *** (0.000)			0.000 (0.000)	0.004 *** (0.001)
east		−0.426 (1.138)			0.811 (1.278)	−0.471 (1.214)
cons	6.161 *** (0.013)	5.662 *** (0.922)	5.564 *** (1.219)	5.670 *** (0.082)	5.564 *** (1.219)	6.197 *** (1.278)
Firm FE	Yes	Yes		Yes		Yes
Province FE	Yes	Yes		Yes		Yes
Industry FE	Yes	Yes		Yes		Yes
Hansen J statistic				0.431 0.512		1.686 0.194
Underidentification test				95.537		70.694 ***
Weak identification test				639.677		104.965 ***
N	194,471	193,375	194,471	194,471	193,375	193,375
R-sq	0.039	0.087		0.040		0.087

Notes: Standard errors in parentheses. ** $p < 0.05$, *** $p < 0.01$.

4.3.3. Instrument Variables Method

To ensure the robustness of our findings, we also employ the instrumental variables approach to address the potential endogeneity problem in the relationship between rural migration and firm productivity. The use of instrumental variables is crucial in this context, as migration flows may be influenced by unobserved factors that simultaneously affect productivity, which leads to biased estimates in a standard regression model. By using suitable instruments, we aim to isolate the exogenous variation in rural migration flows, ensuring more accurate and consistent estimations.

Following the existing literature, we propose two instruments: per capita road area and the Engel coefficient of rural residents. The first instrument, road infrastructure, is widely employed in empirical studies to proxy for transport accessibility and labor mobility (e.g., Holl [65]; Gibbons et al. [66]). For example, Holl [65] finds that improvements in road infrastructure significantly affect firm-level productivity and employment, while Gibbons et al. [66] confirm that new road construction shapes firm performance mainly through enhanced labor mobility and market accessibility rather than through direct technological effects.

The second instrument, the rural Engel coefficient, measures the share of food expenditure in total household consumption, which indicates household welfare and living

standards [67]. According to Engel's law, a higher coefficient signals lower income levels and stronger migration incentives in rural areas. In this sense, the Engel coefficient affects migration flows but not urban firm productivity, satisfying the exclusion restriction for valid instrumental variables.

We implement a two-stage least squares (2SLS) procedure. In the first stage, rural migrant inflows are regressed on the two instruments (per capita road area and rural Engel coefficient), generating predicted migration values that are exogenous to productivity. In the second stage, firm productivity is regressed on the predicted migration inflows and control variables. Our 2SLS estimates, reported in Columns (3)–(4) of Table 6, closely align with the baseline OLS regressions, which confirms robustness. Since both instruments are theoretically tied to migration incentives and mobility rather than to firms' production technologies, their exclusion restrictions are plausible after controlling for regional infrastructure, city economic conditions, and industrial structure.

5. Conclusions and Discussion

5.1. Conclusions

Our study investigates how the inflow of rural-to-urban migration influences the productivity of manufacturing firms in China, focusing on heterogeneity in ownership structure, export orientation, industry characteristics, and wage policies. Using firm-level data from the 2005 China 1% Population Survey and the Annual Survey of Industrial Firms, we find that rural-to-urban migration significantly enhances firm productivity through agglomeration effects, technological efficiency, and cost advantages. These results remain robust across multiple estimation strategies.

Productivity gains are most evident in private, non-exporting, and technology-intensive firms, while the effects are weaker or insignificant in state-owned and exporting firms—mainly due to higher skill demands and mismatches between migrant labor and firm needs. At the regional level, lower minimum wage standards strengthen the productivity effects of migration, whereas higher wage floors erode cost advantages.

These findings suggest that the productivity impact of rural-to-urban migration is conditional and context-dependent, shaped by firm characteristics, labor market institutions, and regional economic environments. The evidence is consistent with international literature that links labor mobility to economic resilience and sustainable productivity (e.g., Dustmann et al. [7]; Combes et al. [51]; Bryan and Morten [2]). The results also echo Fan [63], who highlights that China's sustained productivity gains since the reform era have depended on flexible labor markets and institutional adaptability—factors that remain crucial to maintaining productivity growth under evolving migration and wage conditions.

5.2. Policy Implications

Our empirical results yield several policy implications that underscore the need for differentiated rather than uniform strategies for managing migration and productivity enhancement.

First, the positive correlation between regional economic development and firm productivity implies that improving infrastructure, education, and business environments in less-developed regions can amplify the productivity benefits of migrant inflows. Strengthening local economic foundations would enhance firms' ability to absorb migrant labor effectively and capitalize on the associated agglomeration effects.

Second, the relatively weaker impacts observed in eastern provinces and provincial capitals suggest that high factor costs and intense competition reduce the benefits of migrant labor. Policymakers should therefore consider regionally differentiated wage policies. In central and western provinces, maintaining moderate minimum wage growth can preserve

cost advantages and sustain productivity gains from migration. In contrast, in eastern regions, where the productivity effects of migrant inflows are weaker, policy efforts should shift toward industrial upgrading, digital transformation, and innovation incentives.

Third, although population size—reflecting labor supply and market scale—shows a positive sign, the effect is not statistically significant. This finding indicates that demographic abundance alone is insufficient to ensure productivity growth. Hence, governments should focus on skill development programs, labor market matching mechanisms, and public–private training partnerships to ensure that demographic potential is effectively transformed into productivity advantages.

Fourth, the limited productivity impacts of migration on exporting and technology-intensive firms highlight the need to address skill mismatches. Generic training is inadequate; instead, targeted, industry-specific vocational education, certification systems, and firm–government collaboration are required to align migrant skills with technological and capital-intensive production processes. Such initiatives would improve labor complementarity and enhance firm adaptability amid automation and industrial upgrading.

Finally, these policy implications must be understood within the evolving demographic and technological context. While the 2005 data reflect an era of massive rural–urban migration, recent studies indicate that migration inflows have slowed, and some regions now face labor surpluses due to population aging and automation [67,68]. In regions where migrant inflows remain strong, maintaining wage flexibility and training investment remains essential. Conversely, in regions facing labor surpluses, policymakers should emphasize re-skilling programs, sectoral transition support, and new employment creation. Such adaptive and region-specific policy frameworks will be critical to sustaining the long-term contribution of migrant labor to productivity growth.

5.3. Limitations and Future Research

Despite its contributions, this study faces several limitations that point to promising directions for future research.

First, the analysis relies on cross-sectional data, which limits the ability to capture dynamic or causal evolution of productivity over time. Future research should employ panel or longitudinal data to trace the persistence and long-term mechanisms of migration's productivity effects. Although our 2005 dataset shares this limitation with many prior studies on Chinese firms [58], it nevertheless captures a pivotal period of rural–urban migration during China's WTO accession era—an episode that profoundly shaped industrial structure and labor allocation patterns.

Second, as our dataset focuses on the manufacturing sector, the findings may not generalize to services or other labor-intensive sectors. Exploring productivity impacts in construction, logistics, and urban services—industries where migrant labor is often concentrated—would provide a more comprehensive understanding of the national economic effects. Third, because our dataset includes primarily registered firms, potential sample selection bias arises: informal or microenterprises, where migrants are disproportionately employed, may not be fully represented. This limitation could lead to underestimation of the overall productivity effects of migration. Fourth, our study does not explicitly account for informal employment arrangements, a prevalent feature of China's urban labor markets. The absence of this variable may affect the accuracy of labor cost and productivity measurement, particularly in industries with widespread unregistered labor. Fifth, regional discrepancies in statistical coverage and data quality may also introduce heterogeneity into the estimates, as reporting rigor varies across provinces. Future work should incorporate spatial econometric techniques or multi-level models to better account for these structural differences.

Finally, although our paper highlights the moderating role of minimum wage policies, it does not consider other relevant policy instruments, such as social security programs, housing subsidies, or training incentives for migrant workers. Investigating how these broader interventions interact with migration and productivity dynamics would enrich our understanding of inclusive growth and labor reallocation under structural transformation.

Future research could extend this framework beyond China to conduct comparative cross-country analyses of internal migration, industrial upgrading, and sustainability transitions. Similar approaches have been used in international contexts, such as Card [63]'s study of the Mariel Boatlift in the U.S., which shows how migration shocks can reshape local labor markets and productivity dynamics. Drawing on such global experiences will further illuminate how developing economies can design labor, wage, and innovation policies to balance inclusiveness with productivity growth—thereby advancing global progress toward SDGs 8 and 9.

Author Contributions: M.W.: Conceptualization, Formal analysis, Methodology, Validation, Writing—original draft, Writing—review and editing, Funding Acquisition. Z.X.: Data curation, Formal analysis. Z.H.: Writing—review and editing. J.H.: Formal analysis, Writing—original draft, Writing—review and editing, Methodology, Validation, Funding Acquisition. B.C.: Data curation, Formal analysis, Methodology, Validation, Writing—original draft, Writing—review and editing, Funding Acquisition. All authors have read and agreed to the published version of the manuscript.

Funding: This research is supported by Doctoral Scientific Research Foundation of Hubei University of Automotive Technology (Grant No. BK202520); Hubei Provincial Department of Education Philosophy and Social Science Research Project Youth Project (Grant No. 24Q078); Guiding project of Shiyan Science and Technology Bureau (Grant No. 24Y021); The Key Scientific Research Project of Hubei Provincial Department of Education (Grant No. D20241805); The 2024 Open Research Program of Hubei Collaborative Innovation Center for Modern Logistics and Business (Grant No. 2024LB02); Hubei Province Soft Science Project (Grant No. 2025EDA033; No. 2025EDA034); The Doctoral Scientific Research Start-up Fund of Hubei University of Automotive Technology (Grant No. BK202010).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no competing interests.

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