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Does the development zone promote population urbanization? Evidence from China☆

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ABSTRACT

As the main space carriers of industrial agglomeration and land development, the development zones' (DZs') ability to absorb the population is crucial to the coordination of land urbanization and population urbanization. Based on the theory of New Economic Geography, this study uses China's fifth and sixth census data to empirically analyze the impact and mechanism of DZs on population urbanization by comprehensively utilizing propensity score matching, difference-in-difference model and mediating effect model. Results show that the establishment of DZs can promote the population urbanization. When the dominant industries planned by the DZs are in line with the local comparative advantage, the intensity of population urbanization affected by the DZs will enhance. The "policy rents" provided by the DZs attract firms to gather, which in turn creates additional jobs by attracting new firms and expanding the scale of incumbent firms, attracting additional population inflow. From another perspective, the establishment of DZs improves labor's wages and welfare, promotes the stable living of labor nearby, which boost population urbanization. In addition, the expansion of land supply is also a channel for the DZ to promote population urbanization.

1. Introduction

Urbanization is a process in which non-agricultural industries and rural population gather in cities along with the development of industrialization. In 2021, the urbanization rate of China's permanent population was 64.7%, which was still far below the average level of 80% in developed countries. According to statistics, the permanent population of urban residents in China has increased from 459 million in 2000–831 million in 2018, an average annual increase of 3.4%. Moreover, the urban built-up area has expanded by 5.5% annually, which is 2.1% higher than the rate of population urbanization. As a popular form of land use worldwide, development zones (DZs) are selected and supported by authorities to accelerate structural transformation (Sun et al., 2020). The development zone (DZ) is the main pattern of urban land expansion, and strengthening its role in gathering population is a key policy tool to promote the coordinated development of land and population urbanization.

The DZ is the most representative place-based policy in China. Since the establishment of the first DZ in 1984, as of 2018, China has approved the establishment of 552 national-level and 1991 provincial-level DZs. This establishment of DZs has gradually become an important space carrier for promoting urbanization and new industrialization in the region. The two editions of the "China Development Zone Audit Announcement Catalog" released by the State Council show that from 2006 to 2018, the approved area of China's provincial and above DZs increased from 9435 to 17,989 km^2, an expansion of 90.7%. Will the large-scale wave of DZ establishment attract additional rural surplus labor to achieve complete urbanization, or will it evolve into a "city building movement" that creates more "empty cities" and "ghost cities"? Through what patterns and mechanisms did the establishment of DZs affect population urbanization? The answers to these questions not only help enrich the evaluation of the policy effects of DZs but also have important policy enlightenments for the exploration of new urbanization promotion paths. Based on China's fifth and sixth census data, this study uses the propensity score matching (PSM) and difference-in-difference (DID) model to explore the impact of the establishment of DZs on the population urbanization. Furthermore, the data of Chinese industrial firms are used to explore the mechanism of the DZ influencing population urbanization and provide empirical evidence for the zones to promote the construction of new urbanization.

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As the most representative place-based program globally, the effects of DZs have attracted the research of many scholars. Existing studies on the effectiveness of DZ policies mostly focused on discussing their economic effects, and no unanimous conclusions have been reached. Most studies concluded that the establishment of DZs has a positive impact on the local economy. Under the effect of policy preferences and agglomeration effects, DZ can increase foreign investment (Cheng and Kwan, 2000), promote the upgrading of industrial structure (Zhou et al., 2018), increase the total factor productivity of firms (Wang, 2013; Alder et al., 2016; Lu et al., 2019), and drive regional economic development (Liu and Zhao, 2015). However, the effectiveness of the DZ program, which some scholars are skeptical of, is inconsistently established. These scholars argue that some firms and laborers enter the development zone only for the benefit of the preferential policies, which do not substantially bring benefits to the local development and even have a crowding-out effect on the efficiency and survival period of surrounding firms (Glaeser et al., 2010; Hanson and Shawn, 2013). The key challenge in identifying the causal effects of DZs is the self-selection of location choice in DZ. Two empirical strategies are mainly used in the existing literature. One way is to construct a fitting variable as the instrument variables of the DZ and use a two-stage least square method (2SLS) for empirical test (Xi et al., 2021). The other approach is to use the difference-in-difference model and the PSM to control the unobservable and time-invariant differences between the treatment group and the control group (Heckman et al., 1998), which is adopted in this article. The advantage of this method is that it deals well with the sample selection bias and self-selection bias of the model. In this article, we use the PSM to solve the "counterfactual situation" of the counties that have established DZs in the absence of a DZ in the sample data. For counties with DZs, the matching characteristics of counties without DZs are selected as close as possible to ensure that the development trajectory of the treatment and control groups before the establishment of the DZ is "parallel" except for the feature of "establishment of the DZ". Furthermore, this article uses a mediating effects model to verify the mechanism of the DZs' impact on population urbanization.

The literature on the impact of DZs on population urbanization is limited but mainly has two aspects. One aspect is the impact of DZs on labor migration from the perspective of employment creation, and most of the studies are empirical. Chaudhary and Potter (2019) combed through 33 articles that evaluated the employment creation effects of DZs in the United Kingdom, the United States, and France. Of them, 21 concluded that the DZs create more jobs and lower the unemployment rate, for example, Busso et al. (2013) found that the US Federal DZ policy has increased local employment by 15%. The remaining 12 articles hold the opposite view that the DZs have not attracted more labor to move in. The literature on China as a case in this research is limited. Based on the data of the two economic censuses in 2004 and 2008, Lu et al. (2019) found that China's DZs have created additional jobs. However, the migration of labor to DZs is only the first stage of population urbanization, and research on the impact of the establishment of China's DZs on population urbanization needs to be expanded on this basis. Another document takes individual DZs as a case to explore the characteristics of population changes in DZs. Wei et al. (2015) took Guangzhou Private Technology Park as an example and explored the transition path of DZs from a single industrial zone to a comprehensive zone suitable for living and working under the background of new urbanization. Wang et al. (2018) used the DZs of Hangzhou as an example to explore the problem of the agglomeration and re-flow of the floating population in the DZs and pointed out that most of the floating population in the DZs is in a "semi-urbanized" non-settled state. Yang et al. (2019) empirically studied the multi-dimensional nature of immigrant and non-immigrant livelihoods and their satisfaction in the Nansha DZ in China. Compared with case studies, the article uses a national sample for empirical estimation, and the conclusions obtained are more general.

Compared with the existing literature, the possible extensions of this article are as follows:

First, different from the current research focusing on exploring the economic performance of China's DZs, this study verifies the role of DZs in population urbanization and comprehensively evaluates the policy effects of DZs construction. Moreover, different from the existing literature on the case analysis of the relationship between DZs and urbanization, this study empirically estimates the impact of the DZs on population urbanization and its heterogeneity from the county level across the country, making the research conclusions more universal.

Second, based on the New Economic Geography ("NEG") theory, the theoretical framework of the DZs' influence on population urbanization was constructed. Based on the monopolistic competition model, NEG theory brings the increasing returns to scale, imperfect competition, and transaction costs into the analysis of enterprise location selection. According to the framework of NEG, the establishment of the DZs will break the original spatial structure, and the system will regain a new stable equilibrium under the agglomeration effect, which will impact the flow of non-agricultural workers to the DZ and then affect the population urbanization rate. Moreover, the mechanism of the DZs' effect on urbanization was verified from the two transmission paths, namely, job creation and wage increase.

Finally, existing research on the impact of DZs on urbanization is lack of discussion on the heterogeneity of its impact intensity, which is expanded in this article. This article identifies the factors that affect the impact intensity from different angles, such as the comparative advantage of the leading industry, scale, type and establishment time of the DZ. In addition, this article further discusses the difference of the impact of the expansion of employment scale in the DZ on the population migration of other counties within the city, other cities and other provinces.

This article is further arranged as follows. The next section introduces the institutional background and theoretical hypotheses. The data processing and the construction of econometric models are reported in Section 3. Then, Section 4 empirically examines the impact of DZs on the rate of population urbanization, and Section 5 identify the mechanism of the DZ on population urbanization. Finally, a brief summary and enlightenment are provided.

2. Institutional background and theoretical hypotheses

2.1. Institutional background

Since the reform and opening, with the acceleration of industrialization, China's urbanization has experienced a low starting point and rapid development process. In the process of urbanization, some cities have expanded their built-up areas to obtain more land finance. The growth rate of the urban permanent population and urban built-up area represents the rate of population urbanization and land urbanization, respectively. Fig. 1 shows that land urbanization is faster than population urbanization, which is a typical feature in the process of urbanization in China. This phenomenon of "urbanization of land but not people" has caused considerable rural migrants in cities. In 2018, the number of migrant workers in China reached 288 million, and of which, 170 million were migrant workers who went to work outside the township. During the period 2000–2010, 42% of the new urban population was due to the expansion of urban areas, which resulted in the rural population in urban fringe areas being included in the urban demographics. Another 43% are rural people who come to work in cities, and the phenomenon of "semi-urbanization" is serious.

As the main space carriers of China's land urbanization and industrialization, the DZ is an important policy tool for absorbing the employment of rural migrants, promoting the urbanization of rural migrants, and realizing a new type of people-oriented urbanization. Promoting urbanization through DZ construction is the most representative mode of urbanization in China (Li et al., 2012). At the initial stage of the implementation of the DZ policy, the government adopted a development strategy of "three-oriented and one-dedicate" (i.e.,

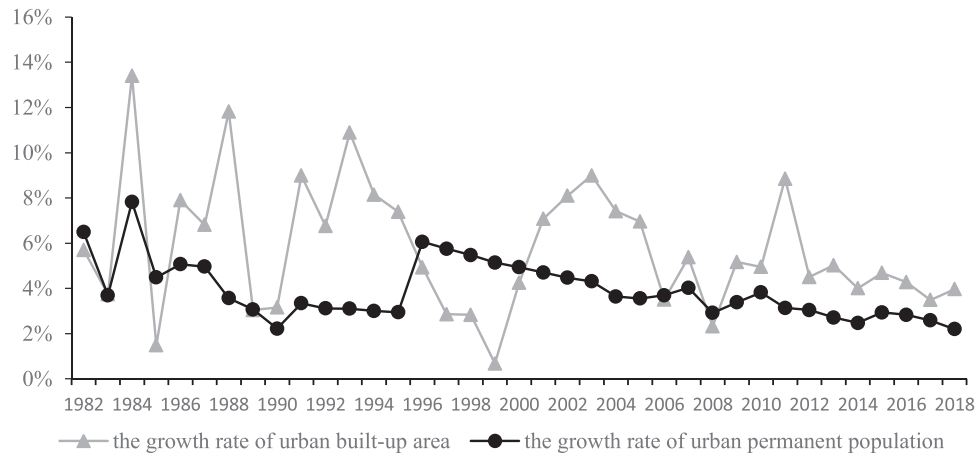

Fig. 1. Comparison of the growth rate of urban permanent population and urban built-up area from 1982 to 2018 in China.

"focusing on industrial projects, attracting foreign investment, and exports and dedicate to the development of high-tech industries"). At this stage, the DZ becomes the main spatial carrier for the agglomeration of non-agricultural industries through infrastructure construction and investment promotion. However, during the construction of the DZs, the supporting facilities for urban functions were neglected. The settlement of several labor-intensive manufacturing firms brought about the migration of rural surplus labor but failed to achieve the citizenization of the migrant population.

In the "Several Opinions on Promoting the Further Improvement of the Development Level of National Economic and Technological Development Zones" issued by the State Council in 2005, the development strategy of the DZ was adjusted to "three-oriented, two-dedicate, and one-promotion" (i.e., focusing on improving the quality of foreign investment, the development of modern manufacturing, and optimizing the export structure; dedicating to the development of high-tech industries and high value-added service industries; and promoted the transformation of national economic and technological development zones into multi-functional comprehensive industrial zones). In 2014 and 2017, the State Council successively issued documents emphasizing that DZs should focus on industrial development while coordinating the construction of urban functions, such as living areas, business areas, and office areas, to promote the development of new urbanization. Under the guidance of the new-type urbanization policy, the construction of China's DZs is changing from "zone construction" to "city building," gradually changing the situation where land and population urbanizations are not synchronized. Taking the land structure of the DZ as an example, in 2018, the proportion of mining warehouse land in the urban construction land in national DZs was 48.5%, showing a downward trend. Among them, the average proportion of mining warehouse land in 110 industry-city-integrated national DZs is only 24.11%, whereas that of residential, commercial, and other living land is on the rise. Evaluation of the impact of DZ on population urbanization is of important guiding significance for improving DZ development strategies and promoting the coordinated development of industrialization and urbanization.

2.2. Theoretical hypotheses

Drawing on the migration model of Tabuchi and Thisse (2002) and Crozet (2004), we investigate a representative mobile rural labor force a from rural area j, choose a region from R areas (including development area i) to engage in non-agricultural labor and live, and focus on analyzing the probability of migration to development area i for employment and residence. We assume that this migration decision depends on the probability of finding a job in each area, the comprehensive comparison of the salary level and the migration cost, and the pursuit of the maximization of the following equation:

$$\pi^a_{ji,t} = V^a_{ji,t} + \varepsilon^a_i = \ln\left(\rho_{i,t}\omega_{i,t}d_{ij}^{-\lambda}\right) + \varepsilon^a_i \tag{1}$$

where $\rho_{i,t}$ represents the probability of migrant rural labor a being employed in the DZ i during the period t, $\omega_{i,t}$ represents its salary level in the DZ, $d_{ij}^{-\lambda}$ is the migration cost increasing with distance, λ is the strict positive coefficient, and ε^a_i is the random interference term, which measures a's preference for all characteristics of DZ i. We assume that the choice of migration in period t is determined by $\pi^a_{ji,t}$ in period t-1. The migrant rural labor force a chooses the development zone i if and only if $V^a_{ji,t-1} > V^a_{jr,t-1}, \forall r \neq i$. Therefore, the probability of selecting DZ i can be expressed by the following ***logit*** equation:

$$P\left(M_{ji,t}\right) = e^{V^a_{ji,t-1}} \Big/ \sum\nolimits_{r=1}^{R} e^{V^a_{jR,t-1}} \tag{2}$$

Denote $L_{j,t}$as the total amount of migrant labor in area j in period t, then the expected migration flow from region j to DZ i is $L_{j,t}P(M_{ji,t})$. Similarly, the total outflow from region j is $L_{j,t}[1 - P(M_{jj,t})]$, so the share of emigrants from region j choosing to go to DZ i is:

$$\frac{migr_{ji,t}}{\sum_{i'\neq j} migr_{ji',t}} = \frac{e^{V^a_{ji,t-1}}}{\sum_{r=1}^{R} e^{V^a_{jr,t-1}} - e^{V^a_{jj,t-1}}} \tag{3}$$

Taking the logarithm of both sides of the above equation, we can get the following form:

$$\ln\left(\frac{migr_{ji,t}}{\sum_{i'\neq j} migr_{ji',t}}\right) = \ln\left(\omega_{i,t-1}\right) + \ln\left(\rho_{i,t-1}\right) - \lambda \ln\left(d_{ij}\right) + \widetilde{a}_{j,t-1} \tag{4}$$

where$\widetilde{a}_{j,t-1} = -\lambda \ln(1 + bF_{ji}) - \ln(\sum_{r=1}^{R} e^{V^a_{jr,t-1}} - e^{V^a_{jj,t-1}})$.

From the above formula, the share of migrant rural laborers choosing to migrate to DZ i among R regions is positively correlated with the probability $\rho_{i,t}$ and the wage level $\omega_{i,t}$ and is negatively correlated with the distance $d_{ij}^{-\lambda}$ between the emigration place and the DZ. Therefore, based on the NEG theory, this article will construct the mechanism of the DZ's impact on population urbanization in terms of job creation and wage increase (Fig. 2). In the process of analysis, the population urbanization is divided into the surplus rural labor force that flows between rural and urban areas, the unstable "Semi-urbanization" stage where non-agricultural jobs are found in cities, and the "Complete urbanization" stage where they have stable employment and live with family members in cities.

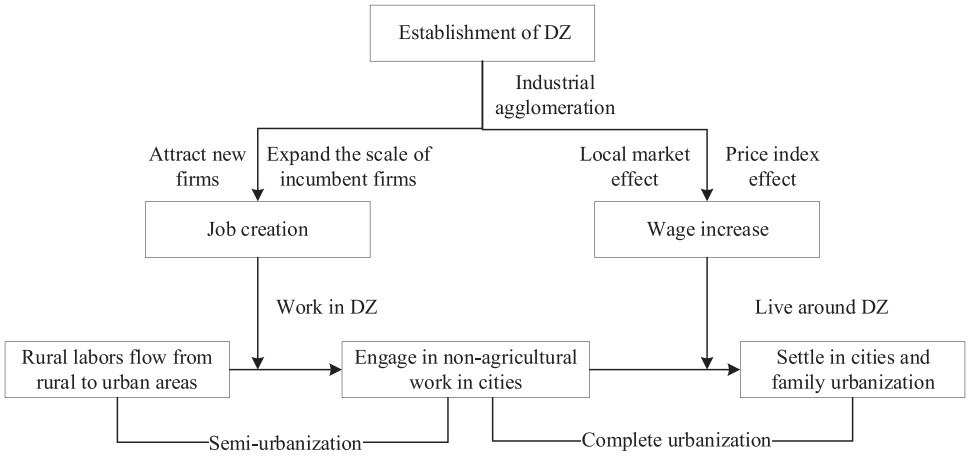

Fig. 2. Mechanism of the DZ's impact on population urbanization.

2.2.1. Job creation in the DZs

The DZ is a government-led industrial agglomeration zone formed by attracting firms through a series of preferential policies or subsidies. Under the theoretical framework of NEG, the establishment of DZs will break the original urban industrial spatial structure, and the system will regain a new stable and balanced spatial structure under the agglomeration effects. Compared with non-DZs, the central and local governments provide DZs with a series of preferential policies, such as tax incentives, financial subsidies, credit facilities, land transfer incentives, and convenient administrative approvals. As a result, the threshold and cost of entering the DZ are lowered, and more firms are concentrated in space, forming an industrial agglomeration zone with high market potential. The NEG model confirms that regions with a high market potential have efficiency advantages, and the source of this advantage is generally attributed to agglomeration economic effects. The agglomeration of similar industries produces Marshall externalities, which improve efficiency through the sharing of intermediate inputs, labor market reservoirs, and knowledge spillover mechanisms. Jacobs' externalities generated by diversified industries will also promote innovation through knowledge spillovers, thereby improving efficiency (Jacobs, 1969). Based on the monopolistic competition model, NEG theory brings the increasing returns to scale, imperfect competition, and transaction costs into the analysis of firm location selection. The theory points out that increasing returns to scale promote firms to concentrate production in a few areas where profits can be maximized, while the existence of transportation costs drives firms to be close to customers and suppliers. The existence of increasing returns to scale and transportation costs drives firms to concentrate production in areas with high market potential.

Different from the industrial agglomeration formed spontaneously by market forces, the DZ is an industrial agglomeration formed by the government providing a series of preferential policies and other policy rents. On the one hand, the entry of several firms will provide more jobs, and on the other hand, the increase in corporate efficiency brought about by industrial agglomeration will prompt incumbent companies to expand their scale to obtain more profits, thereby increasing the supply of jobs. The two mechanisms work together to increase the probability ρ that labor is employed in the DZ, thereby attracting rural surplus labor and increasing the population urbanization rate. Since the reform and opening, DZs have been the main space carrier for job creation, and the newly created jobs provided by national DZs in 2013 alone accounted for more than 25% of the country's total new jobs,[1] in which they absorbed considerable rural surplus labor. Wang et al. (2018) conducted a questionnaire survey of migrant employment in Hangzhou's typical DZ and found that the proportion of agricultural household registration exceeds 60%. Based on the above theories and facts, this article proposes the following hypothesis:

Hypothesis 1. The establishment of the DZ attracts firm agglomeration through "policy rent" and increases the number of jobs by increasing new firms and expanding the scale of incumbent firms, thereby increasing the probability of rural migrant labor being employed in the DZ. That is, the population urbanization rate increases through the employment creation effect.

2.2.2. Wage increase in the DZs

The expansion of market potential brought about by the agglomeration of firms in the DZ will increase the profitability of firms by increasing returns to scale and decreasing transaction costs (Brackman et al., 2004). This case enables firms to pay higher wages to attract labor agglomeration, further expand the final consumer market, and produce a circular cumulative effect. In addition, the agglomeration of firms in the DZ will increase the number of commodity suppliers in the zone and reduce the regional price index, which will help reduce the cost of living of labor and increase the real wage level (Fujita et al., 1999).

The key to new-type urbanization is not only to transfer rural labor to cities but also to stably live in cities for these laborers (Tang and Feng, 2015). The choice of residential location for the rural laborers transferred to cities is determined by weighing wages with housing and commuting costs under the goal of maximizing utility. When the DZ increases the nominal and real wages through the local market effect and the price index effect, based on the diversity of commodities, the labor force obtains the currency externalities and reduces commuting costs brought by transportation costs and economies of scale. Thus, they tend to choose to live in the DZ and its surroundings. Stable employment and residence of labor in the DZ can increase the population urbanization rate. Based on the above analysis, this article proposes the following hypothesis.

Hypothesis 2. The establishment of DZs can increase the real income of rural migrant laborers through the local market effect and price index effect. Moreover, to reduce commuting costs, laborers tend to live in the DZ and its surrounding areas, thereby promoting the population urbanization rate.

Table 1 lists the comparison of urbanization rates and related indicators between counties with newly established DZs and without DZs from 2000 to 2010. Regardless of the average value or the median value, the urbanization rate, employment scale, firm-scale, wage, and welfare level of counties with the newly established DZs are higher than those of counties without DZs. To a certain extent, this finding provides evidence

[1] Data resource: "China Development Zone Yearbook (2013)"

Table 1
Comparison of urbanization rates and related indicators between counties with and without DZs.

	Samples	Urbanization Urb	Employment Emp	Firm Number Num	Wage Wag	Welfare Wel
Mean	DZs	0.5114	9.6141	4.2869	12.6696	10.3181
	Non-DZs	0.4572	8.7988	3.5224	11.8915	9.5137
Median	DZs	0.4343	9.6173	4.2485	12.5518	10.2332
	Non-DZs	0.3724	8.9554	3.5553	11.9424	9.5897

Note: See below for the identification and definition of samples of newly established DZs and non-DZs.

for the above two hypotheses. However, we cannot conclude that the establishment of DZs has promoted the population urbanization rate, and the empirical test still needs to be carried out through the following quantitative regression.

3. Data and methods

3.1. Data processing

The population data of this article are derived from "China 2010 Census Data by Counties" and "China 2000 Census Data by Counties." When constructing the measurement model, the data of the counties in 2000 and 2010 should be matched. However, the administrative divisions at the county level across the country have undergone significant adjustments during the period 2000–2010, so the county administrative divisions need to be processed in a unified manner. Based on the 2010 county-level administrative division, the following adjustments were made to the 2000 counties. First, the counties that were merged from 2000 to 2010 were merged in 2000. Second, the counties whose names are changed are unified to counties in 2010. Third, in response to the situation where the county was divided into multiple districts during 2000–2010, the counties in 2010 were merged. After matching, a total of 2854 county-level unit samples were obtained. In addition, in the empirical process, the census data should be matched with the industrial data of the counties summarized from the "Annual Survey of Industrial Firms". To alleviate the endogeneity, the industrial data lag for a period. Therefore, this study based on the 2854 counties obtained from the previous matching and adjusted the administrative divisions of the counties in 1999 and 2009 accordingly.

According to "China Development Zone Audit Announcement Catalogue (2018 Edition)," this article picks up the latitude and longitude coordinates of the DZ management committee established during 2001–2009 to identify the county where the DZ is located, and then match it with the county code. With these steps, this study obtained 655 treatment groups (i.e., counties that have DZs from 2001 to 2009) and 1844 control groups (i.e., counties that did not have DZs before 2010). The scope of the DZ's impact on the population urbanization evaluated in this study includes the permanent population in and outside the DZ within the county. The reasons are twofold. On the one hand, the existing statistics on the permanent population are based on the basic administrative division unit. Except for some DZs with independent nine-digit township codes, most DZs cannot accurately identify the permanent population in the zone level. On the other hand, the labor force attracted by industrial agglomeration in the DZ tends to choose to live in the zone and its surroundings after weighing wages with housing and commuting costs. Therefore, DZ policies will have an important impact on the urbanization process of the permanent population in the counties. In addition, the data of prefecture-level and above cities involved in this article are from the "China City Statistical Yearbook" and "China Regional Statistical Yearbook." Moreover, the area data of counties are from the "Administrative Divisions of the People's Republic of China 2011." The relevant data of manufacturing firms are from the Annual Survey of Industrial Firms compiled by the National Bureau of Statistics of China. The two censuses provided variables related to the county population, and the geographic slopes of counties were extracted from the ASTER Global Digital Elevation Model of NASA. The land supply situation came from China's state-owned construction land supply database.

3.2. Models

The establishment of DZs by the central and local governments is a concrete manifestation of their development strategy. It is a decision made after comprehensive consideration of many factors, such as geographic location and economic development level, and is not the result of random selection (Li and Shen, 2015). Therefore, to eliminate the estimation bias caused by the self-selection effect in the establishment of the DZ, this study uses PSM to control the unobservable and time-invariant differences between the treatment and control groups. Then, by comparing the changes in the urbanization rate between the matched treatment and control groups, the policy effect of the DZs on urbanization is estimated. However, the comparison should also consider the changes in the urbanization rate after 2001 because of the changes in external economic and social and other factors. Hence, this study adopts the PSM-DID proposed by Heckman et al. (1998) for estimation, which can overcome the self-selection effect and solve the endogeneity problem caused by missing variables.

3.2.1. Propensity score matching

The core logic of this method is to solve the "counterfactual situation" of the counties that have established DZs in the absence of a DZ in the sample data, and use semi-parametric estimation methods to estimate the propensity score (*PS*) value of the establishment of DZs. Furthermore, for counties with DZs, the matching characteristics of counties without DZs are selected as close as possible to ensure that the development trajectory of the treatment and control groups before the establishment of the DZ is "parallel" except for the feature of "establishment of the DZ". According to existing theoretical and empirical literature (Deng et al., 2015; Yang and Wang, 2008; Xi and Mei, 2022), the variables selected in this study to estimate the propensity score matching method (PSM) include the following: whether to establish a development zone before 2001 (*Zo01*), population density (*Den*), the geographic slope of the county (*Slo*), distance from county to city center[2] (*Dis*), the proportion of the output value of high-tech industries in the manufacturing industry (*Tec*), the labor productivity of the manufacturing industry (*Lef*), and the administrative level of the city (*Cit1, Cit2*). After the propensity score value *PS* is estimated, each county in the treatment group is matched with the county that is closest to its propensity score value in the control group. The variables will be more evenly distributed between the matched treatment and control groups, satisfying the "balance condition." Moreover, the "overlap assumption," that is, counties in the treatment and control groups exist at any possible value of the variable, should be satisfied to ensure that both groups have the same part of the propensity score range. After the matching is completed, the DID method is used to calculate the average treatment effect.

[2] This is measured by the distance from the seat of the county government to the seat of the municipal government.

3.2.2. Difference-in-difference

Choosing the DID method can avoid the endogenous problems caused by the omission of variables and estimate the impact of the establishment of DZs on the local urbanization rate. The dummy variable *Zo* represents whether the counties approved the establishment of DZs at the provincial level and above during the period 2001–2009. If established, then we assign *Zo* a value of 1, and 0 if otherwise. Moreover, we set the time dummy variable *Tim*, and the value is 0 in 2000 and 1 in 2010. *Zot* is the cross term of *Zo* and *Tim*, and its regression coefficient is the core coefficient of interest in this article. We estimate the following DID model:

$$Urb_{i,t} = \alpha_0 + \alpha_1 Zo_{i,t} + \alpha_2 Tim_{i,t} + \alpha_3 Zot_{i,t} + \theta X_{i,t-1} + \varepsilon_{i,t} \quad (5)$$

where $Urb_{i,t}$ is the urbanization rate of the permanent population of the county i in year t, expressed as the ratio of the urban permanent population to the total permanent population; $X_{i,t-1}$ is an observable control variable that affects the urbanization rate with a lag of one period. By combing the previous literature, this study selects the control variables at the county and city levels. The control variables at the county level include distance to the city center (*Dis*), geographic slope of the county (*Slo*), Size of DZs (*Are*), the proportion of high-tech industry output value in manufacturing (*Tec*), the proportion of employees in state-owned firms (*Sta*), proportion of employees in foreign-funded firms (*For*), natural population growth rate (*Gro*), and population aging degree (*Old*). The control variables at the city level include the logarithm of GDP per capita (*Pdp*), the proportion of government expenditure in GDP (*Pge*), the logarithm of fixed asset investment per labor (*Lnk*), the number of hospital beds (*Med*), and the number of teachers per capita in primary and secondary schools (*Edu*). $\varepsilon_{i,t}$ is the random interference term. Table 2 presents the descriptive statistics of each variable used in the empirical study.

4. Results

4.1. Benchmark

The PSM method is used to simulate the "counterfactual situation" of the counties without DZs. To keep the sample to the maximum and minimize the mean square error, this study adopts one-to-four matching within the caliper with replacement (Abadie and Imbens, 2006). The Probit model is used to estimate the propensity score value PS, and the Kernel Matching determines the weight, which only matches the individuals within the common value range. By calculating 1/4 of the standard deviation of the propensity score, we get $0.25\widehat{\sigma}_{pscore} \approx 0.025$, and the caliper range is set to 0.02, which means one-to-four matching of observations with a 2% difference in the propensity score. In addition, the premise of the reliability of PSM is to satisfy the conditional independence, that is, no difference exists in observable variables between the matched treatment and control groups, so further matching balance tests are required.

Table 3 reports the Probit regression results and balance test for PSM. By eliminating samples that cannot find matching objects, a sub-sample containing 2724 counties is finally obtained. The results show that the selected observable variables all have an impact on the decision to establish a development zone. Compared with before matching, the standard deviation (%bias) of each observable variable is significantly reduced, and the absolute value is significantly less than 5%, indicating that the matching result is good (Rosenbaum and Rubin, 1983). The concomitant probability value of the T test also shows that the difference in observable variables between the matched treatment and control groups is no longer significant. The changes before and after the standardization deviation of each variable in Fig. 3 show that the standardization deviation of each variable is significantly reduced after the matching. Hence, the post-matching treatment and control group counties have the same characteristics in the initial year, that is, the two groups of counties have similar probabilities for establishing new DZs from 2001 to 2009, and thus, effective comparisons can be made.

We use the matched sub-samples for DID estimation, and Table 4 shows the results. Column (1) shows the result of not controlling any fixed effects, and column (2) presents the results of further controlling the fixed effect of the city. To eliminate the estimation bias caused by the selection of the matching method, the sample in column (3) adopts the matching method of local linear regression to determine the weight and uses the logit model to estimate the propensity score value PS. The matched sample is subjected to DID regression. Column (4) shows the result of considering only provincial DZs.[3] The particularity of municipalities may have an impact on the regression results as it is directly under the Central Government. Column (5) excludes the samples of municipalities and provincial capitals for re-estimation.[4] The results show that the *Zot* coefficients of all models are positive and significant at least at the 10% confidence level, and the coefficients of each column are close to one another. Therefore, the establishment of DZs can effectively promote population urbanization, and the conclusions are very stable. On average, the establishment of DZs can increase the urbanization rate of the local permanent population by approximately 2–4%.

Among other factors, the distance to the city center and the geographical slope have a significant negative effect on the urbanization rate, that is, the distance from the center and uneven terrain significantly hinder the urbanization process. The size of the DZ significantly contributes to the population urbanization in the county. The proportion of high-tech industries has a significant positive effect on the local urbanization rate, indicating that high-tech industries have significant advantages in attracting employment and promoting labor agglomeration. The share of state-owned firms and foreign-funded firms can effectively promote local urbanization, and the degree of aging has a negative impact on the urbanization rate. Economic and social factors such as per capita GDP, the proportion of government expenditures, fixed asset investment per labor, the number of hospital beds, and the number of teachers per student have a positive impact on the local urbanization rate, which is in line with theoretical expectations.

4.2. Robustness test

To improve the robustness of the estimation results, this study selects the DZs approved and established in 2006 as the treatment group to re-regress. The year 2006 was chosen because the number of DZs approved and established in 2006 reached 661, accounting for approximately 70% of the total number during the period 2001–2010. Census data are only available in 2000 and 2010, so the population data of 2000 and 2010 are still used to measure the urbanization rate before and after the establishment of the DZ approved in 2006, similar to Lu et al. (2019). The *Probit* regression results of PSM are still robust, and the balance test ensures the validity of the matching. Table 5 shows the results of DID estimation for the treatment and control groups obtained after matching. In column (1), the establishment of DZs in 2006 has a significant positive impact on the local urbanization rate. In column (2), which controls the fixed effects of cities, the DZ has a positive effect on the urbanization rate. In column (3), which only considers the sample of provincial DZs, and column (4), which excludes the samples of municipalities and provincial capitals, the coefficient is still significantly positive.

Furthermore, according to Tang and Wang (2015), the county-to-district reform stimulated population migration and produced

[3] As provincial-level DZs account for more than 80% of the total zones, and the samples of national-level DZs are small, the results of national-level DZs are no longer considered separately. For the same reason, column (5) no longer considers the results of municipalities and provincial capitals separately.

[4] Columns (4) and (5) have been matched with separate samples. Considering space limitations, we did not include a report.

Table 2
Descriptive statistics.

Variables	Symbol	N	Mean	Standard Deviation	Maximum	Minimum
Urbanization	*Urb*	5695	0.4247	0.2901	1	0
Cross-terms	*Zot*	5708	0.1148	0.3187	1	0
Policy variables	*Zo*	5708	0.2302	0.4210	1	0
Distance to city center	*Dis*	5682	51.7589	47.3242	338.2802	0.4275
Geographic slope	*Slo*	5708	1.9821	2.3859	16.4204	0
Size of DZ	*Are*	5708	0.0627	0.1288	2.7767	0
Proportion of high-tech industry	*Tec*	5478	0.0492	0.1114	1	0
Proportion of state-owned firms	*Sta*	5478	0.3204	0.3172	1	0
Proportion of foreign-funded firms	*For*	5478	0.0467	0.0935	1	0
Natural population growth rate	*Gro*	5695	5.5682	3.9450	23.2551	-8.9500
population aging degree	*Old*	5695	0.0776	0.0226	0.1900	0.0039
GDP per capita	*Pdp*	5619	9.3107	0.9205	11.8086	4.5951
Proportion of government expenditure	*Pge*	5631	0.1296	0.1452	1.2492	0
Fixed asset investment per labor	*Lnk*	5632	8.3584	1.3769	11.5572	5.1963
Number of hospital beds	*Med*	5223	9.2117	0.8814	11.4925	5.9558
Number of teachers per capita	*Edu*	5233	0.0583	0.0135	0.1084	0.0256
Wage	*Wag*	5498	11.358	1.9003	17.8601	3.4012
Welfare	*Wel*	5441	9.1465	1.8938	15.0729	0.6931
Proportion of immigrant population	*Imm*	5695	0.1409	0.1337	0.9204	0.0015
Employment scale	*Emp*	5478	8.9329	1.6622	14.5991	1.6094
Number of companies	*Num*	5392	3.5068	1.3634	8.4617	0
Housing area per capita	*Hou*	5694	25.7529	8.1606	68.4600	1.0600

Table 3
Propensity score matching and balance test.

The results of Probit		Balance Test					
			Mean		%bias	t-test	
Variables	Coefficient		Treated	Control		t	p > t
Zo01	-0.3563 ***	Before	0.134	0. 158	-7.0	-1.52	0.128
	(0.0812)	After	0.134	0. 128	1.7	0.32	0.751
Slo	-0.0752 ***	Before	1.404	2.127	-33.4	-6.79	0.000
	(0.0145)	After	1.406	1.422	-0.8	-0.17	0.868
Cit1	0.1542 *	Before	0.143	0.112	9.2	2.09	0.037
	(0.0856)	After	0.143	0.144	-0.2	-0.03	0.976
Cit2	0.7584 ***	Before	0.060	0.026	17.2	4.25	0.000
	(0.1506)	After	0.059	0.055	1.8	0.28	0.777
Tec	0.3093	Before	0.056	0.045	9.60	2.14	0.032
	(0.2529)	After	0.056	0.054	2.0	0.34	0.732
Lef	0.0014 ***	Before	103.530	86.758	24.3	5.65	0.000
	(0.0004)	After	103.530	102.110	2.1	0.34	0.736
Den	-0.0001 ***	Before	999.740	1113.500	-3.70	-0.75	0.453
	(0.0000)	After	999.740	1050.300	-1.70	-0.35	0.724
Dis	-0.0053 ***	Before	39.087	54.275	-37.1	-7.49	0.000
	(0.0008)	After	39.087	39.275	-0.50	-0.10	0.921

Note: Standard errors in parentheses, ***, **, and * indicate significance at the levels of 1%, 5%, and 10%, respectively, which is the same as the following tables.

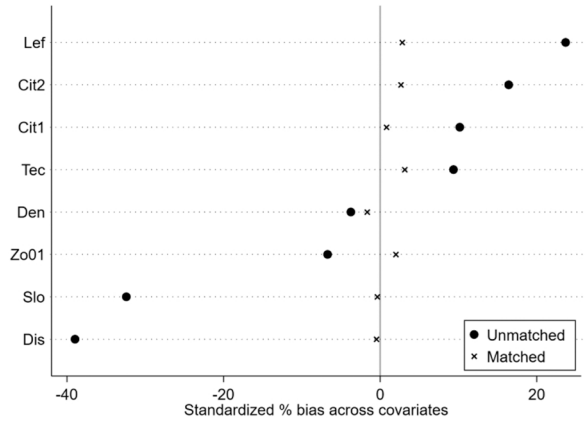

Fig. 3. Standardized deviation.

the effect of population urbanization. Compared with the county, the district is more attractive to the agglomeration of non-agricultural population. Thus, to control the influence of differences between districts and counties, the binary variable *Dst* is added into the model; that is, if it is a district, *Dst*= 1; otherwise, *Dst*= 0. The estimated results are shown in column (5). After adding the district/county binary variable, the effect of the *Zot* remains significant. Hence, the DZ has a relatively stable promotion effect on the urbanization rate.

4.3. Heterogeneity

4.3.1. Heterogeneity of comparative advantages of the leading industries

Several studies in China apply the theory of comparative advantage to the analysis of the effects of industrial policies, and the research conclusions all confirm that the coincidence of the industrial sector and the comparative advantages of the region has a significant role in promoting the effect of industrial policies (Chen and Xiong, 2015; Li and Shen, 2015). DZs follow comparative advantages to establish leading industries, which is more conducive to exploiting the potential of location endowments. This case promotes the agglomeration of leading

Table 4
Results of the impact of DZs on urbanization.

	(1)	(2)	(3)	(4)	(5)
	Urb	*Urb*	*Urb*	*Urb*	*Urb*
Zot	0.0263 *	0.0245 *	0.0278 **	0.0206 *	0.0260 **
	(0.0142)	(0.0125)	(0.0130)	(0.0126)	(0.0129)
Zo	-0.0029	-0.0062	-0.0082	-0.0029	-0.0225 *
	(0.0105)	(0.0107)	(0.0118)	(0.0112)	(0.0116)
Tim	-0.0731 ***	0.0139	0.0117	0.0421	0.0768 **
	(0.0188)	(0.0310)	(0.0359)	(0.0324)	(0.0340)
Dis	-0.0024 ***	-0.0029 ***	-0.0029 ***	-0.0029 ***	-0.0022 ***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Slo	-0.0143 ***	-0.0215 ***	-0.0209 ***	-0.0216 ***	-0.0246 ***
	(0.0014)	(0.0023)	(0.0027)	(0.0024)	(0.0026)
Are	0.2788 ***	0.1859 ***	0.1657 ***	0.2462 ***	0.5181 ***
	(0.0198)	(0.0215)	(0.0255)	(0.0255)	(0.0341)
Tec	0.2542 ***	0.2784 ***	0.3345 ***	0.3102 ***	0.1766 ***
	(0.0301)	(0.0301)	(0.0379)	(0.0319)	(0.0355)
Sta	0.1330 ***	0.1283 ***	0.1436 ***	0.1262 ***	0.0660 ***
	(0.0142)	(0.0150)	(0.0176)	(0.0154)	(0.0159)
For	0.1323 ***	0.0773 *	0.0046	0.0560	0.1399 ***
	(0.0386)	(0.0414)	(0.0487)	(0.0446)	(0.0467)
Gro	-0.0097 ***	-0.0093 ***	-0.0107 ***	-0.0101 ***	-0.0074 ***
	(0.0011)	(0.0014)	(0.0018)	(0.0015)	(0.0014)
Old	-2.8157 ***	-2.8177 ***	-2.6162 ***	-2.7754 ***	-3.9007 ***
	(0.1895)	(0.2516)	(0.2930)	(0.2622)	(0.2740)
Gdp	0.1019 ***	0.0278	0.0211	0.0215	0.0271
	(0.0102)	(0.0170)	(0.0209)	(0.0177)	(0.0170)
Pge	0.1321 ***	0.4160 ***	0.3969 ***	0.3964 ***	0.3426 ***
	(0.0466)	(0.0771)	(0.0891)	(0.0790)	(0.0786)
Lnk	0.0189 **	0.0168	0.0208 *	0.0105	-0.0057
	(0.0077)	(0.0102)	(0.0121)	(0.0106)	(0.0101)
Med	0.0017	0.0398 *	0.0606 **	0.0397	0.0520 **
	(0.0047)	(0.0235)	(0.0282)	(0.0248)	(0.0240)
Edu	2.9676 ***	1.0935 *	1.1801 *	1.2336 **	1.1646 **
	(0.3194)	(0.5938)	(0.6863)	(0.6129)	(0.5886)
City fixed effect	NO	YES	YES	YES	YES
N	4894	4891	3416	4531	4023
R^2	0.4399	0.6221	0.6509	0.6108	0.6228

Table 5
Robustness test.

	(1)	(2)	(3)	(4)	(5)
	Urb	*Urb*	*Urb*	*Urb*	*Urb*
Zot	0.0313 **	0.0354 ***	0.0327 **	0.0354 **	0.0190 *
	(0.0155)	(0.0134)	(0.0135)	(0.0138)	(0.0105)
Zo	-0.0271 **	-0.0274 **	-0.0220 *	-0.0371 ***	0.0039
	(0.0115)	(0.0120)	(0.0124)	(0.0131)	(0.0078)
Tim	-0.0407 **	-0.0117	-0.0060	0.0640 *	-0.0394 ***
	(0.0199)	(0.0330)	(0.0343)	(0.0364)	(0.0140)
Dst					0.3773 ***
					(0.0060)
N	4332	4328	4037	3521	4894
R^2	0.5042	0.6790	0.6817	0.6883	0.7027

Note: Due to space limitations, the results of controlled variables are not reported, which is the same as the following tables.

industries and high-quality development and then the process of local urbanization by creating more jobs and raising wages. Learning from the practice of Chen and Xiong (2015), the present study obtains the industry of each DZ from the "China Development Zone Audit Announcement Catalog (2018 Edition)" and matches it with the two-digit industry code in the "Classification of National Economic Industries (GB/T4754–2002)".[5] Then, the industry location entropy *S* at the county level is used to measure the comparative advantages of the leading industries in the DZ. According to the location entropy *S*, the DZs are divided into two groups, that is, dominant industries with and without comparative advantage. The sub-sample regression is performed, and Table 6 shows the results. Regardless of the classification method used, DZs with comparative advantages in leading industries have a more significant role in promoting the local urbanization rate, and the intensity of their effects is greater than that of DZs without comparative advantages. From the empirical results, DZs that follow

[5] The specific matching operations are divided into three categories. First, the key industry names are relatively clear and direct matching. For example, "biomedicine" matches "medicine manufacturing industry (code 27)," "automobiles and parts" matches, "transportation equipment manufacturing industry (code 37)," and others. The second is to remove modified words and match them according to their subject. For example, "chemical plastics" is matched to "plastic products industry (code 30)" according to its subject "plastics." The third is that independent nouns or names are relatively vague and need to be explained before matching. For example, "Optical Mechatronics" generally includes laser, microelectronics, computer, information, and mechanical technology, so it can correspond to electrical machinery and equipment manufacturing (code 39) and communication equipment, computers, and other electronic equipment manufacturing (code 40).

Table 6
Heterogeneity of comparative advantages of leading industries.

Classification	(1) by median		(2) by 1.5		(3) by 2	
	S< =2.6	S> 2.6	S< =1.5	S> 1.5	S< =2	S> 2
Zot	0.0152	0.0250 *	0.0191	0.0237 *	0.0226 *	0.0232 *
	(0.0130)	(0.0138)	(0.0137)	(0.0134)	(0.0135)	(0.0138)
Zo	0.0209 *	-0.0424 ***	0.0054	-0.0175	0.0153	0.0064
	(0.0119)	(0.0125)	(0.0137)	(0.0117)	(0.0129)	(0.0119)
Tim	0.0341	0.0149	-0.0161	0.0244	0.0403	0.0069
	(0.0329)	(0.0381)	(0.0355)	(0.0352)	(0.0343)	(0.0374)
N	3473	3480	2807	4150	3123	3834
R^2	0.6805	0.6617	0.7114	0.6230	0.6836	0.6348

Note: City fixed effects are controlled, which is the same as the following tables.

their comparative advantages to select leading industries can better promote the local urbanization rates.

4.3.2. Heterogeneity of scale

Table 7 reports the difference in the impact of DZ scale on the urbanization rate. First, we perform a sub-sample regression based on the median of the approved area of the DZ and then a sub-sample regression based on the median of the proportion of the approved area of the DZ in the county. The results show that DZs with a relatively small area can better promote the local population urbanization. Under the wave of the establishment of DZs, local governments have a tendency to blindly construct DZs to increase local fiscal revenue, which has led to the rapid expansion of the number and area of DZs, thereby weakening their agglomeration economy effects and hindering the population urbanization.

4.3.3. Heterogeneity of type

According to the "China Development Zone Audit Announcement Catalogue", the development zones are divided into three categories: economic-technical development zone (ETDZ), high-technical industrial development zone (HTDZ) and other types. Table 8 reports the impact of different types of DZs on the urbanization rate. According to the estimation results, only the ETDZs significantly promote urbanization, while HTDZs and other types are insignificant. ETDZ is the type of development zone with the largest number and the earliest start-up time in China. Since the establishment of the first batch of 14 ETDZs from 1984 to 1988, the construction experience and management mode of ETDZs have been quite mature, and the living facilities are relatively complete. Therefore, ETDZs are relatively attractive to the employment and housing of the population, resulting in a significant effect on the urbanization rate.

4.3.4. Heterogeneity of establishment time

After the establishment of the DZs, the intensity of impact on the urbanization rate may change over time. Therefore, according to the establishment time of the DZ during the study period, this study divides the sample into establishment time less than 5 years and more than 5 years, and less than 6 years and more than 6 years. The sub-sample regression is carried out, and Table 9 shows the results.

The shorter the development zone is established, the greater the promotion of the local urbanization rate. In the later stage of the establishment, the promotion of the urbanization rate is no longer significant. Hence, the establishment of the DZs also has weak sustainability in attracting the employed population.

4.3.5. Heterogeneity of the city scale where the DZ is located

Table 10 reports the impact of DZs in cities of different sizes on the urbanization rate. This article categorizes the sample cities into three categories based on the "Notice on Adjusting the Criteria for City Size Classification" issued by the State Council in 2014. The resident population is less than 500,000 as small cities, 500,000–1000,000 are medium-sized cities, and more than 1000,000 are large cities.[6] The number of permanent residents in urban areas comes from the "China Urban Construction Statistical Yearbook." Columns (1)– (3) of Table 10 show the estimated results of small, medium, and large cities. The results show that only the DZs in small cities have a significant positive impact on the urbanization rate at the 10% confidence level. Although the coefficient of DZs in medium cities and large cities is still positive, the impact is not significant. Furthermore, column (4) reports the results of

Table 7
Heterogeneity of scale.

Classification	(1) by median of approved area		(2) by median of proportion of area	
	Below median	Above median	Below median	Above median
Zot	0.0553 ***	0.0178	0.0398 ***	-0.0016
	(0.0141)	(0.0192)	(0.0128)	(0.0139)
Zo	-0.1336 ***	0.0273 *	-0.0447 ***	0.0266 **
	(0.0161)	(0.0163)	(0.0121)	(0.0118)
Tim	-0.0027	-0.0005	0.0065	0.0434
	(0.0400)	(0.0425)	(0.0343)	(0.0360)
N	2337	2537	3385	3384
R^2	0.6514	0.7003	0.6432	0.6605

Table 8
Heterogeneity of type.

Classification	(1) ETDZ	(2) HTDZ	(3) other types
Zot	0.0224 *	0.0145	0.0250
	(0.0126)	(0.0198)	(0.0212)
Zo	-0.0043	0.0739 **	0.0175
	(0.0111)	(0.0296)	(0.0234)
Tim	0.0204	0.0391 *	-0.0235
	(0.0331)	(0.0202)	(0.0329)
N	4463	1800	2089
R^2	0.6340	0.9147	0.8847

Table 9
Heterogeneity of establishment time.

Classification	(1)		(2)	
	< =5 years	> 5 years	< = 6 years	> 6 years
Zot	0.0557 ***	0.0020	0.0490 ***	0.0108
	(0.0127)	(0.0140)	(0.0128)	(0.0144)
Zo	-0.0359 ***	0.0448 ***	-0.0342 ***	0.0368 ***
	(0.0115)	(0.0135)	(0.0115)	(0.0136)
Tim	0.0086	0.0102	0.0114	0.0197
	(0.0338)	(0.0366)	(0.0328)	(0.0387)
N	3841	3307	3878	3270
R^2	0.6263	0.6005	0.6281	0.5999

[6] The sample of large cities includes supercities and megacities.

Table 10
Heterogeneity of the city size.

Classification	(1)small city *Urb*	(2)medium city *Urb*	(3)large city *Urb*	(4)total city *Urb*
Zot	0.0296 *	0.0332	0.0305	0.1097 ***
	(0.0183)	(0.0239)	(0.0210)	(0.0371)
*Zot*ln(city size)*				-0.0174 **
				(0.0078)
Zo	-0.0163	-0.0456 **	-0.0123	-0.0309 **
	(0.0167)	(0.0206)	(0.0172)	(0.0127)
Tim	-0.0014	0.0572	-0.0325	-0.0360
	(0.0430)	(0.0765)	(0.0519)	(0.0385)
N	1436	1366	1973	4213
R^2	0.6753	0.6228	0.6448	0.5465

estimating the cross-term between the DZ and the city size, and the coefficient of the cross-term is significantly negative at the 10% confidence level, which implies that the DZ's role in promoting urbanization will show a diminishing marginal effect as the size of the city increases. The possible reason for this phenomenon is that the expansion of the scale of the city to a certain extent will bring about an increase in the cost of living and thus weaken the promotion effect of DZs on urbanization.

5. Mechanism analysis

The conclusion of the benchmark regression shows that the DZs have increased the urbanization rate of the permanent population. Based on the theory of NEG, this part will explore the mechanism of DZs' effect on urbanization from the two transmission paths of job creation and wage increase and verify the two hypotheses proposed above. This article draws on the methods of Baron and Kenny (1986) and Shi et al. (2018) and adopts mediating effect model to verify these two mechanisms. The principle of mediating effect considers the influence of independent variable X on dependent variable Y. If X affects Y by influencing variable M, then M is called mediator variable. Based on this method, we first regress the *Zot* with the employment scale and wages (welfare). If the coefficient is significantly positive, then the DZs have created employment and increased wages. Second, we regress the *Zot* and the population urbanization rate (*Urb*). If the coefficient is significantly positive, then the DZs can promote the population urbanization rate. Third, we regress the *Zot*, employment or wage (welfare) and the population urbanization into the model. If the coefficient of the *Zot* is no longer significant or significantly reduced or the coefficient value becomes smaller, then the DZs have promoted the increase of the local urbanization rate through employment creation and wage increase mechanisms. According to the above steps, the following models are set up.

Step 1: Test the impact of DZs on employment or wages (welfare).

$$Emp_{i,t}\left(Wag_{i,t}\right) = \beta_0 + \beta_1 Zo_{i,t} + \beta_2 Tim_{i,t} + \beta_3 Zot_{i,t} + \theta X_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

Step 2: Test the impact of DZs on population urbanization.

$$Urb_{i,t} = \gamma_0 + \gamma_1 Zo_{i,t} + \gamma_2 Tim_{i,t} + \gamma_3 Zot_{i,t} + \theta X_{i,t-1} + \varepsilon_{i,t} \quad (7)$$

Step 3: Test the existence of an employment creation mechanism or wage (welfare) increase mechanism:

$$Urb_{i,t} = \delta_0 + \delta_1 Zo_{i,t} + \delta_2 Tim_{i,t} + \delta_3 Zot_{i,t} + \delta_4 Emp_{i,t}\left(Wag_{i,t}\right) + \theta X_{i,t-1} + \varepsilon_{i,t} \quad (8)$$

Restricted by the micro-data of industries at the county level, this section uses the manufacturing industry as the object for empirical testing.

5.1. Employment creation mechanism

The DZ has caused firms to agglomerate in space, forming an industrial agglomeration area with high market potential. The NEG model confirms that regions with a high market potential have efficiency advantages, and the source of this advantage is generally attributed to the agglomeration economic effect. On the one hand, the industrial agglomeration brought by the DZs promotes the expansion of the production scale of incumbent firms. On the other hand, such agglomeration attracts the entry of new firms, which in turn increases jobs, increases the probability of employment in the zone, and attracts migrants to engage in non-agricultural work. To verify this mechanism, this article uses the Annual Survey of Industrial Firms to explore whether the DZ creates more employment opportunities and promotes population urbanization.

As shown in Table 11, the first stage regression results show the impact of the DZs on the local employment scale (*Emp*) estimated by using the PSM-DID model. Column (1) shows the estimation of the overall impact of the DZs on the scale of local employment, and the results show that the DZ has significantly promoted the growth of local employment under the 1% confidence level. Columns (2) and (3) further present the impact of the DZs on the entry of new firms and the expansion of the scale of incumbent firms in terms of the number of firms (*Num*) and the employment scale of incumbent firms (*Emp_ic*). Both are significantly positive at the 1% confidence level. Thus, the DZ can not only attract the entry of new firms but also promote the expansion of the employment scale of incumbent firms, thereby increasing the local employment scale. Then, we verify whether the DZ has increased population urbanization through the employment creation mechanism. The regression results of the second stage show the impact of the DZs on population urbanization (*Urb*), as shown in Column (4), and the DZ at the 5% confidence level has significantly promoted population urbanization. In the third stage, *Zot* and local employment scale (*Emp*) were added to the regression of population urbanization simultaneously. Column (5) shows the results. The coefficient of *Zot* is no longer significant, which verifies the existence of the employment creation mechanism in the DZs.

5.2. Wage (welfare) increase mechanism

The DZ is a government-led industrial cluster formed by attracting firms through a series of preferential policies or subsidies. Under the influence of the local market effect and the price index effect, DZs increase the nominal and real wages of labor, promote the stable living of labor in the DZ and its surrounding areas, and promote the local urbanization rate. This part also uses the mediating effect method to verify this hypothesis.

As shown in Table 12, the first-stage regression results report the impact of the DZs on the wage (Wag) and welfare (*Wel*). The results in Columns (1) and (2) show that the impact of the DZs on local wages and welfare levels is significantly positive at the 1% confidence level, indicating that the DZs can promote local wages and welfare levels. Column (3) shows the regression results of the second stage. The DZ at the 5% confidence level has significantly promoted the population urbanization

Table 11
Validation of employment creation mechanism.

	Stage 1			Stage 2	Stage 3
	(1) *Emp*	(2) *Num*	(3) *Emp_ic*	(4) *Urb*	(5) *Urb*
Zot	0.1787 ***	0.2092 ***	0.0687 ***	0.0245 *	0.0178
	(0.0580)	(0.0477)	(0.0249)	(0.0125)	(0.0123)
Emp					0.0373 ***
					(0.0032)
Zo	0.0461	0.0048	-0.0329	-0.0062	-0.0079
	(0.0495)	(0.0407)	(0.0210)	(0.0107)	(0.0105)
Tim	-0.0078	-0.2120 *	-0.0462	0.0139	0.0142
	(0.1436)	(0.1182)	(0.0579)	(0.0310)	(0.0305)
N	4891	4814	45,047	4891	4891
R^2	0.6415	0.7136	0.0872	0.6282	0.6393

Table 12
Validation of wage(welfare) increase mechanism.

	Stage 1		Stage 2	Stage 3		
	(1) *Wag*	(2) *Wel*	(3) *Urb*	(4) *Urb*	(5) *Urb*	(6) *Urb*
Zot	0.1913 ***	0.2672 ***	0.0245 *	0.0155	0.0131	0.0150
	(0.0610)	(0.0665)	(0.0125)	(0.0121)	(0.0122)	(0.0121)
Wag				0.0532 ***		0.0545 ***
				(0.0029)		(0.0068)
Wel					0.0471 ***	0.0030
					(0.0027)	(0.0061)
Zo	0.0225	-0.0452	-0.0062	-0.0079	-0.0043	-0.0069
	(0.0521)	(0.0568)	(0.0107)	(0.0103)	(0.0104)	(0.0103)
Tim	1.1612 * **	0.8175 * **	0.0139	-0.0476	-0.0244	-0.0507 *
	(0.1511)	(0.1646)	(0.0310)	(0.0301)	(0.0302)	(0.0302)
N	4879	4829	4891	4879	4829	4829
R^2	0.7089	0.6724	0.6282	0.6538	0.6509	0.6558

rate. The third step is to further verify that the DZ promotes population urbanization through the wage (welfare) promotion effect. The *Zot* and wage (welfare) are put into the model simultaneously to regress on the population urbanization rate (*Urb*), and Columns (4)–(6) present the results. Regardless of whether the wage and welfare variables are added separately or simultaneously, the *Zot* coefficient is no longer significant. Therefore, the wage increase mechanism of the DZ to promote the population urbanization rate has been verified.

6. Discussion

6.1. Employment creation effect and population migration in DZs

The theoretical hypothesis proposes that the DZs will create more employment opportunities, thereby attracting more mobile rural laborers to move in. The probability of mobile laborers choosing to migrate to the DZ is negatively related to the distance between the emigration area and the zones. This part uses the mediating effect method to verify this mechanism, and Table 13 shows the results. The results of the first stage show that the DZ has significantly promoted the scale of local employment. The second stage is to explore the impact of the DZs on the proportion of the migrant population in the permanent population. Columns (2)–(5) show the estimated results. The *Zot* in Column (2) is significantly positive at the 5% confidence level, indicating that the DZ can increase the proportion of migrants. We divide the immigrant population into other counties in this city (*Imm_cit*), other cities in this province (*Imm_pro*), and immigrant populations from other provinces (*Imm_opr*) according to the place of origin of the immigrants. Then, we estimate the impact of the DZs on the proportion of these three types of the immigrant population. The results in Columns (3)–(5) show that the DZ only has a significant impact on the proportion of the immigrant population in other counties of this city. However, the coefficient of the immigrant population in other cities and other provinces is not significant. The results suggest that the DZ mainly attracts the population of other counties of the city. This result is consistent with the conclusion that the probability of rural surplus labor migration to the DZs is negatively correlated with the distance between the two places as shown in Eq. (4). When verifying the impact of the employment creation effect of the DZ on population migration in the third stage, only *Imm* and *Imm_cit* with significant coefficients in the second step are discussed. Columns (6) and (7) show the results. When the *Zot* and the employment scale *Emp* are simultaneously added into the model for regression, the significance and the coefficient size of *Zot* have declined. This finding further proves that the DZs will attract additional people to move in through employment creation effects, particularly those from other counties within the city.

6.2. Wage promotion effect and per capita housing area in the DZs

The key to urbanization is the urbanization of the agricultural migrant population, which includes the transfer of part of the agricultural population to cities. Moreover, solving the problem of "semi-urbanization" of rural labor migrating to cities, housing is the key issue. The location choice of laborers' residential is determined by weighing the wage with housing and commuting costs under the goal of maximizing utility. According to the NEG theory, the industrial agglomeration brought about by the DZs can increase the real income of laborers through the local market and price index effects. Moreover, to reduce commuting costs, laborers tend to live in the DZ and its surroundings. The wage promotion effect of the DZ will help improve housing conditions and increase the per capita housing area. This section will verify this path through the mediating effect method. Table 14 shows the regression results. The results of the first stage show that the DZ has significantly promoted the local wages and welfare levels. The second stage verifies that the DZs can significantly increase the per capita housing area *Hou*. The results of the third stage in Columns (4)–(6) show

Table 13
The employment creation effect on population immigration.

	Stage 1	Stage 2				Stage 3	
	(1) *Emp*	(2) *Imm*	(3) *Imm_cit*	(4) *Imm_pro*	(5) *Imm_opr*	(6) *Imm*	(7) *Imm_cit*
Zot	0.1787 ***	0.0105 **	0.0068 ***	0.0036	0.0001	0.0084 *	0.0054 **
	(0.0580)	(0.0049)	(0.0025)	(0.0030)	(0.0021)	(0.0048)	(0.0025)
Emp						0.0117 ***	0.0083 ***
						(0.0012)	(0.0006)
Zo	0.0461	0.0009	-0.0004	0.0008	0.0005	0.0004	-0.0008
	(0.0495)	(0.0042)	(0.0021)	(0.0025)	(0.0018)	(0.0041)	(0.0021)
Tim	-0.0078	0.0846 ***	-0.0264 ***	0.0635 ***	0.0475 ***	0.0847 ***	-0.0263 ***
	(0.1436)	(0.0121)	(0.0062)	(0.0073)	(0.0051)	(0.0119)	(0.0061)
N	4891	4891	4891	4891	4891	4891	4891
R^2	0.6415	0.7719	0.4811	0.6756	0.8267	0.7763	0.5004

Table 14
The impact of the wage promotion effect on the per capita housing area.

	Stage 1		Stage 2		Stage 3	
	(1) *Wag*	(2) *Wel*	(3) *Hou*	(4) *Hou*	(5) *Hou*	(6) *Hou*
Zot	0.1913 ***	0.2672 ***	0.7191 **	0.2494	0.2509	0.2542
	(0.0610)	(0.0665)	(0.3073)	(0.2812)	(0.2830)	(0.2831)
Wag				0.2548 ***		0.0913
				(0.0684)		(0.1594)
Wel					0.2133 ***	0.1395
					(0.0634)	(0.1436)
Zo	0.0225	-0.0452	-0.0627	-0.3419	-0.3411	-0.3454
	(0.0521)	(0.0568)	(0.2499)	(0.2398)	(0.2412)	(0.2413)
Tim	1.1612 ***	0.8175 ***	5.4881 ***	6.0387 ***	6.1563 ***	6.1122 ***
	(0.1511)	(0.1646)	(0.6921)	(0.6999)	(0.7010)	(0.7053)
N	4879	4829	4891	4879	4829	4829
R^2	0.7089	0.6724	0.7295	0.7766	0.7764	0.7764

that after adding wage and welfare variables in the model, the coefficient of the *Zot* is no longer significant. To a certain extent, the increase in wages brought about by the DZs can help improve housing conditions and promote the urbanization of labor in the vicinity.

6.3. Preference of land supply and urbanization in the DZs

As the most representative place-based industrial policy implemented worldwide, establishing development zones (DZs) is an important mechanism whereby the government can guide the allocation of land resources. Considering that land is necessary to ensure employment and housing in population urbanization, this article further discusses whether establishing DZs will promote population urbanization by obtaining more land supply. We measure the land supply scale with the supply area (*lan1*) and newly increased area (*lan2*) of county construction land and use mediating effect model to explore empirically the impact of land policy inclination in DZ on population urbanization. The results of the first stage in Table 15 show that the DZ has significantly promoted the land supply, which confirms that governments provide more policy preferences for expanding land scale in DZs. In the third stage, after considering the impact of land supply, the coefficient of *Zot* on population urbanization is no longer significant, which verifies that DZs will promote population urbanization by obtaining more land supply.

7. Conclusions

From the perspective of the urbanization process in the world, the simultaneous concentration of population and industries in cities is an important way to ensure the steady improvement of the level and quality of urbanization. As the main front of industrial agglomeration and land development, the population absorption function of the DZs plays a very important role in promoting the coordinated development of land and population urbanization and promoting a new-type of people-oriented urbanization. Under the framework of the NEG theory, this study uses the fifth and sixth national census data to empirically estimate the impact of the DZs on the population urbanization. From the perspectives of job creation and wage increase, the mechanism was verified. This article mainly draws the following conclusions and enlightenment.

Table 15
The impact of the preference of land supply on urbanization.

	Stage1		Stage2	Stage3	
	(1) *lan1*	(2) *lan2*	(3) *Urb*	(4) *Urb*	(5) *Urb*
Zot	0.4106 ***	0.3341 ***	0.0263 **	-0.0048	-0.0022
	(0.1038)	(0.0958)	(0.0126)	(0.0060)	(0.0061)
lan1				0.0174 ***	
				(0.0012)	
lan2					0.0136 ***
					(0.0014)
N	4410	4410	4891	4410	4410
R^2	0.7931	0.7007	0.6221	0.9598	0.9580

On the whole, the establishment of China's DZs has effectively promoted the urbanization of the permanent population. The reasonable construction and exploitation of the DZ is an effective way to solve the problem of unsynchronized industrial and population agglomeration. Speeding up the process of the integration of production and city and transforming from "zone construction" to "city building" are necessary. When the leading industries planned by the DZs are in line with local comparative advantages, the DZ's promotion of the urbanization rate will be strengthened. When local governments formulate industrial development plans, they should fully consider the industrial development foundation of the DZ and its surrounding areas, and promote the urbanization rate through industrial agglomeration.

The employment creation and wage increase effect brought by the DZ have jointly promoted population urbanization. On the one hand, the DZ has created additional jobs by attracting new firms and expanding the scale of incumbent firms, thereby attracting additional population inflows, particularly in attracting people from other counties within the city. On the other hand, the local market effect and price index effect brought about by industrial agglomeration in DZs have increased the real wage and promoted the local urbanization of labor force. In addition, the expansion of land supply is also a channel for the DZ to promote population urbanization. The construction of the DZ should pay attention to the improvement of the socialization function based on the coupling of employment, housing and public services, so as to meet the needs of family urbanization and nearby urbanization of migrant workers, in order to solve the problem of "semi-urbanization" and realize a new type of people-oriented urbanization.

This article explores the impact and mechanisms of DZs on population urbanization based on the counties where the zones are located. Given that the existing census database does not publish data on the population urbanization at a more micro-unit than the county level, it is not possible to empirically estimate the extent of the DZs' impact on the population urbanization within the zones. However, the establishment of DZs may have spillover effects on the urbanization process of non-development zone areas in the county where they are located, so the findings of this article are still valuable for enriching relevant studies on the evaluation of the policy effects of DZs. In the future, the population urbanization and related economic and social data of the zone can be collected through field research to quantify the DZs' impact on the population urbanization of the zone.

Declaration of Competing Interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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