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The impacts of spatially targeted programmes: evidence from Guangdong

Elisa Barbieri[a] , Chiara Pollio[b] and Francesco Prota[c]

ABSTRACT
Spatially targeted policies have been a crucial component of the development strategy pursued by the Chinese government. This paper provides novel empirical evidence in the debate on place-based policy by testing whether the presence of economic development zones is associated with higher values of industrial output and their impact is heterogeneous across territories in the counties/districts in Guangdong province during the period 2000–14. The results show that the level of industrial output is positively correlated with the presence of economic development zones and offer support to the idea that place-based policies have heterogeneous effects across territories.

KEYWORDS
China; economic zones; heterogeneous effects; regional development; industrial output

INTRODUCTION

Spatially targeted programmes have long been used by both industrialized and industrializing countries. These programmes have 'the potential to affect the location of economic activity, along with wages, employment, and industry mix of communities and regions' (Kline & Moretti, 2014, p. 630).

China is probably one of the best-known examples of countries using spatially targeted programmes. The first special economic zones (SEZ) were introduced in the early 1980s as experiments in market allocation in geographically restricted areas along the coast: Shenzhen, Zhuhai and Shantou in Guangdong province and Xiamen in Fujian province. Then different types of economic development zones (EDZ) were extended to other cities along the coast and, starting in the early 1990s, to inland regions. In the last three decades, governments at all levels – central, provincial, prefecture and county – have been involved in the establishment of development zones and the promotion of economic growth.

The benefits and distortions caused by spatially targeted policies have long been debated by economists (Glaeser & Gottlieb, 2008; Kline & Moretti, 2014).[1] The extent to which these incentives can reward in terms of economic performance in a cost-effective way remains an empirical question (Chaurey, 2017). Prior empirical work evaluating place-based policies has mainly focused on developed countries (e.g., Ambroziak & Hartwell, 2018; Busso, Gregory, & Kline, 2013; Ham, Swenson, İmrohoroğlu, & Song, 2011). In the context of developing countries, several papers have studied the effects of China's EDZs on local economies (e.g., Alder, Shao, & Zilibotti, 2016; Wang, 2013; Zheng, Barbieri, Di Tommaso, & Zhang, 2016).

The present paper contributes to a better understanding of the impact of EDZs on local economies in China by focusing on the subnational level, Guangdong, and by highlighting the heterogeneous effects that spatially targeted policy tools may have on different local contexts. In particular, we test whether (1) the presence of an EDZ in a county or district is associated with a higher value of industrial output compared with counties or districts which have never had an EDZ; (2) the impact of an EDZ is heterogeneous across territories and depends on the level of economic development, measured in terms of industrial output; and (3) our results are robust to the inclusion of spatial effects.

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We use a large number of official sources to construct a novel data set covering 75 counties and districts of Guangdong between 2000 and 2014.[2] The focus on Guangdong is justified by the fact that it is one of the most relevant Chinese provinces in terms of its contribution to national wealth and population, and the one with the longest experience in the use of economic zones. In addition, the one-province focus allows one to avoid problems related to the non-homogeneous distribution of spatially targeted programmes across Chinese provinces.

Our empirical strategy follows three steps. First, we employ a non-parametric approach in order to examine the distribution of counties industrial output by type (counties/districts with EDZs and counties/districts without EDZs) and verify whether one group 'dominates' the other. Second, we apply quantile regression (QR) techniques to investigate the possible heterogeneity of the effects of a spatially targeted programme at different levels of industrial output. In the context of regional analyses, QR has two main advantages: it allows one to assess how policy variables affect regions according to their position on the conditional distribution of the outcome variable, and to estimate the magnitude of the effects of explanatory variables at the tail of such distribution, which might be more interesting and informative than the conditional mean (Crespo-Cuaresma, Foster, & Stehrer, 2011; McMillen, 2013). Third, we assess the validity of our results by testing if they are robust to the inclusion of spatial effects. Indeed, it is widely recognized that data collected from geographically close entities can be spatially correlated. In particular, we use the spatial Durbin model (SDM) since it contains the most information regarding spatial spillover channels.

In summary, our paper makes the following original contribution to the literature: (1) it provides new evidence for the debate about the impact EDZs in developing countries by focusing on the subnational level; and (2) it offers empirical support to the idea that spatially targeted policies can have heterogeneous effects across territories.

The paper is structured as follows. The next section presents the main conclusions from the related literature. The third section discusses the EDZ policy; and the fourth section describes the data and the empirical strategy. The fifth section presents the results of the empirical modelling. Finally, the sixth section concludes.

RELATED LITERATURE

Place-based policies have received a lot of scholarly attention (Bailey, Hildreth, & De Propris, 2015; Barca, McCann, & Rodríguez-Pose, 2012; Kline & Moretti, 2014; Neumark & Simpson, 2015). Available studies differ in terms of outcome measurement, spatial unit, modelling approach and conclusions about the success of these policies.

Looking at the United States, there were positive effects on local labour markets of various enterprise zone programmes (Ham et al., 2011; Busso et al., 2013). Conversely, studies of the French Urban Zones programme have found it had at best modest and heterogeneous effects on employment (Briant, Lafourcade, & Schmutz, 2015; Gobillon, Magnac, & Selod, 2012). In a study on the Polish zones policy, Cizkowicz, Cizkowicz-Pekala, Pekala, and Rzonca (2016) found a positive spillover effect of the policy on employment at the *poviat* (county) level and a neutral spillover effect on investment in Poland. Moreover, the effect of SEZ on investments is weaker but nonetheless positive, and investments in a given SEZ neither crowd in nor crowd out investments outside the SEZs. Another recent study on the effect of SEZs in Poland by Ambroziak and Hartwell (2018) finds that SEZs have a heterogeneous impact depending on the development level of recipient areas; in particular, the impact is stronger in least developed regions and weaker or even negative in richer regions.

The present paper contributes to this strand of literature by analysing EDZs in China. The existing empirical studies can be grouped according to the methodological approach they use: descriptive case studies concerning the evolution of particular EDZs (Farole & Akinci, 2011; Zeng, 2015), on one side, and formal econometric analyses, on the other. The majority of the econometric studies make use of difference-in-differences models to evaluate the differences between EDZ hosting and non-hosting regions (Alder et al., 2016; Wang, 2013). Overall, the results show the positive effects of EDZs on several outcome variables. For example, Wang (2013) finds positive effects on foreign direct investments, exports and the output of foreign enterprises. Alder et al. (2016) suggest that the establishment of an EDZ yields large positive effects on gross domestic product (GDP) and GDP per capita for the cities in which these were located. Moreover, the EDZ generates positive spillovers to neighbouring areas.

Our study also relates to a recent literature that has documented the heterogeneous effects of spatial agglomeration policies (Faggio, Silva, & Strange, 2017). With reference to economic zones, part of the debate on their impact in emerging economies suggests anecdotally that they can be more effective where there is already some degree of industrialization (Farole & Akinci, 2011; Monga, 2013). However, such an idea does not seem to be adequately supported by the empirical evidence. Only a few authors have focused on the relationship between the effectiveness of economic zones and the characteristics of the recipient territory (Cypher & Dietz, 2009; Schrank, 2008). In this perspective, one might expect that economic zones perform worse in less developed regions due to greater difficulties in generating spillovers and backward linkages with the local economy (Johansson & Nilsson, 1997). Highly industrialized regions on the contrary would allow economic zones to better exploit specific location advantages such as economies of agglomeration and urbanization (Fujita & Thisse, 2013). On the other hand, however, placing economic zones in less developed areas can offer specific cost advantages of input factors and avoid the typical diseconomies of congested areas (Ago, Isono, & Tabuchi, 2006). This would suggest that economic zones might be even more successful in triggering additional economic growth in areas where it is lagging

(Ambroziak & Hartwell, 2018). Such debate points to a relationship between economic zones and local economic performances that is most probably non-linear and corresponds to different location advantages depending on the local economic conditions.

HISTORICAL AND INSTITUTIONAL BACKGROUND

The role of economic zones in China has been crucial for the Chinese economic transition. The 'open-door' policy process started within the early SEZs in both Guangdong and Fujian. The growth in the number of EDZs has followed different temporal waves, corresponding to a differentiated geographical expansion of the zone policy across China (Figure 1). The first zones were founded before 1990 and were concentrated in the coastal area. Through the 1990s, new zones were founded both in the inner prefectures of coastal provinces and in the inner provinces. The beginning of the 21st century witnessed a growth in the intensity of the use of zones, that is, an increase in the number of zones in areas already hosting zones. This trend continued up to 2008, after which the establishment of new zones tended to stagnate.

One of the most distinctive features of EDZs in China is their heterogeneity: in addition to the original SEZ, there are other types of zones such as the economic and technological development zones (ETDZs), the high-tech development zones (HTDZs), the free-trade zones (FTZs) and the export-processing zones (EPZs). These zones differ in their stated mission, origins and types of incentives provided to attract firms and motivate them to invest. ETDZ, established soon after the launch of SEZ, offer favourable fiscal treatment on foreign investment to attract foreign firms and promote their collaboration with local firms. These zones are organized into functional areas according to the types of activities carried out within the zone. HTDZ specifically aim at increasing the value added of products by supporting the adoption of new technologies and processes. They originated in the late 1980s within the Torch Program, whose main objective was to use the technological capacity of research institutes, universities and large- and medium-sized firms to develop new and high-tech products and to accelerate the technology transfer processes.[3] FTZs and EPZs, both directed by the Duty Office, have been promoted with a different rationale. FTZs were introduced to experiment with free trade before China's inclusion into the World Trade Organization (WTO) and to offer firms a wide range of benefits related to import, export and value-added taxes, while EPZs were created specifically to develop export-oriented production (Zeng, 2015; Zheng et al., 2016).

Another peculiarity of Chinese spatially targeted programmes is that these economic enclaves can be created and administered directly by the national government or by provincial or even local (county or town-level zones) government. Consequently, local officials are found to have a strong incentive to compete among them by
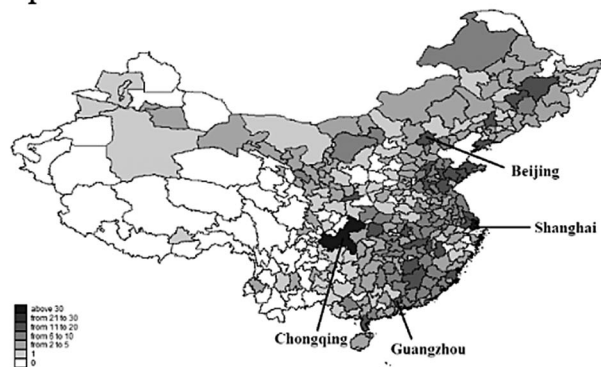

Figure 1. Geographical distribution of the number of zones by waves.
Source: Authors' elaboration based upon data from various sources.

soliciting or campaigning for new investments to locate in their regions and experimenting with different preferential policies to investors and entrepreneurs.

The final element worthy of being stressed is the tendency of Chinese authorities to adapt the use of economic zones to the changing long-term goals of the country economic policy. At the beginning, they were the laboratories for market economy. Soon they became tools to rationalize the location of different types of national and foreign investment (Wei & Leung, 2005). More recently, they were used to further experiment with the liberalization of capital flows, economic upgrading and territorial rebalancing (Bräutigam & Tang, 2014; Yao & Whalley, 2016).

SEZs in Guangdong

Half as large as Germany but with 20 million more people, Guangdong is the first Chinese province in terms of contribution to national GDP (10.8%) and export (nearly 30%) and the second for foreign direct investment (FDI) attraction (about 15%) (National Bureau of Statistics of China (NBS), 2017). Nowadays its economic performance is comparable with those of some important Organisation for Economic Co-operation and Development (OECD) countries: its export value is not far from that of Japan and the GDP figures are comparable with those of Poland or Australia.

Its position as an international important player is due, among other things, to its early experience with EDZs. Guangdong is the province with the longest involvement in the use of economic zones (Di Tommaso, Rubini, & Barbieri, 2013). The very first SEZs were set in Shenzhen, Zhuhai and Shantou, which were very close to potential sources of foreign capital (such as Hong Kong, Macau and Taiwan) and, at the same time, in a lagging region, far from the influence of central Beijing power (Ge, 1999). These territories had heterogeneous economic conditions. Shenzhen was a poor city, depending on subsistence farming and suffering from large flows of illegal

emigration towards the richer industrial neighbouring region of Hong Kong. Zhuhai had an ideal geographical position for trade (right in front of Macao), but the scattered nature of its territory (divided among many small islands within Pearl River Delta – PRD) prevented it from becoming a commercial hub. Finally, Shantou, once a rich commercial port, had seen slowing its economic dynamism in the post-revolutionary era because of its military strategic position (Tao & Zhinguo, 2012).

The location choice of the successive zones was mainly guided by geographical considerations. In particular, the PRD area in Guangdong has been the preferred destination for EDZs because of its accessibility to FDIs and its potential for commercial transports given the presence of the river.

Nowadays, in Guangdong the zone policy is used with different goals, reflected in the distribution of the economic zones by type (ETDZ, EPZ, FTZ and HTDZ). Figure 2 shows the spatial distribution of EDZs across Guangdong counties and districts in 2000 and 2014.[4] As a whole, up to 2014 there were 87 EDZs in Guangdong. The distribution of EDZs across Guangdong territories is uneven both at the beginning and at the end of the period. The number of zones is particularly high in the prefecture-level cities of Shenzhen, Foshan and in few counties of the capital city Guangzhou and of Shantou.

DATA AND EMPIRICAL STRATEGY

In order to evaluate the impact of EDZs, we constructed an original database on 75 counties and districts of Guangdong. It contains information on several economic and geographical variables for the period 2000–14. Specifically, for each county/district we have collected information on the industrial output, amount of investments in fixed assets, number of large enterprises and number of fully employed workers. Additionally, we have recorded how many specialized towns there are in each county/district and whether or
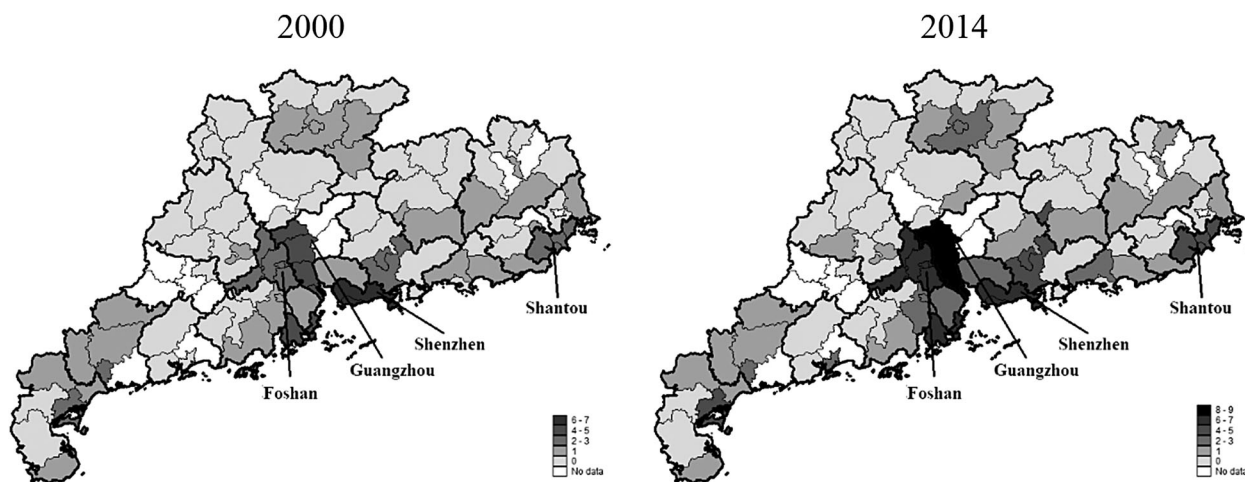

Figure 2. Economic zones by counties in Guangdong.
Note: The districts of Foshan, Guangzhou, Shantou, Shaoguan, Shenzhen and Zhuhai are computed as unique administrative areas.
Source: Authors' elaboration upon data from various sources.

not the county/district is included in the PRD area.[5] The data set comprises the following information on the EDZs: location at the county/district level, year of foundation and type of zone.[6]

We follow three different empirical approaches in order to investigate the relationship between the presence of EDZs and the industrial production in Guangdong.

First, we employ a non-parametric approach that consists of comparing the distributions of counties/districts industrial output corresponding to counties/districts with EDZs and counties/districts that never had EDZs. This strategy, defined as stochastic dominance, allows one to compare robustly industrial output performance differences across the two counties/districts types at all moments of their output distributions, rather than at a single moment (typically the mean).

The hypothesis that the industrial output distribution of one group of counties/districts stochastically dominates the industrial output distribution of another group can be tested by the Kolmogorov–Smirnov (K-S) test. In particular, following Delgado, Farinas, and Ruano (2002), we perform tests of stochastic dominance of a given cumulative distribution function $F(z)$ (in our case, the industrial output of counties and districts hosting EDZs) with respect to another cumulative distribution function $G(z)$ (in our case, the industrial output of counties and districts that never hosted EDZs) by testing two hypotheses:

$$F(z) - G(z) = 0 \text{ uniformly in } z \qquad (1)$$

with strictly inequality for some z.

$$F(z) - G(z) \leq 0 \text{ uniformly in } z \qquad (2)$$

with strictly inequality for some z.

The first hypothesis is tested through the so-called two-sided K-S test whereas the second hypothesis is tested through the so-called one-sided K-S test. We can conclude that $F(z)$, the industrial output distribution of counties and districts hosting EDZs, stochastically dominates $G(z)$, the industrial output distribution of counties and districts that never hosted EDZs, if we reject the null hypothesis in the first test and fail to reject the null in the second test.

Second, we investigate the impact of EDZs at different quantiles of the distribution of the log industrial output instead than at the average. This allows one to capture the heterogeneity of the possible effects of EDZs according to the counties/districts industrial performance. Formally, we estimate the following equation:

$$\begin{aligned}
\ln Y_{i,t} = {} & \beta_0 + \beta_1 * DUMMYZONES_{i,t} \\
& + \beta_2 * NUMBERZONES_{i,t} \\
& + \beta_3 * \ln INVESTMENTS_{i,t} \\
& + \beta_4 * \ln ENTERPRISES_{i,t} \\
& + \beta_5 * SPTOWNS_{i,t} + \beta_6 * PRD + \beta_7 * T \\
& + e_{i,t} \qquad (3)
\end{aligned}$$

where $\ln Y_{i,t}$ is the natural logarithm of the industrial output in county/district i at time t. The regressors of interest are two.

The first is $DUMMYZONES_{i,t}$, a dummy variable that takes a value of 1 if location i hosts an EDZ at time t, and 0 otherwise; it is used to signal the presence of the policy initiative in the location.[7] The second is $NUMBERZONES_{i,t}$, that is, the number of economic zones in county/district i at time t; this variable is a proxy for the treatment intensity on local economic outcomes.[8]

The set of controls is related to the economic environment: $\ln INVESTMENTS_{i,t}$ and $\ln ENTERPRISES_{i,t}$, respectively, the amount of fixed assets in the manufacturing sector and the number of large firms. $SPTOWNS_{i,t}$ accounts for the number of specialized towns in county i at time t; $PRD_{i,t}$ is a dummy taking a value of 1 when the county/district is inside the PRD, and 0 otherwise; T controls for time effects; and $e_{i,t}$ is the error term.

Another possible proxy for the treatment intensity is the size of the economic zones. For this reason, we run further regressions in which we include alternately $NR\_SMALL_{i,t}$ (the number of zones whose area ranges from 0 to 10 km^2) and $NR\_MEDIUM\_LARGE_{i,t}$ (the number of zones whose area is > 10 km^2).

Moreover, our data set allows one to disentangle the impact of different types of zones and, therefore, to overcome the limitation of using a dummy variable, which captures the average effect of EDZs on the economic outcomes of a hosting county. Therefore, we estimate a specification of equation (3) in which we use alternately three variables: $NR\_ETDZ_{i,t}$ (the number of economic and technological development zones); $NR\_HTDZ_{i,t}$ (the number of high tech development zones); and $NR\_OTHERS_{i,t}$ (the number of export processing zones, free trade zones and other industrial zones).

We use QR to estimate equation (3).[9] While the ordinary least squares (OLS) estimator is obtained by minimizing the sum of squares of the residuals, the QR estimator for the τ-th quantile comes from:

$$\hat{\beta}_\tau = \arg\min \sum_{i=1}^{n} \rho_\tau(y_i - \boldsymbol{x}_i \beta_\tau) \qquad (4)$$

where ρ_τ is a 'check' function that, following the least absolute deviations (LAD)-estimator principle (Koenker & Hallock, 2001), weights positive and negative residuals asymmetrically:

$$\rho_\tau(u) = 1(u > 0) \cdot \tau |u| + 1(u \leq 0) \cdot (1 - \tau)|u| \qquad (5)$$

The QR estimator, therefore, estimates the τ-th conditional quantile of Y given x:

$$Q_\tau(Y | \boldsymbol{x}) = \boldsymbol{x} \beta_\tau \qquad (6)$$

Third, we introduce a spatial dimension into econometric analysis. It is widely recognized that data collected from geographically close entities can be spatially correlated. In our case, spatially targeted policies such as EDZs can have an impact not only on the economy of the target region but also on the economies of neighbouring regions. Ignoring the potential spatial dependence either in observable or unobservable variables may bias the estimates of the coefficients of interest (LeSage & Pace, 2009). In order to capture spatial

dependence and to avoid biased and inefficient estimates, we transform equation (3) into a spatial panel model. The SDM adaptation of equation (3) takes the form:[10]

$$\ln Y_{i,t} = \alpha_r + \rho \sum_{j=1}^{75} W_{i,j} \ln Y_{i,t} + \beta Z_{i,t}$$

$$+ \theta \sum_{j=1}^{75} W_{i,j} S_{i,t} + \varepsilon_{r,t} \qquad (7)$$

where $W_{i,j}$ denotes the spatial weights matrix; ρ is the coefficient of the spatially lagged dependent variable; $Z_{i,t}$ is a vector of exogenous explanatory variables; and θ captures the impact of a vector of explanatory variables ($S_{i,t}$) in the adjacent counties on industrial output in county i.[11]

Table A2 in Appendix A in the supplemental data online shows the descriptive statistics and sources of the variables used in the econometric analysis.

RESULTS

The results of the non-parametric estimation indicate a significant 'between-group' heterogeneity for the comparison group, with counties/districts in which EDZs are localized showing a higher value of industrial output than counties without EDZs. Indeed, inspection of Table 1 reveals that we strongly reject the null hypothesis of equality of the cumulative distribution for all years. As we do not reject the null in the one-sided test, we can conclude that cumulative distribution of counties/districts in which EDZs are localized stochastically dominates that of counties/districts without EDZs. These results are in line with previous studies that have found a positive impact of SEZs on local economies (Alder et al., 2016; Wang, 2013).

In addition, we analyse graphically whether the industrial output shows differentiated trends between the group of counties/districts without EDZs and the group hosting the economic zone before and after the introduction of EDZs. We run this check on a subsample of counties (42) that did not have any development zone before the beginning of the period under analysis: six changed their status starting to host EDZs between 2000 and 2014, while 36 did not change their status. The graphical inspection of pre- and post-treatment trends of industrial output is reported in Figure A1 in Appendix A in the supplemental data online. While for the time span before the establishment of the zones, the trend is very similar among counties in which EDZs are localized ('treated units') and counties without zones ('control units'), in the post-treatment period the treated counties' average industrial output is higher, and increasingly larger, than the controls counties' average industrial output. This evidence seems to suggest a causal interpretation of the relation between establishing the zones and the economic performances.

Table 2 shows the results of the QR. In the first two specifications we include either $DUMMYZONES_{i,t}$ or $NUMBERZONES_{i,t}$. The third specification considers the two variables together; since $NUMBERZONES_{i,t}$ is different from 0 only when $DUMMYZONES_{i,t}$ is equal

Table 1. Kolmogorov–Smirnov (K-S) tests for first-order stochastic dominance – industrial output.

	Counties with special economic zones (SEZs) versus counties without SEZs	
Year	Two sided	One sided
2000	0.424	0.000
	(0.003)	(1.000)
2001	0.429	0.000
	(0.002)	(1.000)
2002	0.429	0.000
	(0.002)	(1.000)
2003	0.384	0.000
	(0.008)	(1.000)
2004	0.384	0.000
	(0.008)	(1.000)
2005	0.382	0.000
	(0.009)	(1.000)
2006	0.366	0.000
	(0.013)	(1.000)
2007	0.341	0.000
	(0.025)	(1.000)
2008	0.340	0.000
	(0.027)	(1.000)
2009	0.340	0.000
	(0.026)	(1.000)
2010	0.337	0.000
	(0.028)	(1.000)
2011	0.338	0.000
	(0.028)	(1.000)
2012	0.392	0.000
	(0.006)	(1.000)
2013	0.388	0.000
	(0.007)	(1.000)
2014	0.387	0.000
	(0.007)	(1.000)

to 1, the effect of the two variables has to be analysed jointly. We report the results at each decile of the distribution of the outcome of interest, together with the coefficient for the quartiles.

In the first specification of the model, $DUMMYZONES_{i,t}$ displays a positive and strongly significant coefficient in the lowest part of the distribution (10th–25th quantiles) and in the highest one (70th–90th quantiles), though with a weaker significance. In terms of magnitude, the coefficients are similar. There seems to be, therefore, a positive and significant correlation between the presence of the policy and the industrial output at the extremes of the distribution.

In the second specification, the variable $NUMBERZONES_{i,t}$ is strongly significant across the whole distribution of the industrial output. The sign is positive, and the magnitude increases as we move from lower to higher quantiles. This result suggests that, for

	Quantiles										
	q10	q20	q25	q30	q40	q50	q60	q70	q75	q80	q90
Only _DUMMYZONES_$_{i,t}$											
DUMMYZONES$_{i,t}$	0.154	0.151	0.123	0.0938	0.0198	0.0528	0.0645	0.121	0.0988	0.102	0.128
	(0.048)***	(0.045)***	(0.047)**	(0.050)*	(0.047)	(0.049)	(0.050)	(0.052)**	(.051)**	(0.059)*	(0.076)*
ln_INVESTMENTS_$_{i,t}$	0.234	0.293	0.287	0.314	0.322	0.342	0.369	0.406	0.429	0.445	0.341
	(0.036)***	(0. 033)***	(0.034)***	(0.036)***	(0.029)***	(0.031)***	(0.034)***	(0.037)***	(0.037)***	(0.042)***	(0.069)***
ln_ENTERPRISES_$_{i,t}$	1.011	0.922	0.938	0.917	0.904	0.855	0.812	0.758	0.754	0.757	0.800
	(0.042)***	(0.037)***	(0.036)***	(0.038)***	(0.034)***	(0.034)***	(0.036)***	(0.039)***	(0.042)***	(0.052)***	(0.076)***
SPTOWNS$_{i,t}$	−0.0153	−0.0111	−0.0158	−0.0162	−0.0157	−0.0127	−0.0111	−0.0135	−0.0131	−0.0147	−0.0123
	(0.005)***	(0.004)**	(0.005)***	(0.004)***	(0.004)***	(0.004)***	(0.003)***	(0.003)***	(0.004)***	(0.004)***	(0.004)***
PRD$_{i,t}$	0.218	0.216	0.200	0.182	0.181	0.161	0.156	0.121	0.0537	−0.0236	−0.0316
	(0.070)***	(0.054)***	(0.053)***	(0.057)**	(0.060)**	(0.056)**	(0.059)**	(0.073)	(0.081)	(0.094)	(0.119)
Constant	13.13	12.37	12.50	12.05	12.10	11.96	11.67	11.26	10.90	10.57	12.89
	(0.673)***	(0.612)***	(0.647)***	(0.661)***	(0.550)***	(0.585)***	(0.658)***	(0.716)***	(0.722)***	(0.801)***	(1.325)***
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125
Pseudo-R^2	0.704	0.711	0.712	0.713	0.715	0.718	0.724	0.730	0.736	0.739	0.737
Only _NUMBERZONES_$_{i,t}$											
NUMBERZONES$_{i,t}$	0.0518	0.0584	0.0587	0.0524	0.0579	0.0705	0.0755	0.0786	0.0825	0.0915	0.100***
	(0.014)***	(0.013)***	(0.013)***	(0.014)***	(0.016)***	(0.014)***	(0.0142)***	(0.0153)***	(0.016)***	(0.018)***	(0.022)***
ln_INVESTMENTS_$_{i,t}$	0.218	0.255	0.249	0.276	0.301	0.303	0.333	0.361	0.381	0.384	0.305
	(0.032)***	(0.034)***	(0.034)***	(0.037)***	(0.034)***	(0.034)***	(0.033)***	(0.039)***	(0.045)***	(0.048)***	(0.070)***
ln_ENTERPRISES_$_{i,t}$	1.006	0.930***	0.923	0.901	0.867	0.838	0.785	0.756	0.737	0.718	0.736
	(0.035)***	(0.034)***	(0.034)***	(0.038)***	(0.034)***	(0.036)***	(0.036)***	(0.038)***	(0.041)***	(0.049)***	(0.071)***
SPTOWNS$_{i,t}$	−0.0161	−0.0115	−0.0126	−0.0130***	−0.0159	−0.0153	−0.0153	−0.0161	−0.0172	−0.0153	−0.0155
	(0.004)***	(0.004)***	(0.004)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.004)***	(0.004)***	(0.005)***
PRD$_{i,t}$	0.199	0.232	0.265	0.226	0.231	0.201	0.188	0.125	0.104	0.0263	−0.0214
	(0.075)***	(0.070)***	(0.068)***	(0.063)***	(0.056)***	(0.057)***	(0.062)***	(0.060)**	(0.064)	(0.079)	(0.101)
Constant	13.50***	13.19	13.45	13.02	12.72	12.91	12.59	12.34	12.03	12.09	14.04
	(0.612)***	(0.668)***	(0.659)***	(0.697)***	(0.648)***	(0.654)***	(0.646)***	(0.753)***	(0.870)***	(0.947)***	(1.407)***
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2. Continued.

	q10	q20	q25	q30	q40	q50	q60	q70	q75	q80	q90
						Quantiles					
N	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125
Pseudo-R^2	0.704	0.713	0.714	0.715	0.719	0.722	0.729	0.736	0.742	0.745	0.744
Joint effect											
$DUMMYZONES_{i,t}$	0.123	0.097	0.084	0.043	−0.049	−0.027	−0.035	−0.088	−0.049	−0.093	−0.132
	(0.037)***	(0.022)***	(0.033)**	(0.040)	(0.040)	(0.055)	(0.046)	(0.046)*	(0.044)	(0.050)*	(0.065)**
$NUMBERZONES_{i,t}$	0.03	0.05	0.053	0.048	0.066	0.072	0.079	0.094	0.093	0.103	0.12
	(0.016)*	(0.011)***	(0.012)***	(0.013)***	(0.013)***	(0.011)***	(0.016)***	(0.019)***	(0.020)***	(0.025)***	(0.020)***
ln$INVESTMENTS_{i,t}$	0.208	0.252	0.253	0.275	0.281	0.302	0.333	0.373	0.383	0.378	0.299
	(0.035)***	(0.027)***	(0.027)***	(0.032)***	(0.022)***	(0.031)***	(0.032)***	(0.039)***	(0.045)***	(0.054)***	(0.072)***
ln$ENTERPRISES_{i,t}$	1.011	0.922	0.918	0.898	0.885	0.841	0.789	0.746	0.732	0.728	0.745
	(0.03)***	(0.025)***	(0.026)***	(0.031)***	(0.003)***	(0.034)***	(0.032)***	(0.038)***	(0.047)***	(0.056)***	(0.064)***
$SPTOWNS_{i,t}$	−0.016	−0.013	−0.014	−0.014	−0.016	−0.015	−0.015	−0.017	−0.018	−0.015	−0.014
	(0.004)***	(0.004)***	(0.004)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.004)***	(0.004)***	(0.005)***	(0.006)***
$PRD_{i,t}$	0.249	0.248	0.262	0.23	0.23	0.201	0.185	0.124	0.095	0.023	−0.045
	(0.060)***	(0.050)***	(0.047)***	(0.047)***	(0.060)***	(0.057)***	(0.053)***	(0.056)**	(0.082)*	(0.090)	(0.077)
Constant	13.691	13.3	13.34	13.01	13.116	12.914	12.612	12.137	12.017	12.215	14.146
	(0.686)***	(0.541)***	(0.544)***	(0.619)***	(0.419)***	(0.606)***	(0.653)***	(0.756)***	(0.876)***	(1.022)***	(1.396)***
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125
Pseudo-R^2	0.705	0.714	0.715	0.715	0.719	0.722	0.729	0.737	0.742	0.746	0.745

Notes: Bootstrapped standard errors are shown in parentheses, 500 replications. Significance: *10%, **5%, ***1%. Year dummies 2000–14.

higher values of the industrial output, it is the intensity of the policy (approximated by the number of the zones) that matters rather than the mere presence. Figure A2 in Appendix A in the supplemental data online shows the trend of $DUMMYZONES_{i,t}$ (panel a) and $NUMBERZONES_{i,t}$ (panel b) for the two specifications of the model.

Figure 3 shows the combined effect of $DUMMYZONES_{i,t}$ and $NUMBERZONES_{i,t}$ across all the quantiles and for a various number of zones. A positive and significant relationship between the two policy variables and output is confirmed for all numbers of zones and for all quantiles (expect for hypothetical case of one zone on the 90th quantile). More in detail, for small numbers of zones (one to three) the effect on lower quantiles is larger than on higher quantiles of output; on the contrary, a number of zones above five displays a greater effect on richer areas.

In the light of these results, the current factual economic zones distribution across quantiles in Guangdong raises some concerns on the possible further polarization of economic performances in the province (see Figure A3 in Appendix A in the supplemental data online). While at the beginning of the period under analysis the distribution of zones seemed roughly balanced across quantiles, in 2014 more than half the total number of zones (49 of 87) are located in the counties at the highest decile of the distribution, and the percentage increases to 87% in the highest three deciles.

The signs and the statistical significance of most of the other control variables are stable across the whole distribution: the amount of fixed assets in the manufacturing sector and the number of large firms show a positive and significant coefficient, while the number of specialized towns is negatively correlated with the industrial performance of the areas.[12] This can be explained by the fact that, particularly from 2008 onwards, specialized towns were used as a promotion tool of the more rural and peripheral

counties of the province, which were characterized by low levels of industrialization. The localization of a county/district inside the PRD is positively associated with output for the lower and median values of the distribution, while it loses its significance for high performing counties.

To verify that the coefficients of both $DUMMYZONES_{i,t}$ and $NUMBERZONES_{i,t}$ change significantly along the distribution, we use the interquantile regression (Kang & Liu, 2014). We measure the differences in the effects of both variables between selected quantiles (corresponding to the maximum and minimum effect, i.e., 10th and 90th quantiles). In addition, we measure the difference in a narrower range of the values of output, between the values at the third and the first quartile (75th and 25th quartiles). The results (shown in Table A3 in Appendix A in the supplemental data online) confirm that establishing a development economic zone in lagging areas can be beneficial in terms of output. The establishment of zones can be beneficial also in richer areas, but in this case a higher investment in terms of the number of economic zones is needed.

Heterogeneous EDZ effects
The impacts of development economic zones may be heterogeneous across different treatment intensities (approximated by the size of the economic zones) and according to the type (Wang, 2013).[13]

For what concerns the size, smaller economic zones seem to be associated with smaller effects, as measured by the magnitude of the coefficients, than large-sized zones across the whole distribution (Figure 4). Small zones show a positive effect across all the quantiles: it grows between the 40th and 70th quantiles and then stabilizes, while the effect of large zones is stronger on lower quantiles, then it tends to decrease and exhibits a second (even if smaller) peak on the rich quantiles.[14]

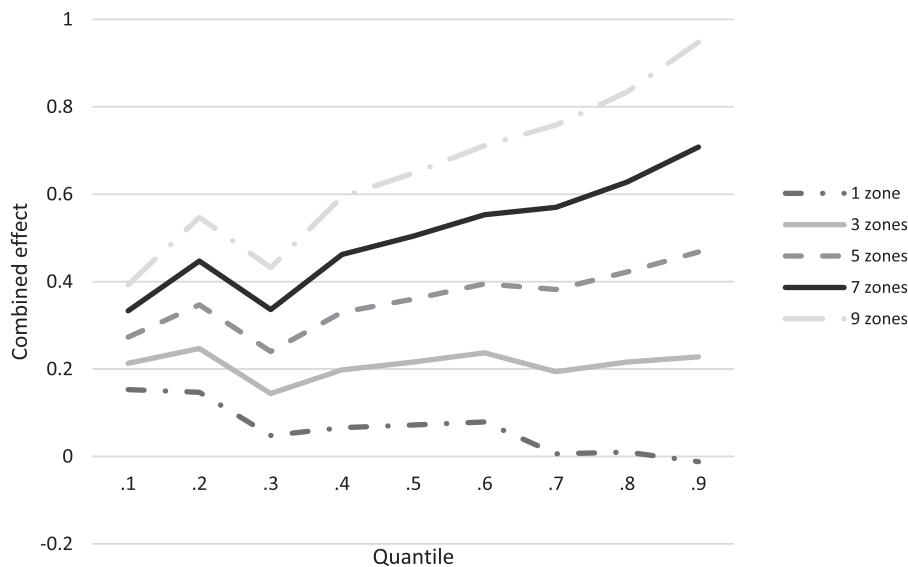We find heterogeneous effects when distinguishing by type of economic zone (Figure 5). ETDZs seem to have

Figure 3. Net effect of the zone policy across quantiles for a various number of zones.
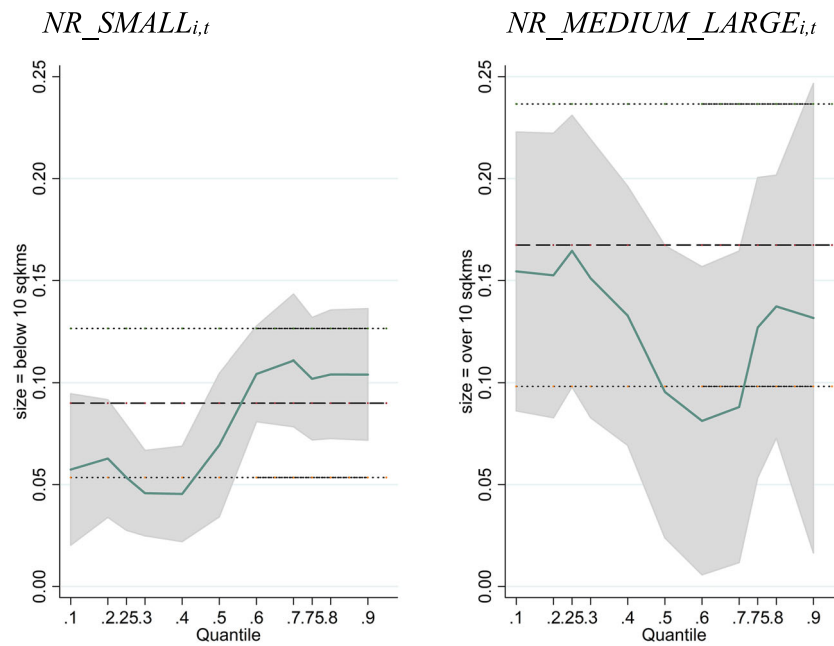
Figure 4. Effect of small and medium–large zones across the distribution of industrial output.

a stronger effect on the medium-to-high values of the distribution compared with poorer areas, while HTDZs' effect is generally decreasing across the distribution, although it is stronger in absolute terms compared with that of ETDZs. We may advance two tentative interpretations of this result. First, HTDZs tend to be larger than other zones and may be affected by negative-scale effects. Second, higher value-added productions such as those promoted in HTDZs may yield weaker marginal effects on richer areas, which presumably already host these kinds of activities.[15]

Spatial EDZ effects[16]
In order to test for spatial autocorrelation, we apply Moran's I test on the dependent variable (Moran, 1950).[17]

The Moran's I statistics indicate the existence of positive spatial dependence for the industrial output over the period analysed, therefore suggesting a spatial econometric model (see Table A7 in Appendix A in the supplemental data online).

Table 3 reports the estimation results with spatial effects. They confirm a positive and highly significant correlation between the presence of EDZs in counties of Guangdong and the level of industrial output.[18] Interestingly, the spatial lag of the dummy variable for the existence of an economic zone is negative and statistically significant meaning that the presence of EDZs in a county is associated with a lower industrial output in the neighbouring counties (Table 3, column 1).[19] The spatial correlation
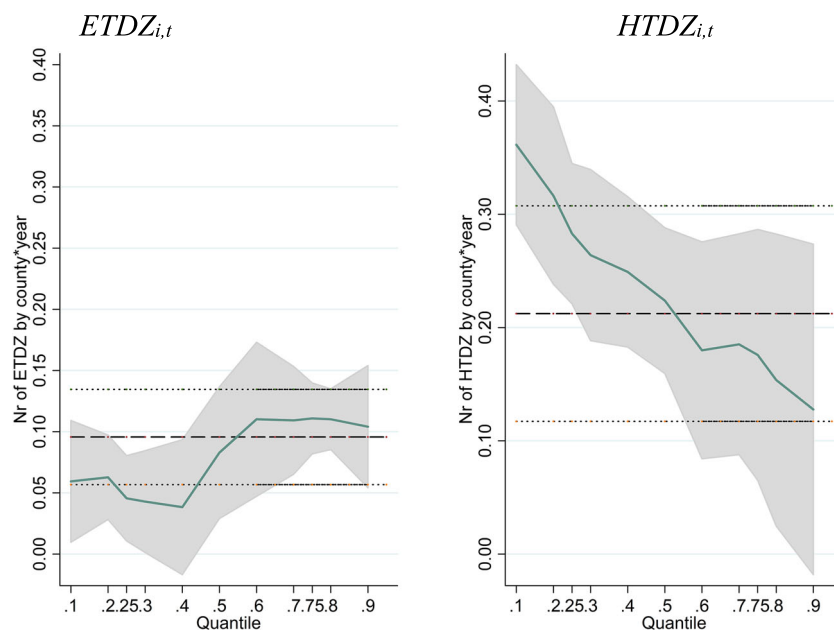

Figure 5. Effects of $ETDZ_{i,t}$ and $HTDZ_{i,t}$ across the distribution of industrial output.

Table 3. Regression results of the spatial Durbin model (SDM) (dependent variable: logarithm of the industrial output).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$DUMMYZONES_{i,t}$	0.200***	0.097					
	(0.053)	(0.063)					
$W \times DUMMYZONES_{i,t}$	−0.158**	−0.064					
	(0.068)	(0.080)					
$NUMBERZONES_{i,t}$		0.068***					
		(0.023)					
$W \times NUMBERZONES_{i,t}$		−0.061**					
		(0.029)					
$SIZE\_SMALL_{i,t}$			0.093***				
			(0.027)				
$W \times SIZE\_SMALL_{i,t}$			−0.077**				
			(0.035)				
$SIZE\_MEDIUM\_LARGE_{i,t}$				0.154***			
				(0.045)			
$W \times SIZE\_MEDIUM\_LARGE_{i,t}$				−0.139**			
				(0.059)			
$ETDZ_{i,t}$					0.112***		
					(0.029)		
$W \times ETDZ_{i,t}$					−0.091**		
					(0.036)		
$HTDZ_{i,t}$						0.265***	
						(0.072)	
$W \times HTDZ_{i,t}$						−0.211**	
						(0.090)	
$NR\_OTHERS_{i,t}$							0.179***
							(0.061)
$W \times NR\_OTHERS_{i,t}$							−0.173**
							(0.077)
P	0.380***	0.382***	0.380***	0.381***	0.379***	0.382***	0.380***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Σ	0.571***	0.568***	0.571***	0.571***	0.571***	0.571***	0.572***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Observations	1125	1125	1125	1125	1125	1125	1125
Log-likelihood	−989.70297	−985.48104	−991.03625	−991.04527	−989.69874	−990.05295	−992.59218

Notes: For clarity and to keep the table manageable, we do not report control variables. *Significant at 10%, **5% and ***1%. Standard errors are shown in parentheses.

coefficients, ρ, is statistically significant, which indicates that the industrial output in county/district i depends on the industrial output in the neighbouring county/district.

We find similar results when considering different sizes and different types of economic zones. Both the presence of small and medium–large economic zones is positively associated with the level of industrial output of the counties in which they are localized (Table 3, columns 3 and 4). Similarly, all the different types of economic zone show a positive and highly significant correlation with the level of industrial output (Table 3, columns 5–7). The magnitude of the coefficient is higher in the case of high-tech development zones.

DISCUSSION AND CONCLUSIONS

This paper analyses one of the most popular spatially targeted programme among policy-makers: the EDZ. Its focus is on the use of this policy instrument in the Chinese province of Guangdong, which is the province that experimented earlier with zone incentives. Through a mix of techniques, we test whether (1) the presence of EDZs is associated with a higher value of industrial output at the level of single county/district; and (2) there is a heterogeneous effect of the presence of EDZs according to the local industrial development. We also assess the validity of our results by testing if they are robust to the inclusion of spatial effects.

The results clearly indicate that counties and districts that host EDZs have better industrial performances than territories that never had EDZs. Indeed, the cumulative distribution of counties/districts in which economic zones are localized stochastically dominates that of counties/districts without economic zones. The findings are in line with earlier literature on the impact of spatially targeted incentives on economic development in China.

In addition, we document the heterogeneous effects of EDZs. In more detail, we find a positive and significant correlation between the (mere) presence of the policy and the industrial output at the extremes of the distribution. The joint analysis of the presence and the intensity of the policy (as measured by the number of zones) shows larger effects on richer areas as the number of zones increases. Given the factual distribution of zones across quantiles in Guangdong, our results warn against possible polarization effects.

When measuring the policy effects by taking into account other sources of heterogeneity: the sizes and the types, our results suggest that there might be major gains by investing more in high-scale and high-tech zone incentives in poorer areas. This may also be a way to address spatial economic disparities across the province.

The findings of this paper provide support to the choice of spatially target programmes and seem to suggest that the use of these programmes can be a catalyst of the development process. It is important to underline that in China the use of EDZs incorporated both efficiency and equity motivations together with the additional target of experimenting with market reforms.

Finally, the analysis is of important policy relevancy as the results suggest that the extent to which spatially target programmes affect the local economy depends on local economic characteristics.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

NOTES

1. For an attempt to put SEZs into a political economy framework, see Moberg (2015) and Hartwell (2018).
2. Counties and districts correspond to the third administrative level in China, below provinces (first level) and cities or prefectures (second level).
3. On the relation between innovation strategies and the 'open door policy' in China see, among others, Petti, Prota, and Rubini (2016).
4. Table A1 in Appendix A in the supplemental data online shows the zone distribution for 2000 and 2014.
5. The specialized towns programme is a provincial cluster-based policy aimed at promoting township-level industrial specialization (Barbieri, Di Tommaso, Pollio, & Rubini, 2019; Di Tommaso, Pollio, Barbieri, & Rubini, 2019). Owing to their economic relevance for the province, it is important to take their presence into account when studying provincial economic performances.
6. The data were collected by merging different official data sources: National Bureau of Statistics of China (NBS) (various years), Ministry of Commerce, Hong Kong Trade Development Council, Guangdong Government prefectures' documents and websites, and specific economic zones official websites.
7. The choice of using a dummy variable indicating zone existence in a particular region and period is in line with the majority of the literature (Wang, 2013; Alder et al., 2016; Jensen, 2018).
8. The decision to establish several zones in a county can be interpreted as a signal of the political commitment for this policy instrument.
9. In such a technique, the quantiles of the conditional distribution of the outcome of interest are expressed as a function of the independent variables (Koenker & Hallock, 2001; Koenker, 2005).
10. The SDM is a generalization of the spatial autoregressive model, which also includes spatially weighted independent variables as explanatory variables. For estimation purposes, we use the SPMLREG Stata command by Jeanty (2013).
11. The spatial weights matrix W is specified as a row-normalized binary contiguity matrix, with elements $w_{ij} =$

1 if two spatial neighbourhoods share a common border, and 0 otherwise.

12.   In order to exclude possible reverse causality issues, we also run the model by lagging the variable *INVESTMENT* at $t − 3$. The results, available from the authors upon request, do not change.

13.   The results of the estimations in which we include the number of zones by size and type are shown, respectively, in Tables A4 and A5 in Appendix A in the supplemental data online.

14.   The results from the interquantile regression measuring the differences between the maximums and minimums of the coefficients confirm the heterogeneity of effects across the distribution (see Table A6 in Appendix A in the supplemental data online).

15.   Although positive, the effects across the distribution of the other types of zones do not show statistically significant differences across the quantiles (see Tables A3 and A4 in Appendix A in the supplemental data online).

16.   Policies oriented to the growth of regions can generate spatial externalities. The analysis of place-based policies should recognize the existence of spillover effects in neighbouring areas. Recent studies have tried to deal with the impact evaluation in presence of spillovers, but the most up-to-date research on this topic has not yet arrived at a satisfactory solution (Cerqua & Pellegrini, 2017, 2018). In the present study, however, this is not a relevant issue since our aim is not to evaluate the Chinese spatially targeted policy and, therefore, we are not interested in the interpretation of average differences in outcomes between treatment and control groups. Notwithstanding, as a robustness test, we have adopted a strategy that tries to minimize the spillovers effects. We compared counties/districts with EDZs (treated areas) and counties/districts without EDZs (untreated areas) which are distant in terms of level of development (as proxied by the industrial output). The results, available from the authors upon request, give support to our analysis.

17.   Moran's *I* index ranges from −1 to 1, where a larger absolute value denotes a greater degree of spatial association. $I > 0$ identifies a positive correlation among spatial units, while $I < 0$ indicates a negative correlation among spatial units.

18.   While spatial autocorrelation does not imply the existence of spillovers between counties, the existence of spatial autocorrelation would have important implications for the analysis of the policy.

19.   This result is partly in contrast with what Alder et al. (2016) find in their study on the establishment of SEZs in China, that is, positive and often significant spillover effects of SEZs on neighbouring regions.

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