Productivity Improvements from Place-Based Policies in Developing Countries: A Study of Indonesia's Industrial Estates Program

John Wilhoite

Johns Hopkins School of Advanced International Studies (SAIS)

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Research Advisor: Ritam Chaurey

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1. Introduction

Manufacturing has long been recognized as a key driver of growth in developing economies, even earning the moniker "the engine of growth"[1]. Unfortunately, manufacturing firms in developing countries are limited by supply-side constraints such as inadequate infrastructure or poor technology that slows firm growth[2]. Developing countries using a policy-neutral approach are hindered by the fact that firms do not internalize production externalities when choosing where to locate, wasting invaluable spillovers that could improve productivity across manufacturers[3].

Recent scholarship has focused on the use of place-based policies such as special economic zones as a potential solution. Place-based policies leverage infrastructure upgrades and technology improvements in specific areas to help local firms overcome supply-side constraints while also generating production spillovers that raise local productivity. Empirical findings support this idea, with recent literature providing evidence that agglomeration spillovers in industry clusters produce total factor productivity gains across all firms within the cluster[4]. Using such policies, government intervention in firm location decisions can generate a "big push" in manufacturing output that improves welfare not only locally but throughout the country[5][6].

This paper contributes to the existing literature by investigating agglomeration spillovers and welfare effects from Indonesia's Industrial Estates program (Kawasan Industri). The program

1 Szirmai, "Industrialisation as an Engine of Growth in Developing Countries 1950–2005," 406-420.
2 Tybout, "Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?" 11-44.
3 Henderson, "The Sizes and Types of Cities," 640–656.
4 Greenstone, Hornbeck and Moretti, "Identifying Agglomeration Spillovers," 536-598.
5 Rosentein-Rodan, "Problems of Industrailisation of Eastern and South-Eastern Europe," 202-211.
6 Murphy, Shleifer and Vishny, "Industrialization and the Big Push," 1003-1026.

provides an opportunity to examine firm-level effects from place-based policy in a developing economy setting. The Industrial Estates program was first established in 1970 and differs from similar policies in that private developers were permitted to construct and manage industrial estates independent of the government beginning in 1989[7].

Using firm-level data from 1992 to 2014, I construct a difference-in-differences model to estimate the impact establishing an industrial estate has on the performance of local manufacturing firms. My results show that the establishment of an industrial estate has a significant and positive impact on local firm productivity, firm entry and local economic welfare. These findings suggest that industrial estates are successful in increasing local firm density, generating agglomeration spillovers among local manufacturers that contribute to an improvement in local welfare. Although further research is needed to determine the efficiency of the program, these findings point to the Industrial Estates program as a successful policy tool for raising local manufacturing productivity and welfare, and possibly as a tool for generating a "big push" in manufacturing output that can raise aggregate welfare.

The paper will adhere to the following structure: Section 2 will provide an overview of the existing literature on placed-based policies and the significance of manufacturing in developing economy settings. Section 3 explores the economic history of Indonesia since 1966 in addition to the Industrial Estates program. Section 4 summarizes the data used for the estimations. Section 5 will cover the methodology and the difference-in-differences model used in the estimations. Section 6 presents the results and provides robustness checks.

[7] Indonesia: Industrial Estate Directory 2015/2016.

2. Literature Review

Growth in manufacturing output has a strong causal positive relationship with growth in gross domestic product (GDP)[8][9]. Indeed, there is a close relationship between the level of per capita income in a country today and the share of manufacturing in their economy in the past[10]. This poses two questions to developing economies: why does manufacturing have favorable growth characteristics relative to agriculture and services, and how can a developing country grow its manufacturing sector?

Several theories explaining manufacturing's role as the "engine of growth" focus on the unique productivity dynamics in the manufacturing sector. In a recent paper, Dani Rodrik demonstrates that manufacturing industries further away from the labor-productivity frontier experience faster productivity growth, allowing these industries to "catch-up" to the most productive firms in an economy[11]. As labor shifts from agriculture to manufacturing, the productivity gains translate into aggregate growth that can be accelerated with faster rates of manufacturing job creation[12].

Another popular theory focuses on the "big push" effect generated from increasing returns to scale in the manufacturing industry. Due to the relatively high-income elasticity of manufactured goods, decreasing costs from economies of scale tend to create a virtuous cycle[13]. As

8 Kaldor, "Causes of the Slow Rate of Growth of the United Kingdom."
9 Kaldor, "Strategic Factors in Economic Development."
10 Asian Development Bank, Ministry of National Development Planning. "Policies to Support the Development of Indonesia's Manufacturing Sector During 2020–2024."
11 Rodrik, "Unconditional Convergence in Manufacturing," 165-204.
12 Lewis, "The Theory of Economic Growth."
13 Rosentein-Rodan, "Problems of Industrailisation of Eastern and South-Eastern Europe," 202-211.

manufacturers scale up their operations, the cost of goods falls and demand increases, prompting more investment in manufacturing. This increase in investment causes capital accumulation, allowing manufacturing firms to further scale up their operations.

Manufacturing firms in developing countries are often hindered by their small scale and low growth. Firms in these countries are constrained by supply-side constraints such as substandard infrastructure, inadequate capital, outdated technology and poor investment climates[14]. Additionally, these firms do not internalize their production externalities, causing them to locate in areas that are too small and remote to raise the production capabilities of other firms[15]. One method for galvanizing manufacturing growth in developing countries is to use place-based policies, such as the special economic zones in China or export processing zones in Thailand and Vietnam[16][17]. Place-based policies provide superior technology, infrastructure and investment opportunities within an economic zone, lowering supply-side constraints and generating productivity spillovers through agglomerated firm clusters. These agglomeration spillovers arise when a concentration of firms makes all firms more productive, creating a virtuous cycle of firm entry and productivity gains[18].

The rationale for why firm concentration raises productivity within an industry cluster is hotly debated, but the literature has generally settled on labor market pooling, low transportation costs

[14] Tybout, "Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?" 11-44.
[15] Henderson, "The Sizes and Types of Cities," 640–656.
[16] Wang, "The Economic Impact of Special Economic Zones: Evidence from Chinese Municipalities," 133–147.
[17] Farole and Akinci, "Chapter 1: Introduction in Special Economic Zones: Progress, Emerging Challenges, and Future Directions," 1-21.
[18] Rothenberg et al, "When Regional Policies Fail: An Evaluation of Indonesia's Integrated Economic Development Zones," 1-44.

or knowledge spillovers as the most probable causes. Labor market pooling improves worker-firm matching by increasing the heterogeneity of workers and firms, and by lowering the search frictions involved in finding a suitable match[19]. Additionally, labor market pooling will insure against idiosyncratic shocks that generate layoffs by making it easier for firms to find new workers and vice-versa[20]. Lower transportation costs also improve firm productivity, because firms in dense areas enjoy faster and cheaper transportation of local services and local intermediate goods[21]. Finally, knowledge spillovers in agglomeration economies can raise productivity through two channels. The first channel is that the proximity of firms results in a more efficient flow of ideas, producing faster innovation amongst firms in a cluster[22][23]. Another channel is that firm proximity increases faster information sharing regarding new technologies, resulting in faster technology adoption[24][25].

A key question for developing countries is whether place-based policies that generate agglomeration economies will raise manufacturing output across all local firms. Conclusive results in this area have been difficult to produce due to problems with identification strategies, but findings from a number of studies suggest that agglomeration economies in the manufacturing sector improve productivity across firms in a cluster. As early as 1985, Ryohei Nakamura demonstrated that doubling the size of an industrial cluster in Japan produced a 4.5%

19 Marshall, "Principles of Economics."
20 Krugman, "Geography and Trade."
21 Krugman, "Increasing Returns and Economic Geography," 483–99.
22 Saxenian, "Regional Advantage: Culture and Competition in Silicon Valley and Route 128."
23 Moretti, "Estimating the External Return to Higher Education: Evidence from Cross-Sectional and Longitudinal Data," 175-212.
24 Griliches, "Research Cost and Social Returns: Hybrid Corn and Related Innovations," 419–31.
25 Romer, "Endogenous Technological Change," 71-102.

increase in productivity in the cluster[26]. These findings were corroborated with research suggesting that a doubling employment density in an American county increased average labor productivity by 6%[27].

More recent research has leveraged the proliferation of firm-level data to determine whether total-factor productivity is higher for firms located in dense clusters. Estimations of plant-level productivity as a function of plant density illustrate a significant and positive causal relationship between plant productivity and plant density, particularly for high tech firms[28]. Findings from a 2010 study show that in counties that attracted large manufacturers, incumbent manufacturing plants had total factor productivity that was 12% higher than plants in counties that failed to attract large manufacturers, five years after opening[29]. This finding is made more relevant by recent evidence from industrial agglomerations in China, demonstrating that agglomeration effects from dense industrial clusters have a significant and positive impact on firm size[30]. Synthesizing these results, agglomeration effects from industrial clusters can produce larger firms that then raise total factor productivity for all firms in the cluster.

Not all place-based policies will create the kind of agglomeration effects necessary to generate productivity spillovers. The welfare impacts from the Tennessee Valley Authority (TVA) demonstrate that the extent of productivity externalities generated by agglomeration economies

26 Nakamura, "Agglomeration economies in urban manufacturing industries: A case of Japanese cities," 108-124.
27 Ciccone and Hall, "Productivity and the Density of Economic Activity," 54-70.
28 Henderson, "Marshall's scale economies," 1-28.
29 Greenstone et al. "Identifying Agglomeration Spillovers: Evidence from Winners and Losers of Large Plant Openings," 536-598.
30 Li, Lu, and Wu "Industrial agglomeration and firm size: Evidence from China," 135-143.

depends on the agglomeration elasticity of participating firms[31]. In order for place-based policies to improve aggregate welfare, the agglomeration elasticity, a mapping of manufacturing density to productivity, must be sufficiently non-linear. If agglomeration elasticities are constant, then productivity spillovers will be negligible and such place-based policies will simply amount to redistributing resources from one location to another[32]. Additionally, there is a risk that even if a place-based policy succeeds in raising local firm productivity, these gains will be negated by increasing land costs. In this scenario, the benefits of the policy will accrue to landowners, and local welfare improvements will be negligible[33].

Countries implementing place-based policies also need to be sensitive to location fundamentals when deciding where to establish agglomeration economies. One important consideration is the natural advantages of a location, such as proximity to a port or availability of natural resources. Ellison and Glaeser determine that 20% of all agglomeration can be explained by natural advantages in the location of an industrial cluster[34]. This suggests that if place-based policies are to be successful in attracting firms, policymakers must also consider the natural advantages of each location as part of their selection criteria.

The economy of a region also plays an important role in determining the size of agglomeration spillovers. Place-based policies in economically disadvantaged regions may suffer from

31 Kline and Moretti, "Local Economic Development, Agglomeration Economies, and the Big Push: 100 Years of Evidence from the Tennessee Valley Authority," 1-29.
32 Glaeser and Gottlieb, "The Economics of Place-Making Policies," 155-239.
33 Rosen, "Wage-Based Indexes of Urban Quality of Life."
34 Ellison and Glaeser, "The Geographic Concentration of Industry: Does Natural Advantage Explain Agglomeration?" 311–16.

attracting low-productivity firms, creating a vicious-cycle of productivity decline and procuring negative aggregate effects[35].

3. Background

3.1 History of Indonesia's Economy

When President Suharto assumed power in Indonesia in 1966, the country's economy had experienced 2 decades of stagnation, mustering a meager 1.8% GDP growth from 1957 to 1966 and -0.6% GDP per capita growth over the same period[36]. Indonesia was beset by capital fight and the industrial sector was suffering from shortages in spare parts and raw materials[37]. A small number of state-owned enterprises that were nationalized under the previous administration dominated the industrial sector, limiting competition and stifling innovation.

Suharto's "New Order" administration sought to reverse these trends and revitalize Indonesia's anemic manufacturing sector through a series of industrial policies that can be divided into four distinct phases. The first three phases lasted from 1966 to 1983 and were defined by an import substitution policy whereby the government incentivized foreign direct investment in prioritized industries, alongside successive nationalization of industries[38]. The initiative to nationalize foreign firms culminated in the third phase of industrial policy (1979 to 1983), during which 52 industries were nationalized, including strategic sectors such as petrochemicals, steel, shipbuilding and aerospace.

[35] Gaubert, "Firm Sorting and Agglomeration," 3117-53.
[36] Boediono, "Ekonomi Indonesia: Dalam Lintasan Sejarah."
[37] Rock, "The Politics of Development Policy and Development: Policy Reform in New Order Indonesia."
[38] Asian Development Bank, Ministry of National Development Planning. "Policies to Support the Development of Indonesia's Manufacturing Sector During 2020–2024."

Successive devaluations of the Indonesian rupiah in 1979 and 1983 prompted the Suharto administration to introduce an export-oriented fourth phase of industrial policy in 1986. The fourth phase was characterized by a state-led industrialization plan whereby oil revenues would finance manufacturing facilities across the country. To accommodate the growing manufacturing sector, export processing zones were established in 1986 and 1992, and many of the nontariff barriers on imports were lifted allowing Indonesian firms to access cheaper inputs[39]. The phase was also marked by a return to the economic liberalization that informed Suharto's original reforms and starting in 1994 foreign-owned firms were once again allowed in the country.

Evaluations of the industrial policies pursued by the Suharto administration suggest mixed results. On the one hand, the share of manufacturing in GDP tripled from 9% in 1966 to approximately 27% in 1997[40], a resounding policy victory for a country that struggled for decades to build a manufacturing base. Criticism against the first three phases of industrial policy is near universal however, with critics pointing out that nontariff barriers were applied ad hoc and did little to improve the efficiency and productivity of firms that received their protection[41]. Additionally, restrictions on foreign investment meant that investment decisions were informed primarily by political feasibility rather than economic reason[42]. Evidence also suggests that despite Indonesia's adoption of export-oriented manufacturing practices in 1986, the country never produced manufacturing firms that achieved a level of complexity or scale that was

[39] Hill, "Indonesia: From 'Chronic Dropout' to 'Miracle'?" 775–789.
[40] Asian Development Bank, Ministry of National Development Planning. "Policies to Support the Development of Indonesia's Manufacturing Sector During 2020–2024."
[41] Hill, "Indonesia: From 'Chronic Dropout' to 'Miracle'?" 775–789.
[42] Rock, "The Politics of Development Policy and Development: Policy Reform in New Order Indonesia."

sustainable. Many of Indonesia's manufacturing firms were dependent on Japanese foreign direct investment, and domestic firms failed to develop self-sustaining operations. Additionally, manufacturing remained focused on assembly and processing operations, rather than the more complex operations common to northeast Asian economies[43].

The 1997 Asian Financial Crisis brought an end to the manufacturing growth that Indonesia had experienced since 1986. Manufacturing's contribution to GDP declined, and manufacturing exports remained stagnant despite a depreciating rupiah. At the same time, rising commodity prices caused a shift in resources away from manufacturing towards natural resources such as food, beverages and tobacco. These trends continue to hold to the present day. Indeed, a 2019 joint report from the Asian Development Bank and Indonesia's Ministry of National Development Planning reveals that approximately 33% of Indonesia's workforce is employed in the agriculture, while another 45% is employed in low-productivity service jobs such as hospitality and retail[44].

3.2 Integrated Economic Development Zones (KAPET)

Alongside Suharto's national policies to promote manufacturing, the administration launched a place-based policy called the Integrated Economic Development Zones (*Kawasan Pengembangan Ekonomui Terpadu*, or KAPET) in 1996. The purpose of the policy was to promote development in lagging regions in Eastern Indonesia by stimulating manufacturing

[43] Asian Development Bank, Ministry of National Development Planning. "Policies to Support the Development of Indonesia's Manufacturing Sector During 2020–2024."
[44] Asian Development Bank, Ministry of National Development Planning. "Policies to Support the Development of Indonesia's Manufacturing Sector During 2020–2024."

growth and export growth[45]. Firms were incentivized to relocate to KAPET zones through a combination of tax deductions, facilities and infrastructure and investment facilitation services. Ideally, firms that relocated to the KAPET zones would generate agglomeration spillovers that would raise the productivity of all firms in the zone and improve aggregate welfare measures in the region.

In a 2017 paper on the policy, Rothenberg, Bazzi, Nataraj and Chari use a difference-in-differences estimator to show that from 2000 to 2010 KAPET zones had no impact on firm entry in the treated districts and failed to generate productivity gains among participating firms[46]. KAPET districts experienced no improvements to development outcomes compared to non-treated districts, and in some cases fared worse. One explanation for this finding proposed by the authors is that KAPET zones failed to generate productivity gains or increase growth precisely because they were located in lagging regions. Essentially, areas with insufficient market access, lagging infrastructure and inadequate natural resources do not present attractive investment destinations, preventing firms from attracting the capital needed to improve productivity. Additionally, the authors suggest that providing subsidies to firms in the country's poorest districts may have the unintended effect of attracting the least productive firms, preventing the kind of agglomeration spillovers required to raise local productivity.

3.3 Industrial Estates Program

The subject of this paper is a separate place-based policy that was launched in 1970 under the Suahrto administration, known as the Industrial Estates program (Kawasan Industri). As

[45] Rothenberg et al, "When Regional Policies Fail: An Evaluation of Indonesia's Integrated Economic Development Zones," 1-44.
[46] Rothenberg et al, "When Regional Policies Fail: An Evaluation of Indonesia's Integrated Economic Development Zones," 1-44.

conceived by the administration, industrial estates are plots of land situated near ports or along major transportation routes that provide manufacturers with pre-exiting infrastructure designed to support industrial activity[47]. The program was developed with the aim of increasing industrial development, accelerating the growth of industry, improving the competitiveness of industry and coordinating the planning and construction of infrastructure. Industrial estates were initially only developed and managed by state-owned enterprises, and from 1970 to 1989 only seven industrial estates were developed mostly in West Java[48].

This changed in 1990 when the Indonesia Industrial Estate Association (Himpunan Kawasan Industri, or HKI) petitioned the government to license out the development and management of industrial estates to private companies. The government formalized the proposal through Presidential Decree 53, and by 2014 the seven industrial estates that existed had grown to 70 industrial estates spanning thirteen provinces[49].

Leveraging tax incentives and natural advantages inherent to the estates' locations, the Industrial Estates program managed to attract 8,517 manufacturers within industrial estates by 2014[50]. Tax incentives include exemptions on value added taxes (VAT) for imports, customs taxes and reductions on corporate income tax[51]. Additionally, firms are allowed to waive construction permits for manufacturing units if they are located within industrial estates, expediting the growth of firms.

[47] Indonesia Investment Coordinating Board (BKPM), "A Brief Guide to Investment in Indonesia Industrial Estates."
[48] Indonesia: Industrial Estate Directory 2015/2016.
[49] Indonesia: Industrial Estate Directory 2015/2016.
[50] Indonesia: Industrial Estate Directory 2015/2016.
[51] Rastogi, "Indonesia's Growing Special Economic Zones – Opportunities and Challenges."

Because industrial estates are developed by private contractors, they fill more niche functions than other Indonesian place-based policies. Based on the facilities and services provided within different estates, these functions can be categorized as follows: industrial estate as the core business, industrial estate as a manufacturing plot provider and industrial estate as residential area support[52]. The natural advantages afforded to manufacturers located within an estate are determined by which of the functions that estate fulfills. Industrial estates as a core business will provide more sophisticated infrastructure and services such as waste management services, customs offices, advertising services (leaflet and mass media), environmental maintenance and ATM rooms. Industrial estates as residential area support provide manufacturers with proximity to end-customers, as well as housing for workers and education campuses for skill acquisition[53]. While industrial estates as plot providers do not afford the same advantages, they are still located near cities, ports or along major transportation routes, decreasing transportation costs and the cost of inputs for manufacturers located within the estate.

While industrial estates may superficially resemble KAPET zones, the similarities pertain only to form but not function. Both industrial estates and KAPET zones provide tax incentives, advanced infrastructure, business services and real estate to attract firms. However, the purpose of KAPET was to stimulate growth in lagging regions in eastern Indonesia, while the purpose of the Industrial Estates program is to facilitate industrial activities and accelerate the process of industrialization in Indonesia[54]. Extrapolating from this difference in purpose, unlike KAPET

[52] Dwiatmoko et al. "Comparison Study of Three Industrial Parks in Central Java Indonesia," 67-75.
[53] Dwiatmoko et al. "Comparison Study of Three Industrial Parks in Central Java Indonesia," 67-75.
[54] Indonesia: Industrial Estate Directory 2015/2016.

zones industrial estates are not limited to low-growth regions. Because the construction of industrial estates is licensed out to private contractors, the location of estates is also not constrained by political considerations. Theoretically, this means that industrial estates are more likely to be located in areas that attract investment and productive firms, leading to the kind of capital build up necessary for a "big push" in productivity across firms in the estate.

4. Data

4.1 Industrial Estates Data

My primary spatial units of analysis in the paper are second-level administrative units in Indonesia, which I refer to as districts. These second-level administrative units consist of regencies (kabupaten) and independent cities (kota), which are situated right below provinces in terms of administrative authority. The administrative divisions in Indonesia are defined from largest to smallest as follows: country, province, regency and independent city, subdistrict and village. Both regencies and independent cities have their own local government and legislative body. The American equivalent to the regency is a county, and while independent cities may exist within the geographic boundary of a regency, they are governed separately. A map of Indonesia's provinces can be viewed in Figure 1, while boundaries for regencies and independent cities can be viewed in Figure 2.

Figure 1: Provinces of Indonesia

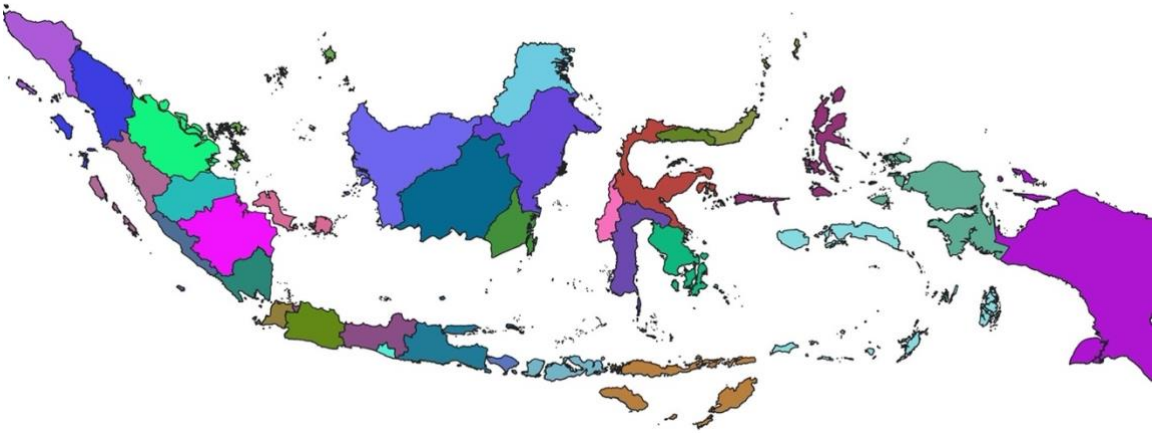
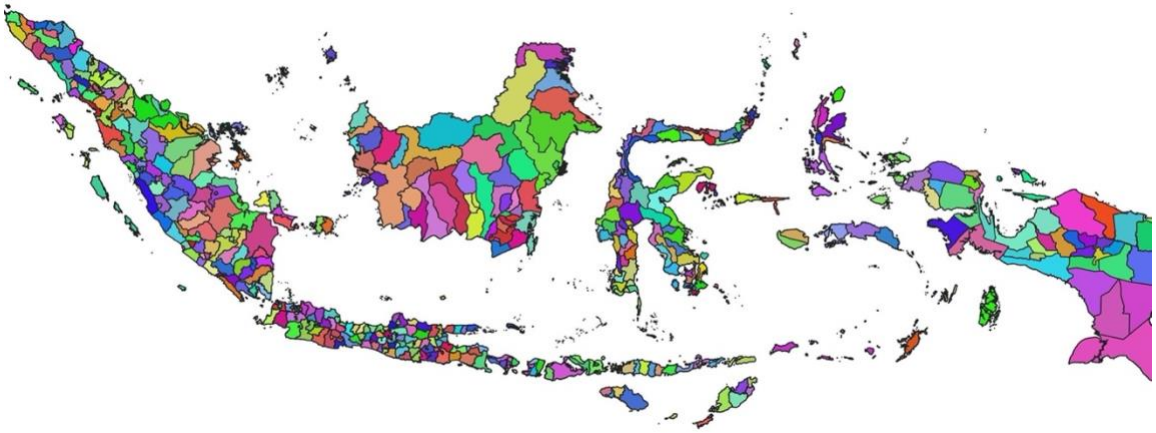


Figure 2: Regencies and Independent Cities in Indonesia

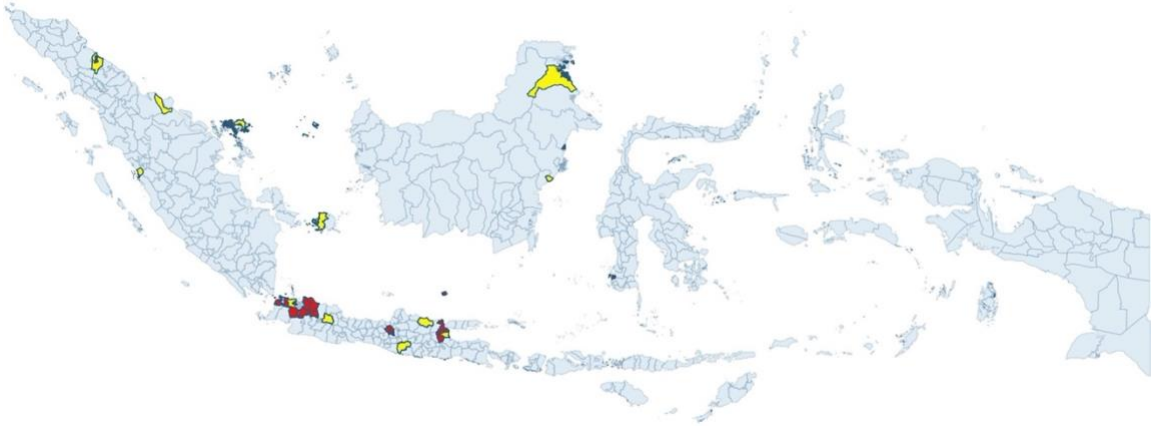


After Suharto left power in 1998, many provinces and districts were partitioned into new administrative units during the period of decentralization that followed. As a result, the identification codes for provinces and districts are inconsistent over the sample period of the data from 1992 to 2014. For example, since Riau Islands province was created in 2002 after separating from Riau province, for the period before 2002 all the districts located in the Riau Islands contain identification codes that indicate they are located in Riau. In order to achieve a consistent geographic unit of analysis, we conform all identification codes to the 2004 administrative definitions.

While data existed for the location of all 70 industrial estates in Indonesia by 2014, these datasets lacked a time component indicating when each industrial estate was established. To construct this data, the establishment date for all 70 industrial estates was tracked down and confirmed, using government documents, research publications and the website of an estate's developer or management company. To account for the presence of an industrial estate, a discrete variable was created indicating the number of industrial estates contained within a district in a given year. So, for a district that contained no industrial estates in 1994 the variable would equal zero. If an estate was later constructed in that district in 1997 the variable would take on a value of 1. If two additional estates were constructed in 2005 the variable would take on a value of 3 for that year and every subsequent year. In total, 26 districts out of the 284 in the sample contained an industrial estate at the start of the sample period, or had an industrial estate established during the sample period. In Figure 3, the 14 districts that already contained at least one industrial estate in 1992 are colored in red. The yellow districts in Figure 4 are 12 districts that gained at least one industrial estate from 1992 to 2014, in addition to the original red districts from Figure 3.

Figure 3: Industrial Estates in 1992

Figure 4: Industrial Estates in 2014



4.2 Firm-Level Data

To capture the impact on manufacturing firms located in districts with an industrial estate, this paper uses firm-level data from Indonesia's Annual Manufacturing Survey conducted by the Indonesian Statistical Office (Chaurey 6). The survey is sent out annually and covers all manufacturing plants with 20 or more workers, totaling approximately 20,00 plants each year. All nominal variables are deflated using price indices from the Indonesian Statistical Office.

The dataset covers 22 years from 1992 to 2014. Observations are included for 54,828 firms across 286 districts in 32 provinces and contains variables for product type, firm income, investments, expenses, capital goods, number of employees, labor composition and wages.

Firms included in the data represent a range of sizes, with firm labor force ranging from 20 employees at the smallest firm to 116,000 employees at the largest firm. The firms also represent over 1,228 unique main products.

The main variable of interest for evaluating the impact of establishing an industrial estate in a treated district is the logarithmic value of labor productivity measured at the firm-level. This variable was generated by dividing firm productivity by firm labor size and taking the logarithm of the result. Other outcome variables measured at the firm level include total firm production, firm labor size, average firm wages and firm capital stock. In my estimations I take the logarithm of these variables to reduce noise from outliers in the data.

Table 1

	count	mean	sd	min	max
Log(Labor Productivity)	416646	11.31828	1.445847	-7.509221	21.57613
Log(Production)	416646	15.49517	2.126514	.0619877	25.89734
Log(Labor)	444704	4.16908	1.172635	2.397895	11.66179
Log(Wages)	444478	13.36515	1.706206	.0619877	22.44283
Log(Capital Goods)	290645	14.21779	2.168041	0	30.62654
Observations	444704				

4.3 Nightlight Data

Nightlight data was sourced from United States Air Force Defense Meteorological Satellite Program - Operational Linescan System (DMSP-OLS) Nighttime Lights time series. Satellites from the DMSP have been circling the earth recording the intensity of Earth-based lights since the 1970's. The satellites observe every location on the planet every night at some instant between 8:30pm and 10:00pm local time. Data from the collective orbits of each satellite in a year are averaged to produce a satellite-year dataset. Each dataset uses 30 arc-second output pixels between 65 degrees south and 75 degrees north latitude to construct a grid reporting the intensity of earth-based lights as a digital number between 0 (no light) and 63[55].

[55] Henderson, Storeygard and Weil, "Measuring Economic Growth from Outer Space," 994–1028.

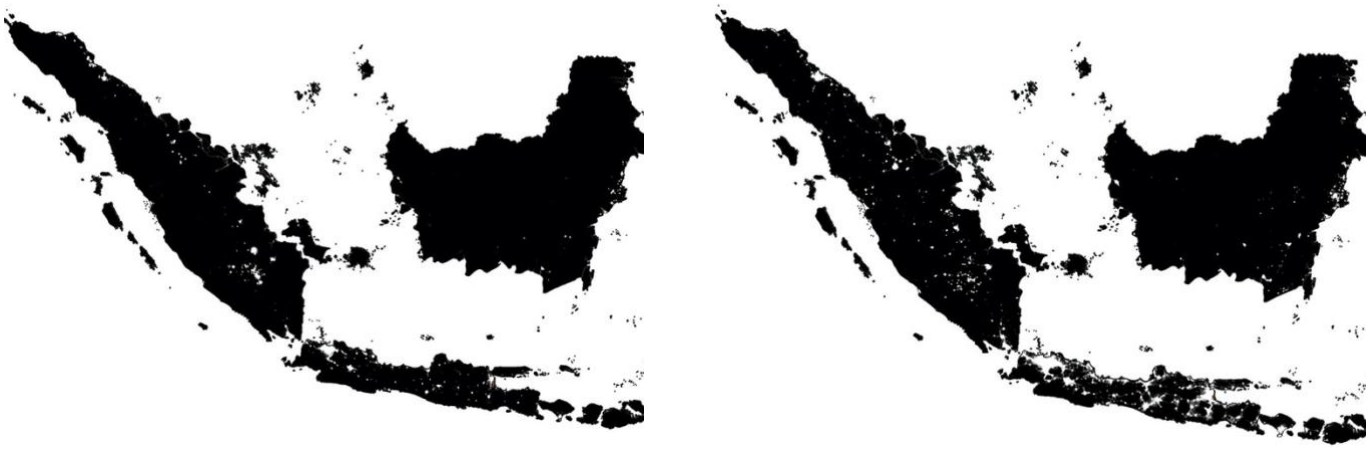
DSMP-OLS sensors collect low-intensity light in urban settings and small-scale industrial areas, distinguishing them from dark rural areas. Nightlight data can thus use brighter lights from increased business activity as a proxy for economic activity and relatively greater wealth. In fact, nightlight data has been shown to be significantly correlated with aggregate economic measures like GDP[56]. For the purposes of this paper, nightlight data can be used as a strong proxy for sub-national economic growth, specifically in Indonesia[57].

In order to process the nightlight data, I used the Quantum Geographic Information System (QGIS) desktop software. DSMP-OLS satellite data from 1992 to 2013 was loaded in QGIS as raster layers. For the years 1994 and 1997 to 2007, two satellite-year datasets were produced from the orbits of two separate satellites, while only one satellite-year dataset was produced in other years. For the years with two satellite-year datasets, the average value of the two raster layers was used when processing the data. The raster layer in each year was then clipped using a shapefile of Indonesia's district-level boundaries to produce annual light intensity data for each district on the 0 to 63 scale.

From the following images of Western Indonesia, we observe significant growth in the number of lights and light intensity in Java, South Sumatra, Riau, North Sumatra and East Kalimantan, which correspond with the regions with the most economic activity during this time period.

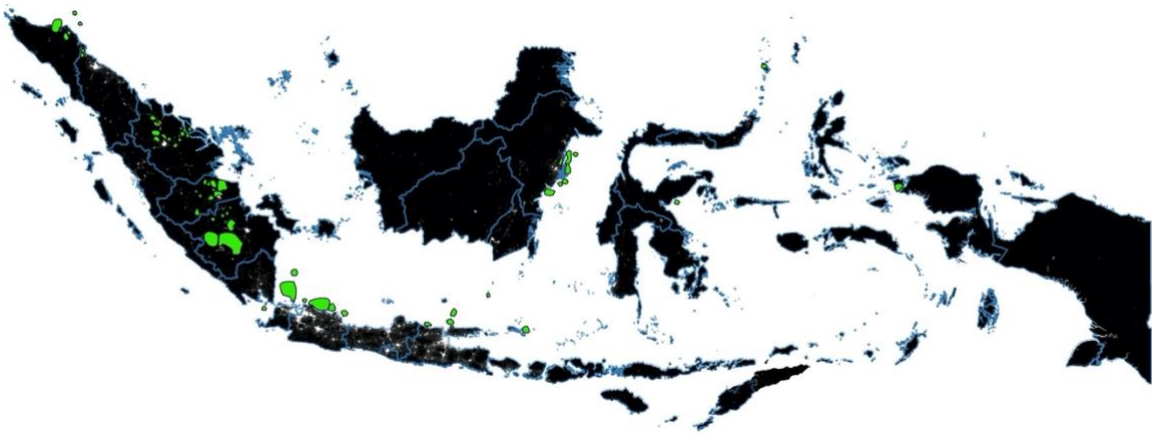
56 Henderson, Storeygard and Weil, "Measuring Economic Growth from Outer Space," 994–1028.
57 Olivia and Gibson, "Economic Rise and Decline in Indonesia–As Seen from Space."

Figure 5: Indonesian Satellite Nightlight Images from 1992 and 2013



Given that Indonesia is a major oil-producing country, it is prudent to eliminate contamination of the raster layer from gas flares, a byproduct of oil production (Henderson 21). The light from the gas flares is filtered out of the data using a separate shapefile that covers the areas responsible for the most flaring. Areas responsible for flaring are shown in green in Figure 6.

Figure 6: Indonesia's Gas Flaring Regions



5. Methodology and Model

5.1 Methodology

The objective of my empirical strategy is to measure the difference in outcome variables between the treatment districts with industrial estates and the control districts without industrial estates before and after the introduction of industrial estates in the district. A difference-in-differences estimator is used to capture the impact of industrial states on the logarithmic value of the outcome variables for firms located in the treatment districts. The cutoff point will vary for each district given that the establishment of industrial estates varied across districts. The differences-in-differences coefficient in the estimation will take the following form:

$$E\left[\left(logY_{idpt}^{treated} - logY_{idpt}^{control}\right)_{After\ IE}\right] - E\left[\left(logY_{idpt}^{treated} - logY_{idpt}^{control}\right)_{Before\ IE}\right]$$

Where "Before IE" and "After IE" refer to the difference between the treatment and control groups before and after the establishment of the industrial estates. Of the 286 districts included in the data, 26 districts contained an industrial estate within their borders. 14 of these districts already contained at least one industrial estate by the start of the sample period in 1992, and 12 of these districts established an industrial estate within their borders between 1992 and 2014.

5.2 Model

The difference-in-differences model for firm-level outcomes is as follows:

$$\log\left(Y_{idpt}\right) = \alpha + \beta_1 IE_{dpt} + \delta_i + \gamma_t + \phi_{pt} + \epsilon_{idpt}$$

In the model, $\log(Y_{idpt})$ represents the log of the outcome variable for firm productivity, production, labor force, wages and capital goods in firm *i* in district *t* in province *p* in year *t*. $\beta_1 IE_{dpt}$ is the treatment variable that represents the marginal impact of having at least one industrial state in the district. The treatment variable will take on a value of 0 if there is no industrial estate in district d at time t and will take on a value of 1 if there is at least one industrial estate in district d at time t. δ_i represents firm fixed effects and γ_t represents year fixed effects. The ϕ_{pt} represents province-year fixed effects, which are the year fixed effects at the province level. This is included in the model to control for endogeneity resulting from the fact that provinces with better economic prospects may be corelated with higher outcome variables and also have a higher likelihood for establishment of an industrial estate. Thus, without controlling for province-year fixed effects the coefficient for industrial estates will be upward biased from this selection bias.

$$\log(Y_{idpt}) = \alpha + \beta_1 IE_{dpt} + \beta_2 IE2_{dpt} + \delta_i + \gamma_t + \phi_{pt} + \epsilon_{idpt}$$

An additional estimation with the $\beta_2 IE2_{dpt}$ term is used to represent the marginal effect from additional industrial estates beyond the first estate. The purpose of this estimator is to capture the marginal effect of having multiple industrial estates in a single district.

The differences-in -differences model for district-level outcomes takes the follows form:

$$Y_{dpt} = \alpha + \beta_1 IE_{dpt} + \pi_i + \gamma_t + \phi_{pt} + \epsilon_{dpt}$$

This model is used to capture the impact of industrial estates on district-level outcomes including firm-entry and mean light intensity. Y_{dpt} represents the outcome variables in district *d* and province *p* in year *t*. $\beta_1 IE_{dpt}$, γ_t and ϕ_{pt} still represent the marginal impact of an industrial estate in district *d*, year fixed effects and province-year fixed effects respectively. Instead of controlling for firm fixed effects in this model, we use π_i to control for district-level fixed effects since the outcome variables are measured at the district level.

All estimations have standard errors clustered at both the district level and by year. Using this strategy, the standard errors are corrected for the possibility of district errors that are correlated over time, or that year errors that are correlated across districts. This is a concern for the estimation, given that the period of analysis covers the 1997 Asian Financial Crisis, where we might expect the impact of the crisis in that year and following years to be correlated with the treatment districts since they are more exposed to international trade flows.

6. Results

My primary interest is whether the establishment of an industrial estate in a district had a significant and positive causal impact on firm productivity. If treated districts fail to realize productivity improvements following the establishment of an industrial estate, then neither the natural advantages of an industrial estate, improvements to local infrastructure nor agglomeration spillovers did anything to raise the productivity of Indonesian manufacturers. Column (1) in Table 2 shows that the establishment of an industrial estate in a district has a significant and positive impact on firm productivity. Specifically, the establishment of an industrial estate produces a 12.4% increase in firm productivity for firms in the treated district. The direction and

size of the coefficient is consistent with my expectation and confirms that Indonesia's Industrial Estates program raises firm productivity either through shifting firms to locations with more natural advantages, improvements to technology and infrastructure or agglomeration spillovers. Column (2) shows that the establishment of an industrial estate has a significant and positive impact on firm output, at a magnitude of approximately 10%. This lends evidence to the idea that Indonesia's industrial estate program can facility a "big push" in manufacturing through virtuous cycles that increase total output.

Questions still remain regarding the specific mechanisms through which the industrial estate program is increasing firm productivity in treated districts. Column (3) and column (4) in Table 2 both show that the establishment of an industrial estate has a nonsignificant impact on labor size and wages at firms in the treated districts. While column (4) shows industrial estates have a positive impact on wages, that the coefficient is not significant below the 10% level suggests labor pooling is not the primary mechanism driving productivity gains. Column (5) instead shows a significant and positive relationship between the establishment of an industrial estate and the total amount of capital goods owned by a firm. This suggests that the establishment of an industrial estate may remove supply-side constraints on firms, such as inadequate infrastructure, allowing firms to increase their capital stock and generate more output. Another explanation is that the increase in firms' capital stock is a result of knowledge spillovers due to closer firm proximity, increasing the rate of technological adoption within treated districts.

Table 2

	(1) Log(Labor Productivity)	(2) Log(Production)	(3) Log(Labor)	(4) Log(Wages)	(5) Log(Capital Goods)
Industrial Estate	0.124***	0.101+	-0.0270	0.0321	0.0743+
	(0.000)	(0.076)	(0.421)	(0.103)	(0.079)
Constant	11.29***	15.48***	4.182***	13.37***	14.21***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	409735	409735	438005	437773	284232
r2	0.739	0.857	0.891	0.819	0.832
F	18.66	3.468	0.673	2.886	3.421

p-values in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The findings in Table 3 largely conform to my previous results. Column (1) shows a significant increase in firm productivity due to the marginal impact of establishing a single industrial estate, and column (2) still provides evidence for an increase in manufacturing firm output in treated districts. However, column (5) shows that the increase in firms' capital stock is no longer significant below the 10% level of significance. Instead, there is a significant and positive effect on firms' capital stock from the marginal impact of establishing more than one industrial estate in a treated district. This finding suggests that the capital deepening responsible for productivity gains may be concentrated in districts with multiple industrial estates.

Table 3

	(1) Log(Labor Productivity)	(2) Log(Production)	(3) Log(Labor)	(4) Log(Wages)	(5) Log(Capital Goods)
Industrial Estate	0.133***	0.107+	-0.0289	0.0316	0.0597
	(0.000)	(0.055)	(0.403)	(0.168)	(0.150)
Multiple Estates	-0.0828	-0.0564	0.0194	0.00507	0.165*
	(0.139)	(0.475)	(0.605)	(0.928)	(0.016)
Constant	11.30***	15.49***	4.180***	13.36***	14.20***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	409735	409735	438005	437773	284232
r2	0.739	0.857	0.891	0.819	0.832
F	11.76	2.063	0.540	1.585	5.484

p-values in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For agglomeration spillovers to play a role in firm productivity gains, it must be that treated districts experience an increase in firm entry following the establishment of an industrial estate. Column (1) in Table 4 shows a significant and positive relationship between firm entry measured as a level and the establishment of an industrial estate. Column (2) shows that after taking the inverse hyperbolic sine of firm entry, the relationship between percent change in firm entry and the establishment of an estate is still positive but insignificant. Since agglomeration spillovers require the formation of dense firm clusters, this provides strong evidence that treated districts are generating agglomeration economies by increasing firm density within their borders.

Table 4

	(1) Entry	(2) ASINH(Entry)
Industrial Estate	10.64*	0.173
	(0.036)	(0.471)
Constant	0.452	0.0492**
	(0.398)	(0.003)
Observations	5819	5819
r2	0.0612	0.157
F	4.389	0.522

p-values in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A chief concern for developing countries implementing place-based policies is that firm productivity gains will be negated by increasing land prices, preventing local welfare improvements. Column (1) and column (2) in Table 5 instead suggest that Indonesia's industrial estate program produced positive local welfare effects within treated districts. Column (1) shows that the establishment of an industrial estate had a significant and positive impact on the mean light intensity in a treated district, and column (2) shows that the introduction of an industrial

estate produced a positive percent change in mean light intensity. Given that mean light intensity proxies for aggregate economic indicators, these findings indicate that productivity gains from the Industrial Estates program exceed increasing local costs.

Table 5

	(1) Lights	(2) Log(Lights)
Industrial Estate	4.046*	0.264+
	(0.028)	(0.095)
Constant	16.09***	2.123***
	(0.000)	(0.000)
Observations	414376	414022
r2	0.955	0.944
F	5.607	3.065

p-values in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The industrial estate program is more likely to target districts with positive economic outlooks and welcoming investment environments. This endogenous placement can produce a positive targeting bias that leads to an overestimation of the program impact in treated districts versus control districts. In order to check the robustness of my results, I run the same estimation in Table 2 after dropping the West Java and Banten provinces from my sample. Both West Java and Banten contain large urban populations, have a high GDP per capita and host multiple industrial estates within their border.

Table 6 demonstrates that even after dropping observations for Banten and West Java from the sample, the same results hold across all outcome variables for the establishment of an industrial estate in a treated district. Column (1) and column (2) show that firm productivity and firm ouput still increases after the establishment of an industrial estate, even after dropping West Java and

Banten. In Column (5) the impact from the establishment of an industrial estate on firm's capital stock is still significant and positive.

Table 6

	(1) Log(Labor Productivity)	(2) Log(Production)	(3) Log(Labor)	(4) Log(Wages)	(5) Log(Capital Goods)
Industrial Estate	0.124***	0.102+	-0.0263	0.0312	0.0817*
	(0.000)	(0.078)	(0.435)	(0.110)	(0.049)
Constant	11.38***	15.59***	4.207***	13.46***	14.33***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	314314	314314	334798	334605	213264
r2	0.741	0.858	0.884	0.809	0.824
F	18.08	3.415	0.631	2.772	4.388

p-values in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7. Conclusions

After years of manufacturing growth under the Suharto administration, Indonesia's manufacturing industry has experienced decades of anemic growth following the Asian Financial Crisis in 1997. Over the same time period a larger percentage of the country's population has been employed in low-productivity agriculture and services jobs. While the government could wait for a solution from the free market, a government solution appears merited given Indonesia's supply side constraints from inadequate infrastructure in addition to firms' inability to internalize production externalities when deciding where to locate.

Place-based policies can relieve supply-side constraints on manufacturing production by situating firms in areas with improve infrastructure, business services and include natural advantages such as port proximity or proximity to natural resources. Additionally, if place-based policies succeed in increasing firm density they can create agglomeration economies that

generate a “big push” in manufacturing output, leveraging production externalities to increase productivity across firms.

This paper contributes to the literature by providing evidence that place-based policies with market-determined location selection criteria can generate local productivity improvements, increase firm entry and generate local welfare gains. Previous place-based policies in Indonesia failed to generate productivity improvements due to poor selection criteria that resulted in inadequate investment opportunities and attracted low-productivity firms. Results from this paper provide evidence that Indonesia’s Industrial Estates program found much more success, producing productivity gains and increases in firm output in districts that received an industrial estate. Data on firms-level capital stock and firm entry provides evidence that firms in treated districts benefited from weaker supply-side constraints and agglomeration economies that facilitated productivity spillovers. Additionally, nightlight data for Indonesia demonstrates that treated districts also experienced local welfare improvements, suggesting that firm productivity gains were not negated by rising land prices or wages.

This paper suffers from a lack of concrete knowledge regarding the agglomeration elasticities of firms in treated districts. Without this knowledge, it could be that firms in treated districts have linear agglomeration elasticities, so that the Industrial Estates program is merely redistributing resources from one district to another. Under this scenario, productivity improvements in treated districts will be matched by productivity losses in control districts, producing no net gains or losses. Additionally, the estimation strategy used may contain endogeneity bias from the selection criteria used when locating an industrial estate. This could create an upward bias for the

estimates, causing the coefficients to overestimate the impact of the industrial estate program on firm outcome variables.

Moving forward, the Industrial Estates program would benefit from a cost-benefit analysis to determine whether this policy represents an efficient alternative to existing industrial policies in Indonesia. In either case, my results demonstrate that place-based policies using market-determined location selection criteria generate superior firm productivity gains, greater firm entry and larger local welfare gains when compared to place-based policies located in lagging regions. Developing economies looking to use place-based policies to increase manufacturing output should consider these results when designing their own policies.

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