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Abstract

This paper exploits a short-lived cooperation program between the U.S.S.R. and China, which led to the construction of 156 "Million-Rouble plants" in the 1950s. We isolate exogenous variation in location decisions due to the relative position of allied and enemy airbases and study the long-run impact of these factories on local economic activity. While the "156" program accelerated industrialization in treated counties until the end of the command-economy era, this significant productivity advantage fully eroded in the subsequent period. We explore the nature of local spillovers responsible for this pattern, and provide evidence that treated counties are overspecialized and far less innovative. There is a large concentration of establishments along the production chain of the Million-Rouble plants, which limits technological spillovers across industries.

JEL-Codes: R110, R530, J240, N950.

Keywords: industrial clusters, agglomeration economies, specialization.

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The structural transformation of agrarian economies involves high spatial concentration of economic activity (Kim, 1995; Henderson et al., 2001). Industrial clusters that emerged during this transformation typically experience a boom followed by a bust, as illustrated by declining factory towns in the United States (Detroit and the "Rust Belt"), the United Kingdom (Manchester and other cotton towns), Germany or France (locations of steel mills and collieries in the Ruhr region and Northeast, respectively). Natural explanations behind the decline of industrial clusters are (i) structural change, as aggregate employment shifts away from industry and into services (Ngai and Pissarides, 2007; Desmet and Rossi-Hansberg, 2014), and (ii) exposure to international competition (Pierce and Schott, 2016). This paper documents a boom-and-bust cycle of industrial clusters without an aggregate decline in manufacturing. This allows us to focus on the internal factors that contribute to the decline. We identify overspecialization in the short run and a lack of technological spillovers across industries in the long run as underlying drivers.

In our empirical strategy, we exploit the iconic "156" program—an unprecedented technology transfer where China "received the most advanced technology available within the Soviet Union, and in some cases this was the best in the world" (Lardy, 1987). The 156 "Million-Rouble Plants" (henceforth, MRPs) built with the help of Soviet engineers during the period 1953–1958 constitute the cornerstone of Chinese industrialization (Naughton, 2007).[1] We study the emergence of industrial clusters around these MRPs and estimate the local effect of early industrialization on long-term economic activity. The ephemeral geopolitical context that enabled the "156" program allows us to isolate exogenous variation in the allocation of 156 MRPs across Chinese counties. Conditional on economic suitability, the crucial criterion was to be out of reach of enemy bombing, and we use information on the relative position of enemy and allied airbases to predict the risk of being attacked. Conveniently, the threat of enemy bombings changed radically with the Sino-Soviet split in 1960, thus reducing concerns about lasting effects on investments. Our estimates show strong positive effects of the "156" program until the early 1990s. The industrial clusters in treated counties are markedly more industrialized and two to three times more productive. However, they experience a swift decline over the following decades of economic transformation, even though the MRPs themselves remain extremely productive.

To better understand the phase of decline, we exploit data on manufacturing

[1] In contrast with the Great Leap Forward or the Third Front Movement, this program was efficiently implemented. The choice of locations for these plants was economically sound and spanned a wide range of locations in China; great attention was given to production efficiency, including material incentives for managers (Eckstein, 1977; Selden and Eggleston, 1979).

establishments (1992–2008) linked with patent applications. Industrial clusters in treated counties appear to be overspecialized with a large concentration of establishments along the MRP's production chain. These results are consistent with specialization during the early phase of industrialization (Glaeser et al., 1992), possibly due to technology adoption or economies of scale (Ciccone, 2002). This overspecialization is shown to be detrimental in the longer run, pointing to the relative importance of within-industry spillovers for the formation of an industry, while industrial diversity and between-industry spillovers may facilitate reorientation during phases of structural change. In particular, we observe a relative decline in productivity and a sharp drop in patenting, the latter mostly driven by the lack of innovation in upstream and downstream establishments. The limited co-agglomeration patterns, with few establishments outside the production chain, may also reflect a shift in the entrepreneurial supply curve (Chinitz, 1961; Glaeser et al., 2015) induced by the large factory. By contrast, we find little support for negative spillovers along factor demand, most notably an underinvestment in human capital (Glaeser, 2005; Franck and Galor, 2017) or favoritism and preferential access to capital (Fang et al., 2018; Harrison et al., 2019).

While the negative effect of specialization and over-industrialization on innovation and entrepreneurship is often highlighted in the policy debate, there is little work identifying the mechanisms that underpin the long-run response of the local economy. This is likely due to three empirical challenges.

First, identifying industrial spillovers in the long run requires exogenous variation in the spatial distribution of large industrial units. In an ideal setting, actual project sites would have a natural set of counterfactual industry locations, e.g., a list of candidate locations as in Greenstone et al. (2010), and a well-identified exogenous component in the selection process among these locations. We emulate this setup in two steps. We rely on the historical site-selection criteria described in Bo (1991) to determine a set of suitable counties based on geographic fundamentals. In this regard, we construct measures of connectedness, market access and access to natural resources through the existing transportation network (1948). We then exploit the ephemeral geopolitical context to isolate exogenous variation in the selection of hosting counties. The planning period coincided with (i) the immediate aftermath of the Korean War, in which China intervened directly, and (ii) the short-lived Sino-Soviet Treaty of Friendship, Alliance and Mutual Assistance. Location choices were crucially influenced by vulnerability to air strikes from major U.S. Air Force (U.S.A.F.) bases and the shield provided by U.S.S.R. and North Korean bases.[2] We

[2]Senior generals were directly involved in siting decisions to protect the state-of-the-art factories

construct an instrumental variable by penalizing travel time from enemy bases using proximity to allied bases. Following the Sino-Soviet split, the protective role of these allied bases became irrelevant for all subsequent strategic decisions, and we condition our analysis on this ex-post vulnerability to air strikes. The set of protected locations became smaller, justifying the strategy "close to the mountains, dispersed, and hidden in caves" of the Third Front Movement (see Fan and Zou, 2019).

Second, this research requires high-quality disaggregate data on economic activity spanning the pre- and post-industrialization periods. China and its rapid structural transformation allows us to cover both periods with measures of economic activity between 1950 and 2015, and these measures can be nested at the county level (about 2,400 in China). The first data source that is readily available in the early stages of industrialization is county gazetteers, which report total population, rural population and output at the county level between 1949 and 1982. We complement these data with the 1953, 1964, 1982, 1990, 2000 and 2010 Population Censuses. In the recent period, we rely on a quasi-census of manufacturing firms, which we geolocate at the postcode level and link with patent applications.[3] These high-quality establishment data allow us to reconstruct carefully the local structure of production and possible linkages with the local MRP, i.e., (i) input-output linkages, (ii) technology closeness, and (iii) factor demand and factor market distortions.

Third, the identification of spillovers across production units is not straightforward. With treatment heterogeneity, i.e., with MRPs operating different technologies to produce different products and drawing on different factor markets, a simple difference-in-differences procedure cannot be implemented: It would require us to observe the sub-population of firms susceptible to be affected in control counties. We specifically develop a two-step procedure to address this issue. In a first step, we stratify counties by their propensity to receive a Million-Rouble plant. In a second step, we run Monte-Carlo simulations in which we draw—for each control county—one treated county (and its MRPs) from the same stratum and hypothetically attribute the associated MRP(s) to the control county. The identification of spillovers through this procedure relies on a version of the Conditional Independence Assumption.

of enemy bombers, using intelligence maps of the U.S. and Taiwanese airbases (Bo, 1991). Historical U.S.S.R. documents report the same strategy to locate Soviet Science Cities out of the reach of enemy bombing (Schweiger et al., 2018).

[3]The National Bureau of Statistics "above-scale" annual establishment survey (1992–2008) constitutes a census of establishments (more specifically, "legal units") with annual sales in excess of RMB 5 million and of all state-owned firms. Our data further include information gathered from the China City Statistical Yearbooks during the period 1994–2013, the 2004 and 2008 Economic Censuses covering all firms of the secondary and tertiary industries, and night-time luminosity (DMSP/OLS, 1992–2013).

Our paper contributes to several strands of existing research. It contributes to the literature on agglomeration economies and urban growth, as reviewed in Duranton and Puga (2014). Few papers have followed industrial clusters over a period of structural transformation (Kim, 1995; Henderson et al., 2001; Ciccone, 2002) which is important to understand their evolution (Glaeser, 2005; Franck and Galor, 2017) and long-run impact on regions (Glaeser et al., 2015; Chinitz, 1961). We contribute to this literature by studying the boom-and-bust cycle of industrial clusters and exploring changes in the externalities that large industrial sites exert on their local economy. Specifically, we look at the influence of co-agglomeration (Faggio et al., 2017) and local diversity (Duranton and Puga, 2001), the effect of increased competition for local resources (Falck et al., 2013; Franck and Galor, 2017), and the relative importance of within-industry and across-industry technological spillovers (Glaeser et al., 1992; Beaudry and Schiffauerova, 2009). To assess these effects, we develop a new strategy to identify treatment spillovers across establishments in the presence of treatment heterogeneity.[4]

The paper further relates to a recent body of research on place-based policies, including Busso et al. (2013); Kline and Moretti (2014); von Ehrlich and Seidel (2018) and Schweiger et al. (2018), as reviewed in Neumark and Simpson (2015). The closest paper to ours is Kline and Moretti (2014). It uses the boundaries of the Tennessee Valley Authority (TVA) to study the transition from agriculture to manufacturing. In contrast to this regional development program that came with large-scale infrastructure investments, the "156" program consisted of turnkey factories that immediately generated jobs and income. The Chinese setting further allows us to look at two different transitions: from agriculture to (heavy) manufacturing in the command-economy era and from heavy to light, export-oriented industries and eventually to services in the subsequent reform period. The study also relates to research looking at other spatial policies in China, e.g., the impact of Special Economic Zones and industrial parks policies (Wang, 2013; Crescenzi et al., 2012; Alder et al., 2016; Zheng et al., 2017) or the impact of the Third Front Movement (Fan and Zou, 2015).

Finally, the paper relates to an important aspect of transition economies: the misallocation of resources across production units, in particular the role of credit constraints (Song et al., 2011; Buera and Shin, 2013), dispersion in factor produc-

[4] This empirical strategy could apply to most of the literature analyzing the spillovers of Foreign Direct Investment on domestic firms (Head et al., 1995; Aitken and Harrison, 1999; Konings, 2001; Smarzynska Javorcik, 2004; Haskel et al., 2007). We indeed rely on similar definitions of possible linkages/spillovers between the treatment and local firms: links through competition on goods markets, vertical linkages in the input/output matrix, competition on factor markets, etc.

tivity (Brandt et al., 2016; Hsieh and Klenow, 2009; Hsieh and Song, 2015) and labor market distortions (Brandt et al., 2013; Tombe and Zhu, 2015; Mayneris et al., 2016). One source of distortions is specific to the Chinese context. Brandt et al. (2016) observe wide dispersion in output per worker within the non-state sector across localities in China, which derives from "entry wedges" that are highly correlated with the share of state-owned enterprises (SOEs) in the local economy. These SOEs are indeed shown to benefit from privileged access to resources even after privatization (Harrison et al., 2019). Corruption and political favoritism may divert productive factors away from productive establishments (Chen et al., 2017; Fang et al., 2018), and pro-competition policies may be particularly effective (Aghion et al., 2015). Our paper complements these studies by highlighting other externalities induced by the local presence of a large industrial champion.

The remainder of the paper is organized as follows. Section 1 describes the historical context. We detail our main data sources and empirical strategy in Section 2. Section 3 presents empirical facts about the rise and fall of early-industrialized counties. Section 4 provides evidence about the mechanisms behind the reversal of fortune with more granular establishment-level data. Section 5 briefly concludes.

1 The "156" program

The "156" program is a unique experiment to study agglomeration effects in the long run. First, the Million-Rouble Plants (MRP) constitute a massive push shock in an otherwise agrarian economy (Lardy, 1987; Rawski, 1979). The investment precedes the structural transformation of the Chinese economy by about 30 years and presents the features of a large counterfactual experiment off the equilibrium path. Second, the geopolitical context introduces unique exogenous variation in the decision to locate projects: The "156" program was unanticipated before 1950, and strategic considerations behind the opening and location of plants became irrelevant after 1960 and the Sino-Soviet Split. Third, the MRPs consist of many different types of factories allowing to better identify treatment spillovers.

Sino-Soviet cooperation (1950–1960) Although Sino-Soviet cooperation was central in the first years of the People's Republic, it was not based on strong preexisting economic relations. In 1949, after decades of destruction through the Sino-Japanese and Chinese civil wars, Chinese leaders studied the possibility of international economic cooperation to foster the development of heavy industry and transform China's agrarian economy. For geopolitical and ideological reasons,[5] the Chinese government engaged in economic cooperation with the Soviet Union to give China its own independent industrial system (Dong, 1999; Lüthi, 2010). The U.S.S.R. agreed to cooperate and assist China in the creation of state-of-the-art industrial sites with the purpose of extending its influence in the region. The possibility of economic cooperation became credible after the Sino-Soviet Treaty of Friendship and Alliance of 1950, which included a large loan. In August 1952, Chinese Prime Minister Zhou Enlai visited Moscow to formalize the involvement of the Soviet Union in the long-delayed First Five-Year Plan (1953–1957). The U.S.S.R. would assist China in the construction of about 50 industrial sites. In May 1953, 91 new projects were agreed on and an additional 15 in October 1954.

The economic aid from the U.S.S.R. extended beyond large loans. First, during the peak of the cooperation, between 1953 and 1956, 20,000 scientific, industrial and technical experts from the Soviet Union lived and worked in China to design the construction of factories and rationalize production (Zhang, 2001; Wang, 2003). In order to build capabilities, 80,000 Chinese students were trained in Soviet universities and technological institutes. Second, the U.S.S.R. provided more than half of the required equipment.[6] Third, while some blueprints were destroyed, the existing technology could be imitated and represented a large shift in the technological frontier for an agrarian economy (Bo, 1991).[7] Chinese scholars credit the "156" program with having (i) invested in basic sectors such as the energy and steel industries and laid the foundations for the development of other industries, (ii) boosted production capacity and shifted the technological frontier, and (iii) promoted a more even spatial development by industrializing central and western provinces (Dong and Wu, 2004; Zhang, 2009; Shi, 2013). The construction of the large MRPs also triggered the rapid development of Chinese cities in the following decades (He and Zhou, 2007).

Location decisions The "156" MRPs were regarded as iconic firms and planners put much thought in siting decisions. First, planners selected locations using eco-

[5] The regime's revolutionary agenda, American support for the Nationalist government in Taiwan in the aftermath of the civil war, the Western embargo (Zhang, 2001) and then the Korean War, in which China directly participated by sending troops, reinforced links between China and the Soviet Union—which Chairman Mao called "leaning to one side" (*yi bian dao*) in a famous speech ("On the People's Democratic Dictatorship") delivered on June 30, 1949.

[6] As a payment, China was to give 140,000 tons of tungsten concentrate, 110,000 tons of tin, 35,000 tons of molybdenum concentrate, 30,000 tons of antimony, 90,000 tons of rubber and other produce including wool, rice or tea. Some low-skilled workers were also sent to Siberia.

[7] The 15 last projects agreed on in 1954 even benefited from state-of-the-art equipment that few Soviet factories enjoyed (Goncharenko, 2002), allowing China to make the most of Gerschenkron's (1962) "advantage of backwardness" (Tang, 2009).

nomic criteria. These suitability criteria, detailed in Bo (1991), are: (i) access to natural resources through existing roads and rail, (ii) connection to the transportation network and (iii) belonging to an agrarian province, as the investments were seen as an opportunity to smooth the spatial distribution of income. We will use these criteria to identify a relevant control group.

However, this period was an era of heightened geopolitical tensions that culminated in the Korean War—where U.S. soldiers and Chinese "volunteers" directly confronted. Planners were concerned that the brand-new plants might become the target of enemy attacks. The decision process involved senior military officials to decide where factories should be built, accounting for the locations of enemy and allied airbases. Major enemy airbases in Japan, South Korea and Taiwan were remnants of the major U.S. airbases used during World War II, the Korean War, and bases used by the United States Taiwan Defense Command. Most of the Chinese territory was in the range of U.S. strategic bombers; the decision process thus heavily relied on the locations of allied airbases, mostly in the Soviet Union and North Korea, able to intercept them.

Sino-Soviet Split (1960–1991) Rapid ideological divergence precipitated a Sino-Soviet split that ended all cooperation between the two countries. The split materialized in 1960 with the sudden withdrawal of experts and engineers from China, the repatriation of Chinese students from the U.S.S.R. and the cancellation of ongoing projects. The only remnants of this short-lived Sino-Soviet alliance are the "156" MRPs. Six factories were not viable at this stage and forcefully closed. We shall here make use of the 150 plants that had been already completed and were operational by 1960. Importantly, the Sino-Soviet split made one of the main location criteria redundant. Proximity to military U.S.S.R. air bases no longer guaranteed security, and thus played little role in later strategic decisions (e.g., the Great Leap Forward or the Third Front Movement).

Million-Rouble Plants and economic growth For the first 30 years of their existence, the MRPs developed in a planned economy. These factories and their local economies were fueled by the provisions of the plan. Factor movement was not free, and if more workers or capital could be productively employed, the plan would reallocate resources. The command-economy era as a whole will be considered as the treatment. Treated counties enjoyed a significant head start at the onset of the reform period.

Reforms to deregulate the economy were introduced in the 1980s. Private firms could be set up and a dual price system allowed market transactions alongside the old quota requirements. In the 1990s, restrictions on labor mobility were gradually loosened, and migration began to rise as a major feature of Chinese economic growth. Most MRPs successfully adapted to the market economy and remained leaders in their respective industries.[8] These industrial clusters have diversified their activities, their products ranging from computer screens to carrier-based aircraft.

2 Data and empirical strategy

This section describes data sources, the empirical strategy and provides some descriptive statistics.

2.1 Data sources

One requirement for estimating the long-term agglomeration effects of the opening of large plants is to collect local data on economic production, ideally covering 60 years from 1950 to 2015. In this paper, we mobilize the following main data sources to shed light on the short- and long-term effects of the "156" program: (a) information on the Million-Rouble Plants and their evolution over time, (b) county-level data on production and factor prices (1953–2015) and (c) establishment-level data in recent years (1992–2008), linked with patent applications and other product-level information (factor intensities and technological content).

The Million-Rouble Plants In order to define the local treatment induced by the presence of an industrial cluster, we collect information on the geo-coded location of the factories that constitute the "156" program, information on the timing of construction, the initial investment, the original industry and the evolution of production over time. The counties containing the MRPs are mapped in Figure 3, where we see that they span a wide variety of regions. These pieces of information are extracted primarily from Bo (1991) and Dong and Wu (2004), and from historical archives, while the recent activity of these factories is retrieved using establishment-level data (see Appendix D).

[8] A small number of firms went bankrupt. The first firm forced into bankruptcy (in the late 1970s) was a coal mine, because of resource depletion. Since then, eight other factories have been closed, all coal or non-ferrous metal mines. Two other firms, a paper mill and a former military electronics plant, were partly restructured and continue to operate. Note that, when construction plans were made in the 1950s, most plants were built in the city center. As pollution issues and the need for expansion had not been anticipated, nine plants were moved to the suburbs.

County-level data We rely on various data sources that are nested at the county-level. We first use county gazetteers which provide information on industrial and agricultural production in the command-economy era, as well as information on population, broken down by education, age, gender and broad sector of activity.[9] Second, we use Population Censuses in 1953, 1964, 1982, 1990, 2000 and 2010. The 1953 data only provide population and household counts, but subsequent censuses capture the agricultural status of households. At the time of the command economy, the household registration (*hukou*) type is a faithful reflection of both activity and the environment of residence. This piece of information offers us the opportunity to start tracking the evolution of urbanization and economic sectors from 1964 onward. Additional county-level information is available in 1982, most notably a disaggregation of employment by broad sectors and measures of output. In 1990, precise data are collected on the sector and type of employment and occupation, as well as on housing and migration, a phenomenon that mostly involved agricultural-*hukou* holders moving to cities in search of better earning opportunities. The 2000 and 2010 Censuses further include information on the place of residence five years before, timing of the last migration spell, reason for migrating, and place and type of household registration.[10]

Data collected by statistical offices—gazetteers, censuses, surveys and yearbooks—rely on official administrative divisions at the time of data collection. County boundaries, and to a lesser extent prefecture boundaries, are subject to frequent and sometimes substantial changes in China. To deal with this issue, we use the 2010 administrative map of China as our benchmark and re-weight the data collected in other years to match the 2010 borders. More precisely, we overlay the 2010 map with the map for every other year y and create a new map with all the polygons defined by the 2010 and year-y divisions. We then compute the area-weighted value of the variable of interest for each polygon and collapse the values at the level of the 2010 counties.

Establishment-level data We rely on the National Bureau of Statistics (NBS) "above-scale" manufacturing firm data, which constitute a longitudinal census of all state-owned enterprises (SOEs) and of all non-SOEs as long as their annual

[9] County gazetteers are currently being digitized and harmonized as part of the China Gazetteer Project—see https://www.chinagazetteer.com/.

[10] Data from Statistical Yearbooks, 1994–2013, are used to shed light on the effect of MRPs on local wages. These data also allow us to capture environmental disamenities related to the presence of a MRP (e.g., ground pollution readings).

sales exceed RMB 5 million.[11] These data cover the manufacturing sector over the period 1992–2008 and contain a wealth of accounting information at the level of "legal units." A legal unit can be a subsidiary of a firm, but has its own name and is financially independent (Brandt et al., 2014). Nearly 97% of legal units in our data corresponded to single plants. We will refer to these units as establishments. We use the link provided by He et al. (2018) to match establishments with patent applications, and distinguish three types of patents (utility, invention and design). We further complement the establishment data with product-level information, in particular a benchmark input-output matrix (United States, 2000), measures of technological closeness using patenting in the United States (Bloom et al., 2013) and the revealed factor intensity using the factor endowments of countries producing each good (Shirotori et al., 2010).

Historical maps We exploit historical maps and geo-coded information for identification purposes. Our empirical strategy hinges on geographic criteria that need to be reconstructed. The economic location criterion requires us to reconstruct access to raw resources, connectedness and market access. To this purpose, we digitize maps of roads and railways in 1948. We complement this transportation map with geo-coded information on terrain ruggedness and elevation, the river network, and raw materials, i.e., coal, ore, oil and gas deposits. The strategic location criterion is based on minimum-cost calculations between Chinese counties and military enemy bases, corrected for the presence of allied airbases.

2.2 Empirical strategy

This section describes the two steps of the baseline empirical strategy. We first discuss the selection of control counties based on suitability for hosting a Million-Rouble Plant. We then discuss how we construct a measure of vulnerability to enemy bombings and use it to explain the choice of industry locations among suitable counties.

Propensity score and suitable locations We isolate a group of control counties by implementing a propensity-score matching based on the eligibility criteria described in Bo (1991). A crucial criterion is market access and connectedness to the transportation network. In the baseline matching procedure, we rely on an in-

[11]Unique establishment identifiers can be retrieved thanks to the algorithm designed by Brandt et al. (2014) and extended in Imbert et al. (2018), thereby allowing us to construct a panel of firms spanning the period 1992–2008.

dicator variable that equals 1 if a county belongs to the provincial capital,[12] county population at baseline (measured by the 1953 Census) and county area to capture the former. We reproduce the transportation network in China at the time of the First Five-Year Plan using the existing railroad network in 1948 (see the left panel of Figure 1) and we construct a measure of proximity to a railroad hub to model connectedness. A second criterion is access to raw materials: coal, mostly, but also ore and coke deposits. We create a fine grid over China, allowing for different costs of crossing a cell depending on the means of transportation available.[13] We then calculate the minimum travel cost from the closest mineral field for all points through the existing transportation network and collapse it at the county level. The spatial distribution of transport costs to coal fields is displayed in the right panel of Figure 1. As apparent in Figure 1, the historical development of the railway network and the location of natural resources induces that a crescent of counties are prone to receiving large industrial infrastructure. This crescent, located few hundred kilometers from the Eastern coasts and borders, may be interpreted as a Second Front for industrialization; the later Third Front Movement will go deeper into the hinterland—a decision that will be rationalized by our empirical strategy.

Although they do not feature among the list of explicit determinants, other geographical and economic factors may have entered siting decisions, e.g., distance to major ports, and we condition our analysis on some of these factors susceptible to affect long-term economic growth in robustness checks.[14]

We regress the treatment, i.e., being in the close neighborhood of one of the MRPs (within 20 kilometers), on the location determinants described above, $\mathbf{H}_c$, to generate a propensity measure $P_c = P(\mathbf{H}_c)$ for each county. We define the set of suitable locations $C = \{c_1, \ldots, c_N\}$ by matching treated counties with the five

[12] We consider a county as part of the provincial capital if it belongs to the prefecture in which the provincial capital was located at the time of the First Five-Year Plan.

[13] We derive the cost of transporting goods on roads by exploiting the road structure in 1962 and assuming the same cost ratio as Glaeser and Kohlhase (2004), who estimate costs of 28 cents per ton mile for trucks and 3 cents per ton mile for rail in the United States at the end of the 20$^{\text{th}}$ century. The relative cost of transporting goods through cells that lie neither on a road nor on a railroad line is set at twice the transport cost by truck (Fogel, 1964). Waterways are omitted from the cost-minimization procedure, as only 2.5% of total freight traffic was carried out by barges (Rong, 2012).

[14] It is worth noting that siting decisions were certainly informed by little more, and perhaps much less, than our GIS measures. The lack of a well-functioning statistical administration, which explains the delay in devising the First Five-Year Plan (1953–1957), put severe constraints on policy making in the early years of the People's Republic of China. In the current strategy, few county characteristics are targeted thus leaving many variables available for a balance test. By contrast, more variables could be used to refine the initial matching, thereby leaving few characteristics to compare across treatment and control groups in an "over-identification" check. We will show that our findings are not sensitive to small variations around the baseline matching procedure.

nearest neighbors in terms of the propensity P_c. We restrict the matching procedure to counties with a measure P_c in the support of the treated group. We impose that matched control counties be selected outside the immediate vicinity of treated counties, in order to avoid spillover effects into the control group. In the baseline, we exclude counties whose centroids lie within a 4-degrees $\times$ 4-degrees rectangle—roughly 2-3 times the size of the average prefecture—centered on a treated county. Figure 2 shows the distribution of propensity scores in the group of treated counties and the control group (left panel), and the balance of few covariates within the whole sample and within the selected sample of suitable counties (right panel). The geographic dispersion of the treated and control counties is shown in Figure 3: most treated and control counties are located along this "Second Front" crescent, treated counties are however less likely to be located in Central China.

Vulnerability To isolate exogenous variation in the decision to select counties, we construct measures of vulnerability to air strikes from major rear U.S. Air Force (U.S.A.F.) and Taiwanese bases, accounting for the presence of allied bases acting as a shield. To this end, we geo-locate active U.S. Air Force bases and Taiwanese military airfields, as well as U.S.S.R. and North Korean major airbases. In order to account for the presence of allied airbases, we penalize travel time for enemy bombers in the vicinity of U.S.S.R. and North Korean bases. The procedure, discussed in Appendix C, is disciplined by the technical characteristics of jet fighters at that time, most notably their range, and produces a continuous measure of the cost for enemy airplanes of traveling through any given point of the Chinese territory. We compute the minimum travel cost from each active U.S.A.F. or Taiwanese base to each county and define the measure of vulnerability V_c as the minimum of penalized distances across all major enemy bases. We report an illustration of the spatial variation in vulnerability in Figure 4: the left panel (resp. right panel) shows vulnerability in 1953, i.e., before the Sino-Soviet split (resp. in 1964). Military concerns should favor the North-East at the expense of Central China in 1953; the set of suitable and protected locations however becomes much smaller after 1960 and investment during the Third Front had to be targeted towards interior provinces. Our empirical strategy will use the pre-split measure as an instrument for factory location decisions, conditioning for the post-split measure, thereby using the ephemeral alliance between China and Soviet Union as the main source of identification (Figure 4 shows the conditional variation in vulnerability to air strikes in treated and control counties).

Figure 5 provides a kernel density representation of the relationship between the unconditional and the conditional proximity to U.S. and Taiwanese airbases and factory location choices. Although we find both treated and control counties at most levels of vulnerability, the distribution of travel cost across treated counties has a much fatter right tail than that of the control group, which shows that factories were preferably established at a (penalized) distance from enemy threats.

The relationship between the treatment and the vulnerability measure constitutes the first stage of our empirical specification. Table 1 shows that vulnerability to enemy bombings is a crucial factor of the location choice. One additional standard deviation in penalized distance from enemy bases increases the propensity to host a Million-Rouble plant by about 26 percentage points among suitable counties. The average difference in vulnerability between treated and control counties is about three quarters of a standard deviation; our instrument thus explains $0.75 \times 26 \approx 20\%$ of the allocation of MRPs among suitable counties. Table 1 displays three specifications, one without any controls (column 1), one with the propensity controls only (column 2), and one with the full set of controls (baseline specification, column 3). All specifications are restricted to the set of treated and control counties defined by matching on access to natural resources and the additional economic and geographical determinants. The full set of controls is used to condition the analysis on characteristics that may directly affect outcomes of interest in the second stage; it is however reassuring that the first stage is not dependent on their inclusion.

Benchmark specification Let c denote a county and T_c the treatment variable indicating whether a county hosts a factory. We estimate the following IV specification on the sample of suitable counties:

$$Y_c = \beta_0 + \beta_1 T_c + \beta_{\mathbf{x}} \mathbf{X}_c + \varepsilon_c \tag{1}$$

where T_c is instrumented by V_c, and Y_c is a measure of economic activity at the county level. The controls include the propensity controls, a set of propensity score dummies (stratifying the sample along their propensity score), and the following additional controls: travel cost to major ports, proximity to 1900 cities, proximity to Ming-dynasty courier stations, distance to military airfields and the post-split vulnerability to air strikes. Standard errors are clustered at level of 4-degree $\times$ 4-degree cells.

A key assumption underlying the empirical strategy is that the instrument has no effect on outcomes of interest other than through the location of the Million-Rouble plants. We now discuss few possible concerns with this assumption. First, the respective locations of military bases could have influenced investment at later stages of the Chinese structural transformation. Conditioning by the same vulnerability to enemy raids, but after the Sino-Soviet Split and the start of the Vietnam War rebalanced the geographic distribution of military power in the region, should reduce this concern. We also provide a sensitivity analysis by controlling for later spatial policies and large shocks (e.g., Third Front Movement, Cultural Revolution, Great Leap Forward, Special Economic Zones etc.). Second, vulnerability may correlate with unobserved amenities, which would explain both the decision to locate factories and later patterns of economic growth. For instance, China's south east was considered extremely vulnerable but widely benefited from the opening of Chinese ports to trade in the reform era.[15] Such a violation of the exclusion restriction would induce a spurious negative correlation between economic growth and the presence of "156"-program industries in the reform period. To deal with this concern, we will run a series of robustness checks, most notably excluding a buffer around the Pearl river delta, excluding all Chinese counties below a certain latitude or controlling for distance to the coast. Third, we can repeat our exercise by replacing actual factories by the unfinished projects.[16] While the first stage still applies, the second stage shows no differences between placebo locations and other suitable locations.

2.3 Descriptive statistics

The Million-Rouble Plants expanded and modernized the Chinese industry in a wide range of sectors, but mostly heavy, extractive and energy industries (e.g., coal mining or power plants, see Table 2).[17] Construction started between 1953 and 1955, and was achieved at the latest in the first quarter of 1959. The last two columns of Table 2 show planned and actual investment; the figures attest the scale of the program for an agrarian economy like China in the 1950s. The average planned investment by factory was about 100,000,000 yuan, which amounted to 15,000,000 Soviet roubles in 1957 ($120,000,000 in 2010 U.S. dollars); total investment was of the order of a fifth of annual production in 1955.

Table 3 provides key descriptive statistics for treated and control counties. About 5% of Chinese counties are defined as being treated, and we use 15% of Chinese counties as suitable control counties in our baseline specification. As expected from a context of heightened international tensions in Asia following the Korean War,

[15] Note, however, that the vulnerability measure does not overlap with the coast-interior divide that characterizes the spatial distribution of economic activity in China. Some factories were indeed set up on the coast, first and foremost in Dalian, but not on the southern shore, too exposed to American or Taiwanese strikes.

[16] In this exercise, we exclude counties that hosted one of the completed and operational factories.

[17] The "156" program follows the "Russian model" of industrialization (Rosenstein-Rodan, 1943), with coordinated and large investments across industries to modernize agrarian economies. These upstream factories were expected to irrigate the economy downstream.

treated counties are located at a much greater distance from U.S.A.F. and Taiwanese bases. The difference in mean penalized distance between treated places and the average Chinese county is about 75% of a standard deviation. Note, however, that control and treated counties do not differ markedly in their exposure to enemy raids *after* the Sino-Soviet split.

Differences in terms of population are small at baseline (1953), jump in 1964 and stabilize somewhat afterwards. Descriptive statistics about urban registration show a similar gradient between treated and control locations, albeit more persistent. Households in treated counties are more likely to hold an urban registration even after the reform. These differences are, however, not indicative of economic activity from 1990 onward, given the large number of rural migrants working in cities.

The bottom panels of Table 3 describes possible differences in matching variables and additional controls used in the baseline. Consistent with the propensity matching procedure, differences in topography and connectedness are less pronounced among suitable locations. Treated counties exhibit slightly lower travel costs to coal, coke and ore deposits. These differences are nonetheless accounted for by propensity-bin dummies and matching weights in specification (1). Two historical control variables appear as being important in explaining the allocation of treatment, even though they do not explicitly feature among location criteria: proximity to cities in 1900 and proximity to Ming stations. We thus include these variables as controls in the baseline specification.

3 The rise-and-fall pattern

This section presents the implications of early industrialization at the county level. The influence of the Million-Rouble plants on local trajectories however spans two very different periods; the rise in the command-economy and the fall during the reform period.[18]

The rise We first derive empirical facts about the local impact of industrial clusters in 1982; the analysis and the choice of outcomes are unfortunately limited by the availability of information at the county level. Table 4 shows OLS and IV estimates of the relationship between the presence of a MRP and population, share of urban residents, output per capita and the employment share in industry (1982).

[18]Note that reforms in the non-agricultural sector were introduced gradually. Private firms were allowed to develop and compete with state-owned enterprises (SOEs) from the mid-1980s onward, which was instrumental in introducing market discipline in state-owned enterprises. Nonetheless, the large privatization wave did not start until the 1990s.

We find that industrial investment under the "156" program has a positive and significant impact, albeit small, on population in the earlier period. Treated counties are 22% more populated than control counties (column 1). The treatment effect on urbanization is much larger; the share of the population that has non-agricultural household registration is about 35 percentage points higher (column 2). The impact of the MRPs shows a large reallocation of labor, which could be interpreted as evidence of structural transformation and urbanization. The higher share of urban residents is associated with a much higher output per capita, and a higher industry share in the local economy (columns 3 and 4). GDP per capita is more than twice larger in treated counties; the employment share in industry is 24 percentage points higher. The magnitude of these differences is far beyond the mere output of the average MRP, indicating that counties are richer and more developed—the effect is equivalent to the difference between the median and the top 10% of the control-group distribution.

A few remarks are in order. First, the IV estimates are larger than the OLS estimates, possibly reflecting that places selected to host a MRP were less likely to host major industrial developments prior to the First Five-Year Plan (Bo, 1991). Second, the extent of the short-run impact of industrial clusters may have limited external validity. Before the advent of the reforms, the government would instruct workers where to live and where to work to accommodate rising demand for labor and ensure the growth of the plants and local economy.[19] Changes in labor allocation mostly reflect government intervention, which is likely to temper agglomeration effects. The population increase, while larger than the expected labor force of the MRP itself, remains limited and probably lags behind labor demand in treated counties.

To summarize the impact of the "156" program between 1953 and 1982, we find a moderate effect on urban population, but a very large effect on the local structure of production. The substantial productivity gap between treated and control counties indicates that treated areas enter the subsequent period with a substantial head start. Lower mobility costs and the liberalization of the economy should allow agglomeration economies to operate, and one could expect treated counties to grow even further apart from the rest of the economy. As we see next, we find the opposite.

The fall We find that there is a full catch-up between 1982 and 2010. Table 5 presents the relationship between hosting a MRP and population, share of urban

[19] While some free movement of labor still occurred after the advent of "New China" in 1949, mobility was subject to authorization from the late 1950s onwards. The government had tightened its grip on labor movement in the wake of the Great Leap Forward, when famines threatened the sustainability of urban food provision systems.

residents, output per capita and the employment share in industry (2010). We find that population is still higher in treated counties (column 1); treated locations also continue to have a significantly higher share of urban population (column 2). In stark contrast with the treatment effect in 1982, however, output per capita and the industry share are now similar or even lower in treated counties (columns 3 and 4). The significant gap in industrialization before the transition has thus fully eroded: treated counties are equally productive as control counties and the employment share in industry is 13 percentage points lower. This fast reversion to the mean does not result from a swift decline in employment in the Million-Rouble plants themselves.[20]

A further illustration of the catch-up between 1982 and 2010 is provided in Figure 6. The left panel shows a rapid and linear drop in the industrial employment share, from + 24 to -13 percentage points relatively to control counties. Treated counties keep, however, some marks of their early industrialization. The right panel shows that the share of urban area, as captured using recognition of impervious surfaces on satellite images, remains higher in treated counties.[21] Before turning to the mechanisms underlying this puzzling stylized fact, we provide a series of robustness checks.

Sensitivity analysis We start by analyzing variation along the baseline specification (Appendix Table A2). In Panel A, we run a simple OLS regression with province-fixed effects on the whole sample of counties in China. The identification thus relies on a comparison of treated counties with their immediate neighbors. The treatment effect in 1982, and the reversal of fortune in 2010, are found to be slightly smaller than in the baseline specification, possibly reflecting spatial spillovers. In Panels B to E, we revert to the IV specification on the sample of counties selected through a matching procedure. In Panel B, we add proximity to Ming stations, distance to military airfields and access to the main trading ports to the matching process. In Panel C, we restrict the matching process to a small set of variables: travel cost to coal mines, proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log) and county area (log). In Panel D, we use a one-to-one matching procedure without replacement between treated and control

[20]Appendix D provides a comparison between the MRPs and similar "above-scale" manufacturing establishments within treated counties. Appendix Tables D1 and D2 show that MRPs account for a moderate share of their local economies and are extremely productive. Total Factor Productivity, measured following the procedure developed in Imbert et al. (2018), is four times as high in Million-Rouble plants.

[21]There seems to be an inflection point around 2000, which corresponds to the opening of the Chinese economy and the acceleration in manufacturing growth: control counties appear then to catch up with treated counties.

counties. Finally, Panel E doubles the exclusion zone around treated counties (see Section 2). The main result, i.e., the large difference in GDP per capita in 1982 and the subsequent catch-up, is qualitatively unchanged relatively to the baseline.

We then provide a sensitivity analysis of the choice of regression weights, the sample selection and the choice of control variables (Appendix Table A3). In the baseline specification, observations are weighted by matching weights accounting for the extent to which the distribution of propensity scores coincides between treated and control counties. Panel A of Appendix Table A3 provides the main estimates without any weights; they are similar to the baseline estimates.

There are two empirical concerns with specification 1 and the rise-and-fall pattern: (i) the baseline specification does not account for the evolution of Million-Rouble plants themselves; (ii) the specification relies on a geographic instrument which may correlate with the later spatial developments of the Chinese economy. First, while we already document the healthy condition of Million-Rouble Plants in recent decades (see Appendix D), we further provide a robustness check in Panel B of Appendix Table A3 by excluding treated counties with either a closed or displaced MRP. Second, we exclude a large buffer of (mostly control) counties within a buffer of 500 kms around the Pearl river delta (Panel C), and we exclude all counties below the 28-degree latitude (Panel D). These robustness checks show that our findings are not driven by the closure of unhealthy MRPs in some treated counties or by the correlation between our instrument and patterns of the overall development of the Chinese economy.

We provide a sensitivity analysis of choice of control variables (Appendix Table A3, Panels E to H). We add to specification 1 the following variables: distance to the coast (Panel E, to capture a comparative advantage in an exporting economy), elevation, ruggedness, indicators of soil quality—lacustrine plains, sand hills, tidal marshes—and expected yield—rice, maize, wheat—(Panel F). The geographic conditions do not explain the main empirical fact.

The rise and fall of treated counties may reflect a very abrupt take-off in control counties, for instance related to the implementation of the Third Front Movement (Fan and Zou, 2019) or other place-based policies (Special Economic Zones or industrial park policies, as in Wang, 2013; Crescenzi et al., 2012; Alder et al., 2016; Zheng et al., 2017), or severe disruption due to pre-transition policy shocks in treatment counties, e.g., during the Cultural Revolution. We control for such policies and events in Panel G. Beyond these emblematic spatial policies, the regime could have favored certain counties due to their strategic location, and these further investments may correlate with the vulnerability instrument. We already control for the general vulnerability to air strikes in 1964; we separately add the vulnerability to Soviet air strikes in 1972. Neither alternative policies nor alternative measures of vulnerability affect the main treatment estimates.

We consider alternative outcome measures in Appendix Table A4. In Panel A, we extract few additional variables from the 1982 Census, i.e., labor force participation, illiteracy rate and the male to female ratio. The illiteracy rate is much lower in treated counties (16 percentage points). There are no sharp differences in the male-to-female ratio, which shows that selected immigration, if any, was not strongly tilted towards males. In Panels B and C, we shed additional light on the nature of the rise-and-fall pattern: we document the allocation of workers across sectors in 1990 and 2010. The observed difference in household registration (see Table 4) does reflect a difference in employment shares across sectors of the local economy: the employment share in agriculture is 27 percentage points lower in treated counties. The "released" labor force is equally absorbed by industry and services. In particular, a significant share of workers in the service sector are allocated to distribution and transportation (results not shown), two sub-sectors very likely to intervene in the production chain of a MRP. The magnitude of these estimates is large: the local allocation of workers in treated counties resembles the aggregate Chinese economy after the transition. In 2010, however, treated counties are less industry-intensive, a result mostly explained by a higher prevalence of services (distribution and transportation).

Panel D of Appendix Table A4 provides some support for the slowdown of economic activity in treated counties. We use remote sensing in order to derive alternative measures of living standards at the county level, and resort to night-time luminosity between 1993 and 2012 ("Average Visible, Stable Lights, & Cloud Free Coverages") as a complement for census-based measures. Our findings show that luminosity is three times higher in treated counties in 1993, and a large share of this head start disappears by 2012 (column 2).

4 Mechanisms behind the fall of treated counties

This section analyzes the possible spillovers exerted by a MRP on the local structure of production at the county level. We proceed in two steps. In a first step, we analyze the structure of firm production in the average establishment. In a second step, we refine the analysis of the production structure by looking at treatment heterogeneity across counties and across establishments of the same county. This exercise allows us to explore various aspects of the tangle of economic relationships across establishments, most notably spillovers along the production chain.

4.1 Structure of firm production

Firm characteristics We start our analysis of the structure of production in treated counties by looking at (i) factor use, (ii) labor cost and (iv) three measures of factor productivity, i.e., establishment-specific labor productivity (MPL), capital productivity (MPK) and total factor productivity (TFP). We rely on estimates of industry-specific CES production functions, identified using an exogenous labor supply shifter (see Imbert et al., 2018, for a description of the empirical strategy). In all specifications, we exclude the MRPs from the sample.

In Panel A of Table 6, we extend specification (1) at the establishment-level, consider all establishment × year observations between 1992 and 2008, and regress a measure of employment on the treatment T_c, instrumented by V_c. In all establishment-level specification, we clean for year interacted with 4-digit industry fixed-effects. Factor use appears to be slightly different in treated and control counties (columns 1 and 2): establishments in treated counties are more capital-abundant than in control counties; real capital is 36% higher while employment is 28% higher.[22] Factor cost sharply differs in treated counties. We find that the average compensation per employee is about 33% lower in treated counties (Table 6, column 3). These findings point to a downward shift in labor supply in treated counties compared to control counties. We now turn to factor productivity. Labor productivity is lower in treated counties and consistent with the drop in labor cost (Table 6, column 4), capital productivity and TFP are 38 and 32% lower than in control counties.[23]

Next, we characterize the establishment "type" in treated counties, specifically whether the average establishment is more likely to be publicly owned, smaller, older and biased towards a more educated and experienced workforce. Panel B of Table 6 shows that manufacturing establishments are 8 percentage points more likely to be publicly-owned, and they are more likely to be larger than 100 employees and older

[22]Results are robust to the introduction of year fixed effects interacted with a dummy for public firms and the percentage of skilled workers (as measured in 2004) in order to control for the slow demise of public enterprises and time variation in returns to skills.

[23]Factor cost and factor productivity appear to be low in treated counties, but dispersed. In Panel A of Appendix Table A3, we calculate the standard deviation in labor cost within county × year (weighted by firm employment), and regress the measure of wage dispersion on the treatment T_c, instrumented by V_c. We find a higher dispersion of about 14% in treated counties (Table A3, column 1). In columns 2, 3 and 4 of Appendix Table A3, we replicate the previous exercise with the standard deviations of productivity measures as dependent variables. Measures of labor productivity are more dispersed within treated counties than within control counties. The dispersion in labor cost and productivity indicates frictions in the allocation of resources across establishments. In Panel B of Appendix Table A3, we show that there is a higher concentration of production in large establishments of treated counties. In Panel C of Appendix Table A3, we show that there is no higher likelihood of exit in treated counties; this observation also holds for establishments not along the production chain of the local MRP(s).

than three years; these effects are however small. The composition of the workforce markedly differs between treated and control counties: the average employee in treated counties is more likely to have college education, and *much* more likely to be a skilled worker, and 11 percentage points more likely to occupy a "senior" position within the firm (to be compared with the 28 percentage points share of senior workers). In view of this observation, our finding that wages are lower in treated counties is puzzling, and this finding is inconsistent with an explanation based on under-investment in human capital (Franck and Galor, 2017).

We describe the financing structure of establishments in treated counties, their investment, and the expenditures devoted to R&D in Panel C. The patterns from this analysis do not support a story based on political favoritism (Chen et al., 2017; Fang et al., 2018): public subsidies appear to be non-significantly higher in treated counties (see column 1). The results are inconsistent with a privileged access to resources (Harrison et al., 2019): total liabilities are not higher than in control counties (column 2). Long-term and short-term investments are lower but not very strongly so (see columns 4 to 5). The financing structure in the average (other) establishment in treated counties appear to be quite similar to that of control counties.

Finally, we characterize production in treated counties using product codes at the 4-digit level (Panel D). We regress the (log) factor intensity, as predicted by the 4-digit product code (following the classification of Shirotori et al., 2010), on the treatment T_c, instrumented by V_c. In this specification, we omit year interacted with 4-digit industry fixed-effects and only include year-fixed effects. The average product in treated counties is 6% more human-capital-intensive, 19% more physical-capital-intensive and 4% more land-intensive. These findings point toward some specialization of treated counties in capital-intensive production, but the extent of such specialization remains moderate.

Innovation and patenting We now turn to the more direct analysis of technological innovation through the analysis of patent applications across establishments.

We estimate specification (1) at the establishment-level between 1998 and 2007, and regress the number of registered patent applications on the treatment T_c, instrumented by V_c (see Panel A, Table 7), controlling for 4-digit industry fixed effects.[24] We distinguish three categories: design (minor changes in design), innovation and

[24]Controlling for the local industry structure is innocuous for the structure of production but quite important for patenting behavior. Indeed, the presence of the MRP(s) tilts the the local industrial fabric towards innovative sectors; these innovative sectors are however far less innovative in treated counties. See Panel A of Appendix Table A5 for a specification without industry fixed effects.

utility, the latter categories being the most relevant to capture technological progress. We find that establishments in treated counties produce fewer patents: -0.026 (design), -.018 (invention) and -.081 (utility). The latter effect is of the order of magnitude of the yearly number of patents produced in the average establishment: there are very few patents that are registered in treated counties.

The number of patents may be a noisy indicator of innovation as few establishments submit many applications at once. We thus replace the number of patents by a dummy equal to one when (at least) one patent application is submitted during the year. As shown in Panel B of Table 7, patenting activity is 1 p.p. less likely in the design category, and 0.6-0.7 p.p. less likely in the invention and utility categories. Again, these effects are large given that the average establishment submits a patent application with probability 0.012 in a given year.

These results cannot be directly attributed to compositional differences induced by the presence of public enterprises, subsidized establishments (Harrison et al., 2019) or young firms. Indeed, (i) controlling for the exact type of an establishment (ownership structure) does not change the main insight conveyed by Tables 6 and 7 (see Panel B of Appendix Table A5).[25] (ii) Public or subsidized establishments in treated counties are not less innovative than in control counties; their likelihood to register a patent in design being even larger (see Appendix Table A7).

Dynamics The county-level empirical facts point to a relative slowdown of economic activity in treated counties between 1982–1990 and 2010. The previous evidence is however cross-sectional and spans the whole period during which the reversal of fortune occurs. In order to shed some light on the the dynamics in the production structure during the transformation of the Chinese economy, we select four main outcomes, i.e., employment, public ownership, whether the establishment was created in the previous 3 years, the number of patents (utility), and we estimate the treatment effect each year between 1998 and 2008.

Figure 7 reports these estimates. As apparent from Panel (a), the average treated establishment is much larger in 1998, and shrinks considerably between 1998 and 2002. This finding is not due to the liquidation of public enterprises, as shown in Panel (b), or the creation of firms, as shown in Panel (c). The main compositional effect appears to be a lack of dynamism between 2001 and 2006: many young

[25] We characterize the nature of establishments along other dimensions of their "type", by interacting treatment with (i) a dummy equal to one for establishments receiving some subsidies (see Panel C of Appendix Table A5), (ii) a dummy equal to one if the establishment is less than three years old (see Panel D of Appendix Table A5). Note that the drop in patenting is attenuated once controlling for the direction of subsidies within counties, an effect that we will explain later.

establishments enter control counties relatively to treated counties.

Finally, the gap in patenting behavior between treated and control counties mostly widens after 2000, especially so for the two most relevant categories of patents, i.e., invention and utility–reported in Panel (d): the deterioration in productivity is accompanied by a stagnation in technological innovation.

In the next section, we investigate whether these findings are related to the structure of production and co-agglomeration patterns in treated counties.

4.2 Treatment heterogeneity

The use of establishment-level data implies that we may identify differences in the local structure of production from the interaction of the treatment with establishment characteristics or treatment characteristics. For instance, one may compare the activity of downstream establishments in the treated county with similarly defined establishments in control counties, relatively to the same difference for non-downstream establishments. A difference-in-difference specification cannot however be implemented as such, due to treatment heterogeneity, and we rationalize the use of a slightly more involved empirical strategy below.

Identification of heterogeneous effects We aim to estimate the externalities exerted by Million-Rouble plants on manufacturing establishments of the same county, for instance through the markets for final goods, factor markets, or technological spillovers. For this purpose, we develop an empirical strategy to identify treatment spillovers across establishments in the presence of treatment heterogeneity. This procedure will also be useful in studying treatment heterogeneity across counties or across treatment type.

Without treatment heterogeneity, spillovers can be estimated as follows. Consider an establishment i located in county c. We would like to estimate the statistical model $E[Y_{ic}|T_c, S_i]$ where Y_{ic} is the outcome at the establishment level, $T_c \in \{0,1\}$ is the treatment, and $S_i \in \{0,1\}$ characterizes the sub-population of firms susceptible to be affected. The previous statistical model can be estimated through a simple difference-in-differences procedure, in which the instrument for treatment T_c would be interacted with the spillover measure S_i.

With treatment heterogeneity, however, the latter cannot be constructed in *control* counties, where $T_c = 0$. Indeed, such measure would crucially depend on the characteristics of the associated *hypothetical* Million-Rouble Plant (see Figure 8 for a childish illustration). Let $T_c^\tau \in \{0,1\}$ denote the MRP-specific treatment, equal to 1 if county c hosts the MRP indexed by τ, and $T_c = \max_\tau\{T_c^\tau\}$ the average treatment (i.e., hosting at least one MRP). We can define a measure of MRP-specific linkages in all counties, given the characteristics of an establishment and the characteristics of the MRP. We describe next how we attribute hypothetical MRPs to control counties.

We stratify control counties by their suitability to host Million-Rouble Plants. We define strata of counties based on deciles of the propensity score $P(\mathbf{H}_c)$, as produced by the propensity-score matching procedure described in Section 2 (relying on observable characteristics $\mathbf{H}_c$). In each stratum, there is a subset of treated counties and their associated MRP types. We assume that the probability to host any such MRP type τ is the same for all control counties in the stratum. Under this assumption, we can simulate Monte-Carlo draws of the distribution of MRP types within treated counties in control counties of the same stratum.[26] For each simulation, we calculate hypothetical links S_{ic}, using the observed characteristics of establishments in these control counties.

For each Monte-Carlo draw, we estimate the following IV specification in difference-in-differences on the sample of all establishments surveyed in year t and located in suitable counties, excluding the MRPs themselves:

$$Y_{isct} = \beta_0 + \beta_1 T_c + \beta_2 T_c \times S_{ict} + \beta_{\mathbf{x}} \mathbf{X}_c + \nu_{st} + \varepsilon_{isct} \tag{2}$$

where $(T_c, T_c \times S_{ict})$ is instrumented by $(V_c, V_c \times S_{ict})$, and Y_{ict} is measured at the establishment level. The identification relies on the difference between linked and non-linked establishments in treated and control counties, using product market dummies ν_{st} to clean for omitted variation across sectors. A similar specification can be estimated replacing S_{ict} by treatment characteristics.

The identification crucially hinges on a weaker version of the Conditional Independence Assumption. The allocation of a certain MRP of type τ needs to be independent of unobserved country characteristics which may directly affect outcome Y, conditional on the propensity score $\tilde{P}(\mathbf{H}_c)$.

Treatment heterogeneity across treatment characteristics Before analyzing the effect of the treatment on various establishments within counties, we study a simpler aspect of treatment heterogeneity: the heterogeneity in treatment effects across county characteristics and treatment characteristics. Are negative spillovers limited to remote locations, or limited to MRPs in non-processing industry?

We report a selection of heterogeneity dimensions and outcomes in Table 8. We

[26] We simulate these draws as follows. In each control county, we draw one treated county of the same stratum and attribute to the control county the MRP(s) present in the drawn county.

focus on patenting behavior and restrict the analysis to one county characteristic, i.e., whether the county is the province capital, and the following treatment characteristics: whether the MRP(s) is classified as heavy industry, the average I/O intensity (summing the share of input and output linkages in the U.S. input/output matrix at the 4-digit industry level) to capture the expected extent of the production chain, the relative position of MRP(s) downstream or upstream the production chain (dividing the total intensity of downward linkages by the total intensity of upward linkages), the number of different products produced by local MRPs.

We find little to no evidence that initial county characteristics matter in explaining the effect of the treatment. Panel A of Table 8 reports the interaction of the treatment with a province capital dummy; similar small effects could be found for initial population or travel cost to major ports [not reported].

By contrast, treatment characteristics do seem to matter. Heavy-industry MRPs appear to affect utility patenting in particular (Panel B). The average I/O intensity aggravates the drop in patent applications (Panel C), while MRPs with high intensity of downward linkages relatively to upward linkages reduce this drop (Panel D). Both effects are however very imprecisely measured. The most striking finding is reported in Panels E and F: the larger the number of different products produced by MRP(s) and the smaller the drop in innovation. Having MRPs operating in only one 2-digit industry decreases the probability to submit a patent by 1.5-1.7 percentage points; having MRPs operating in three distinct 2-digit industries increases the probability to submit a patent (innovation or utility) by 0.5-0.8 percentage points. This finding is consistent with co-agglomeration patterns as being beneficial for the local economy. The observed co-agglomeration pattern is here captured by the nature of the initial investment and its transformation over time. In the following section, we investigate the structure of production including the other establishments around the MRP(s).

4.3 Local structure of production

Definition of linkages between establishments In order to capture production links between establishments, we first construct a measure of vertical linkages and a measure of horizontal linkages. We describe below the ideal measures, and the empirical counterpart. We consider each good g and G produced by an establishment and the MRP, and define the degree of horizontal product proximity S_h as follows:

$$S = \left(\sum_{g,G} \alpha_g \alpha_G \delta_{g,G} \right) / \left(\sum_{g,G} \alpha_g \alpha_G \right)$$

where α_g and α_G are the shares of good g and G in total revenues of the establishment and the MRP, and $\delta_{g,G}$ is an indicator of the degree of substitutability between goods g and G. In practice, however, we do not have (yet) consistent measures of substitutability between goods and it is hard to allocate revenue shares to different goods produced by an establishment. Our empirical measure S will thus be a dummy, *Same product*, equal to 1 if the establishment produces at least one good (4-digit level) which is also produced by a local MRP.

We define a measure of downstream linkages, from the MRP down to the establishment, as follows:

$$V^d = \left(\sum_{g,G} \alpha_g \alpha_G \beta_{g,G} \right) / \left(\sum_{g,G} \alpha_g \alpha_G \right)$$

where α_g and α_G are the shares of good g and G in total revenues of the establishment and the MRP, and $\beta_{g,G}$ is the share of input expenditures spent on g in order to produce good G. We proxy $\beta_{g,G}$ using the input/output matrix in the United States in 2000, and a bridge between standardized product codes (HS6) and Chinese codes. As we cannot allocate revenue shares to the different goods produced by an establishment, we use a simple average of product-specific measures $\beta_{g,G}$ across goods and define a dummy, *Downstream*, equal to 1 if such average is higher than the 90%-quantile across all establishments of the sample. We define a dummy, *Upstream*, in a similar way to characterize upstream establishments.

We then define a measure of competition on factor markets based on revealed factor intensities as predicted by trade patterns in 2000 (see Shirotori et al., 2010, for the construction of revealed factor intensities at the HS6-level). Letting FI_g denote the revealed factor intensity for factor F (human capital, physical capital or land) and good g, we define a dummy, *More F-intensive*, equal to one if the average FI_g over all goods produced by an establishment is higher than the average FI_G over all goods produced by local MRPs. The rationale is that MRPs may have a higher bargaining power on factor markets, e.g., because they face lower search frictions; their privileged access to resources may particularly affect those establishments whose needs for this production factor are more pressing.

Finally, we define a continuous measure of technological closeness computed at the industry-level, i.e., a matrix of technological closeness measures, using U.S. data (Bloom et al., 2013) and a bridge between SIC codes and Chinese industry codes. We define a dummy, *Tech. clos.*, equal to 1 if technological closeness is higher than the 90%-quantile across all establishments of the sample.

Spillovers across establishments Table 9 (Panel A) reports the relative presence of establishments operating downstream, upstream, and in the same product market as the local MRP(s). In column 1, we report the result of a specification in which the measure of downstream linkages V^d_{isc} is regressed on the treatment, instrumented by vulnerability to air strikes. One alternative specification would be to estimate Equation (1) with an aggregate measure of linkages as the dependent variable in order to understand the formation of the network around the MRP(s), e.g., an excess of downstream establishments. Both specifications give similar results and we only report the estimates of Equation (2). We find that the treatment increases the probability for an establishment to operate downstream of the MRP by about 11 percentage points (an effect equivalent to doubling this probability). Columns 2 and 3 of Table 8 report the results of specification (2) with upstream linkages and horizontal linkages as dependent variables. The treatment does affect the probability to operate in the same product market increases by 5 percentage points—an effect which we can attribute to economies of scale (Ciccone, 2002). The treatment effect on the probability for an establishment to operate upstream of the MRP is small, as most of the MRPs tend to operate early in the production chain.

As the estimation procedure relies on multiple draws, we report here the average effect and the average standard error over 100 simulations. Correct inference would require to bootstrap standard errors. Note that we exclude the MRPs from the estimation, that we control for year and 4-digit product-fixed effects, and that standard errors are clustered at the level of 4-degree $\times$ 4-degree cells.

Table 9 (Panel B) reports the relative presence of establishments with more acute demand for human capital (column 1), physical capital (column 2) and land (column 3) than the local MRP(s). The differences between treated and control counties are minimal—few percentage points, to be compared with averages at around 50 percentage points. These findings provide little support for the existence of spillovers in factor markets.

Table 9 (Panel C) reports the relative presence of establishments with a technology closeness measure above the 90%-quantile. The difference between treated and control counties is very large but imprecisely measured, possibly reflecting treatment heterogeneity. The treatment increases the probability for an establishment to share technology with the MRP by 27-37 percentage points, an effect which is partly explained by production linkages.

The previous table has identified the change in the structure of production induced by the presence of the MRP: there are many more establishments operating along the same production chain. Spillovers seem to be non-negligible along the production chain, which is consistent with economies of scale within the same product market (Kim, 1995; Ciccone, 2002). We now characterize the nature of establishments along the production chain and across technological links, by interacting treatment with linkages. We select the following outcomes for this exercise: the probability to submit a patent (design, invention, utility) in Table 10; establishment characteristics (SOE, subsidized, young) in Table 11; employment, real capital, the average labor cost at the establishment level, Total Factor Productivity in Appendix Table A6.

The gap with control counties in patenting intensity is surprisingly *more* pronounced for downstream establishments (see Panel A of Table 10). The treatment (negative) effect on innovation or utility patents is three times larger for downstream establishments than for other establishments. This effect illustrates that downstream establishments usually operate in very innovative industries; these establishments do not however innovate in treated counties. The gap across other establishments is less pronounced.

The same pattern can be observed for upstream establishments (Panel B of Table 10), but also for establishments in the same product market (Panel C) for which the absence of innovations is even more striking.[27] There are several interpretation of these findings. One such interpretation is that proximity to the MRP allows firms to benefit from economies of scale, specific public infrastructure or a rent from their privileged relationship with the MRP but these advantages deter them from innovating. Another interpretation is that the MRP locks downstream, upstream and similar establishments into certain production patterns, with little incentives to innovate (creative destruction of a rent).

Establishment characteristics do differ along the production chain (Table 11). First, downstream establishments or establishment sharing the same technology are more likely to be public (see column 1). This finding cannot however explain the patenting behavior of those establishments, as SOEs are not less innovative than other establishments in these counties. Second, establishments operating in the same sector as the MRP(s) are significantly older than their counterparts in control counties; they are also less likely to receive subsidies. Surprisingly, these observations, which are consistent with barriers to entry related to the presence of the MRP(s), do not prevent same-product establishments to be more numerous in treated counties.

With a very concentrated structure of production and a non-innovative nucleus of firms, treated counties do not benefit from any externalities in local technological

[27]See Panel D of Table 10 for a similar analysis based on technology closeness where we find smaller negative effect of linkages on patenting.

progress, whether it be within or across industries (Glaeser et al., 1992; Beaudry and Schiffauerova, 2009).[28]

5 Conclusion

Industrialization and concentration of large industrial clusters may have long-lasting effects on local economies. This paper provides evidence of a (local) reversal effect in the long run, even without *aggregate* manufacturing decline, and identifies the externalities supporting this effect using granular data on production units.

The paper relies on a unique experiment (the "156" program), in which large factories were (quasi-)randomly allocated across suitable counties in China, and it follows the evolution of these locations along the structural transformation of the economy. While the "156" program was effective in spurring transformation from agriculture to manufacturing and in raising living standards, this head start failed to generate agglomeration economies in the later period. Low mobility costs and the liberalization of the economy would have been expected to widen the gap between treated places and the rest of the economy. We find the opposite.

The reforms reversed the fate of the places that received investments under the "156" program. A large share of the GDP gains from the command-economy period vanished in the course of the opening-up era, bringing treated and control counties closer over time. This reversal of fortune occurred even though the Million-Rouble plants created under the program were still about four times as productive as similar firms in the 1990s and 2000s. However, treated areas did not merely revert to the path followed by other places in the absence of the "156" program; they are now far less innovative than control counties. The structure of production is far too concentrated along the production chain of the 156 Million-Rouble Plants, and technological spillovers appear to be minimal. Early industrialization has a persistent, albeit now adverse, influence on local economies.

[28] We investigate differences in production factors and factor productivity along the production chain in Appendix Table A6. As apparent in Panel A, factor use in the average downstream establishment tends to be quite similar to that in other establishments, even though these establishments are slightly larger. The productivity gap with control counties is about the same for these establishments, if not lower (column 4). A similar observation can be made for productivity and labor cost in upstream establishments (Panel B). Upstream establishments are however smaller. Establishments within the same product market are surprisingly productive compared to the average other establishment, possibly benefiting from the structure of production induced by the MRP (including possible public infrastructure).

References

Aghion, Philippe, Jing Cai, Mathias Dewatripont, Luosha Du, Ann Harrison, and Patrick Legros, "Industrial policy and competition," *American Economic Journal: Macroeconomics*, 2015, *7* (4), 1–32.

Aitken, Brian J and Ann E Harrison, "Do domestic firms benefit from direct foreign investment? Evidence from Venezuela," *American Economic Review*, 1999, *89* (3), 605–618.

Alder, Simon, Lin Shao, and Fabrizio Zilibotti, "Economic reforms and industrial policy in a panel of Chinese cities," *Journal of Economic Growth*, 2016, *21* (4), 305–349.

Ansteel Group Corporation, *Ansteel Group Corporation Sustainability Report 2016*, Ansteel, 2016.

Beaudry, Catherine and Andrea Schiffauerova, "Who's right, Marshall or Jacobs? The localization versus urbanization debate," *Research policy*, 2009, *38* (2), 318–337.

Bergin, Bob, "The Growth of China's Air Defenses: Responding to Covert Overflights, 1949–1974," *Studies in Intelligence*, June 2013, *57* (2), 19–28.

Bloom, Nicholas, Mark Schankerman, and John Van Reenen, "Identifying technology spillovers and product market rivalry," *Econometrica*, 2013, *81* (4), 1347–1393.

Bo, Yibo, *Review of Several Major Decisions and Events [Ruogan Zhongda Juece yu Shijian de Huigu]*, Beijing: The Chinese Communist Party School Press [Zhonggong Zhongyang Dangxiao Chuban She], 1991.

Brandt, Loren, Gueorgui Kambourov, and Kjetil Storesletten, "Firm Entry and Regional Growth Disparities: the Effect of SOEs in China," Technical Report May 2016.

_ , Johannes Van Biesebroeck, and Yifan Zhang, "Challenges of working with the Chinese NBS firm-level data," *China Economic Review*, 2014, *30* (C), 339–352.

_ , Trevor Tombe, and Xiaodong Zhu, "Factor market distortions across time, space and sectors in China," *Review of Economic Dynamics*, 2013, *16* (1), 39–58.

Buera, Francisco J. and Yongseok Shin, "Financial Frictions and the Persistence of History: A Quantitative Exploration," *Journal of Political Economy*, 2013, *121* (2), 221–272.

Busso, Matias, Jesse Gregory, and Patrick Kline, "Assessing the Incidence and Efficiency of a Prominent Place Based Policy," *American Economic Review*, 2013, *103* (2), 897–947.

Chen, Ying, J. Vernon Henderson, and Wei Cai, "Political favoritism in China's capital market and its effect on city sizes," *Journal of Urban Economics*, 2017, *98* (C), 69–87.

Chinese Academy of Social Sciences and State Archives Administration, *Selected Economic Archives of the People's Republic of China, 1953–1957: Volume on Fixed Assets and Construction [in Chinese]*, Beijing: China Price Press, 1998.

Chinitz, Benjamin, “Contrasts in Agglomeration: New York and Pittsburgh,” *The American Economic Review*, 1961, *51* (2), 279–289.

Ciccone, Antonio, “Input chains and industrialization,” *The Review of Economic Studies*, 2002, *69* (3), 565–587.

Crescenzi, Riccardo, Andrés Rodríguez-Pose, and Michael Storper, “The territorial dynamics of innovation in China and India,” *Journal of Economic Geography*, 2012, *12* (5), 1055–1085.

Desmet, Klaus and Esteban Rossi-Hansberg, “Spatial development,” *American Economic Review*, 2014, *104* (4), 1211–43.

Dong, Zhikai, “On the Establishment of the “156 Program” [in Chinese],” *Researches in Chinese Economic History*, 1999, *4*, 93–107.

_ and Jiang Wu, *Industry Cornerstone of New China [in Chinese]*, Guangzhou: Guangdong Economy Publishing House, 2004.

Duranton, Gilles and Diego Puga, “Nursery cities: Urban diversity, process innovation, and the life cycle of products,” *American Economic Review*, 2001, *91* (5), 1454–1477.

_ and _ , “Chapter 5 - The Growth of Cities,” in Philippe Aghion and Steven N. Durlauf, eds., *Handbook of Economic Growth*, Vol. 2 of *Handbook of Economic Growth*, Elsevier, 2014, pp. 781 – 853.

Eckstein, Alexander, *China’s Economic Revolution*, Cambridge: Cambridge University Press, 1977.

Faggio, Giulia, Olmo Silva, and William C Strange, “Heterogeneous agglomeration,” *Review of Economics and Statistics*, 2017, *99* (1), 80–94.

Falck, Oliver, Christina Guenther, Stephan Heblich, and William R. Kerr, “From Russia with love: the impact of relocated firms on incumbent survival,” *Journal of Economic Geography*, May 2013, *13* (3), 419–449.

Fan, Jingting and Ben Zou, “Industrialization from Scratch: The Third Front and Local Economic Development in China’s Hinterland,” 2015.

_ and _ , “Industrialization from Scratch: The “Construction of Third Front” and Local Economic Development in China’s Hinterland,” Technical Report, Working Paper 2019.

Fang, Lily, Josh Lerner, Chaopeng Wu, and Qi Zhang, “Corruption, Government Subsidies, and Innovation: Evidence from China,” Working Paper 25098, National Bureau of Economic Research September 2018.

Fogel, Robert, *Railroads and American economic growth: Essays in econometric history*, Baltimore, MD: Johns Hopkins University Press, 1964.

Franck, Raphaël and Oded Galor, “Industrial Development and Long-Run Prosperity,” NBER Working Papers 23701, National Bureau of Economic Research, Inc August 2017.

Gerschenkron, Alexander, *Economic Backwardness in Historical Perspective: A Book of Essays*, Cambridge, MA: Belknap Press of Harvard University Press, 1962.

Glaeser, Edward L., "Reinventing Boston: 1630–2003," *Journal of Economic Geography*, 2005, *5* (2), 119–153.

_ **and Janet E. Kohlhase**, "Cities, regions and the decline of transport costs," *Papers in Regional Science*, 2004, *83* (1), 197–228.

Glaeser, Edward L, Hedi D Kallal, Jose A Scheinkman, and Andrei Shleifer, "Growth in cities," *Journal of political economy*, 1992, *100* (6), 1126–1152.

Glaeser, Edward L., Sari Pekkala Kerr, and William R. Kerr, "Entrepreneurship and urban growth: An empirical assessment with historical mines," *Review of Economics and Statistics*, 2015, *97* (2), 498–520.

Goncharenko, Sergei, *Beijing and Moscow: From Allies to Enemies [in Chinese]*, Guangxi Normal University Press, 2002.

Greenstone, Michael, Richard Hornbeck, and Enrico Moretti, "Identifying Agglomeration Spillovers: Evidence from Winners and Losers of Large Plant Openings," *Journal of Political Economy*, 2010, *118* (3), 536–598.

Harrison, Ann, Marshall Meyer, Peichun Wang, Linda Zhao, and Minyuan Zhao, "Can a Tiger Change Its Stripes? Reform of Chinese State-Owned Enterprises in the Penumbra of the State," Technical Report, National Bureau of Economic Research 2019.

Haskel, Jonathan E, Sonia C Pereira, and Matthew J Slaughter, "Does inward foreign direct investment boost the productivity of domestic firms?," *The review of economics and statistics*, 2007, *89* (3), 482–496.

He, Yimin and Mingchang Zhou, "The 156 Program and the Development of Industrial Cities in New China (1949–1957) [in Chinese]," *Contemporary China History Studies*, 2007, *14* (2), 70–77.

He, Zi-Lin, Tony W Tong, Yuchen Zhang, and Wenlong He, "A database linking Chinese patents to China's census firms," *Scientific data*, 2018, *5*, 180042.

Head, Keith, John Ries, and Deborah Swenson, "Agglomeration benefits and location choice: Evidence from Japanese manufacturing investments in the United States," *Journal of international economics*, 1995, *38* (3-4), 223–247.

Henderson, J Vernon, Zmarak Shalizi, and Anthony J Venables, "Geography and development," *Journal of Economic Geography*, 2001, *1* (1), 81–105.

Hsieh, Chang-Tai and Peter J. Klenow, "Misallocation and Manufacturing TFP in China and India," *The Quarterly Journal of Economics*, November 2009, *124* (4), 1403–1448.

_ **and Zheng Song**, "Grasp the Large, Let Go of the Small: The Transformation of the State Sector in China," NBER Working Papers 21006, National Bureau of Economic Research, Inc March 2015.

Imbert, Clement, Marlon Seror, Yifan Zhang, and Yanos Zylberberg, "Migrants and Firms: Evidence from China," Technical Report December 2018.

Javorcik, Beata Smarzynska, "Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages," *American economic review*, 2004, *94* (3), 605–627.

Kim, Sukkoo, "Expansion of markets and the geographic distribution of economic activities: the trends in US regional manufacturing structure, 1860–1987," *The Quarterly Journal of Economics*, 1995, *110* (4), 881–908.

Kline, Patrick and Enrico Moretti, "Local Economic Development, Agglomeration Economies, and the Big Push: 100 Years of Evidence from the Tennessee Valley Authority," *The Quarterly Journal of Economics*, 2014, *129* (1), 275–331.

Konings, Jozef, "The effects of foreign direct investment on domestic firms," *Economics of transition*, 2001, *9* (3), 619–633.

Lardy, Nicholas R., *Economic Recovery and the First Five-Year Plan*, Cambridge University Press, 1987.

Li, Fuchun, *Achievements of the First Three Years of the Five-Year Plan and Missions for the Next Two Years: Report at the National Assembly of Young Activists for the Construction of Socialism [in Chinese]*, Beijing: China Youth Publishing, September 1955.

_ , *Report on the First Five-Year Plan for the Development of the National Economy—At the Second Meeting of the First National People's Congress on July 5–6, 1955 [in Chinese]*, Beijing: National Committee of the Chinese People's Political Consultative Conference, July 1955.

Lüthi, Lorenz M., *The Sino-Soviet split: Cold War in the communist world*, Princeton University Press, 2010.

Mayneris, Florian, Sandra Poncet, and Tao Zhang, "Improving or Disappearing: Firm-Level Adjustments to Minimum Wages in China," IRES Discussion Paper 2016-27 2016.

Naughton, Barry, *The Chinese Economy: Transformation and Growth*, Cambridge, MA: MIT Press, 2007.

Neumark, David and Helen D. Simpson, "The Handbook of Regional and Urban Economics," in Gilles Duranton, J.V. Henderson, and William Strange, eds., *The Handbook of Regional and Urban Economics*, Elsevier/Academic Press, 2015.

Ngai, L. Rachel and Christopher A. Pissarides, "Structural Change in a Multisector Model of Growth," *American Economic Review*, March 2007, *97* (1), 429–443.

Pierce, Justin R and Peter K Schott, "The surprisingly swift decline of US manufacturing employment," *American Economic Review*, 2016, *106* (7), 1632–62.

Rawski, Thomas, *Economic Growth and Employment in China*, Oxford: Oxford University Press, 1979.

Rong, Xinchun, "On the Development and Changes of the Shipping Business in New China (1949–2010) [in Chinese]," *Researches in Chinese Economic History*, 2012, *2*, 127–137.

Rosenstein-Rodan, Paul N., "Problems of Industrialisation of Eastern and South-Eastern Europe," *The Economic Journal*, 1943, *53* (210/211), 202–211.

Schweiger, Helena, Alexander Stepanov, and Paolo Zacchia, "The long-run effects of R&D place-based policies: evidence from Russian science cities," Technical Report, European Bank for Reconstruction and Development June 2018.

Selden, Mark and Patti Eggleston, *The People's Republic of China. A Documentary History of Revolutionary China*, New York: Monthly Review Press, 1979.

Shi, Wenjie, "A Study of the "156 Program" and its Influence on the Early Modernization of New China [in Chinese]," *Financial Information*, 2013, *1*, 42–45.

Shirotori, Miho, Bolormaa Tumurchudur, and Olivier Cadot, *Revealed factor intensity indices at the product level*, Vol. 44, UN, 2010.

Song, Zheng, Kjetil Storesletten, and Fabrizio Zilibotti, "Growing Like China," *American Economic Review*, 2011, *101* (1), 196–233.

Tang, Yanyan, "An Analysis of the Advantage of Backwardness Based on the Construction of the "156" Program [in Chinese]," *Theory Monthly*, 2009, *20.*

Tombe, Trevor and Xiaodong Zhu, "Trade, Migration and Productivity: A Quantitative Analysis of China," June 2015.

von Ehrlich, Maximilian and Tobias Seidel, "The Persistent Effects of Place-Based Policy: Evidence from the West-German Zonenrandgebiet," *American Economic Journal: Economic Policy*, 2018, *10* (4), 344–74.

Walder, Andrew G, "Rebellion and repression in China, 1966–1971," *Social Science History*, 2014, *38* (3-4), 513–539.

Wang, Jin, "The economic impact of special economic zones: Evidence from Chinese municipalities," *Journal of development economics*, 2013, *101*, 133–147.

Wang, Qi, "An Analysis of the "156 Program" and Sino-Soviet Relations in the 1950s [in Chinese]," *Contemporary China History Studies*, 2003, *10*, 110–116.

Xia, Fei, "The Third Front Movement: One of Mao Zedong's Major Strategic Decisions [in Chinese]," *Over the Party History*, 2008, *1*, 45–48.

Xiao, Xiang, *Study of the Role of Government in China's Industrialization [in Chinese]*, Economic Science Press, 2014.

Zhang, Jiuchun, "A Study of the "156 Program" of Industrial Construction in the 1950s [in Chinese]," *Journal of Engineering Studies*, 2009, *1*, 213–222.

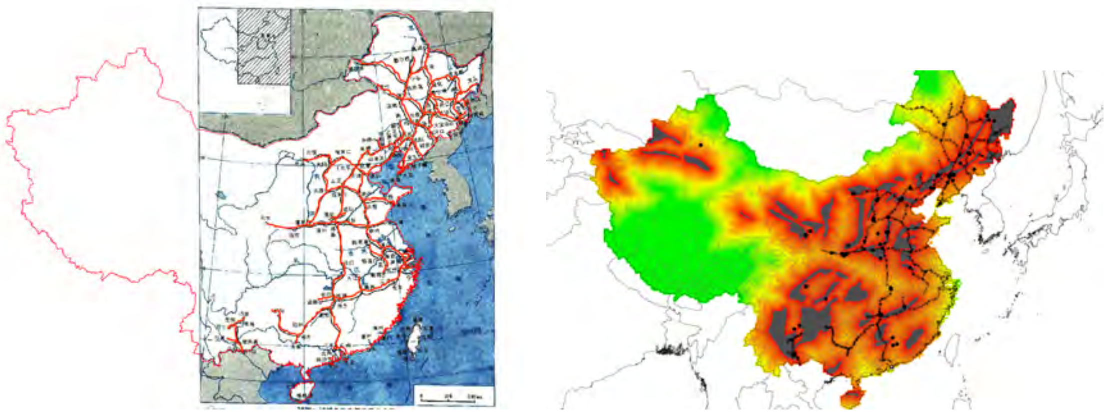
Zhang, Shuguang, *Economic Cold War: America's Embargo against China and the Sino-Soviet Alliance, 1949–1963*, Stanford, CA: Stanford University Press, 2001.

Zheng, Siqi, Weizeng Sun, Jianfeng Wu, and Matthew E. Kahn, "The birth of edge cities in China: Measuring the effects of industrial parks policy," *Journal of Urban Economics*, July 2009, *100*, 80–103.

— , — , — , and — , "The birth of edge cities in China: Measuring the effects of industrial parks policy," *Journal of Urban Economics*, 2017, *100*, 80–103.

A Figures and tables

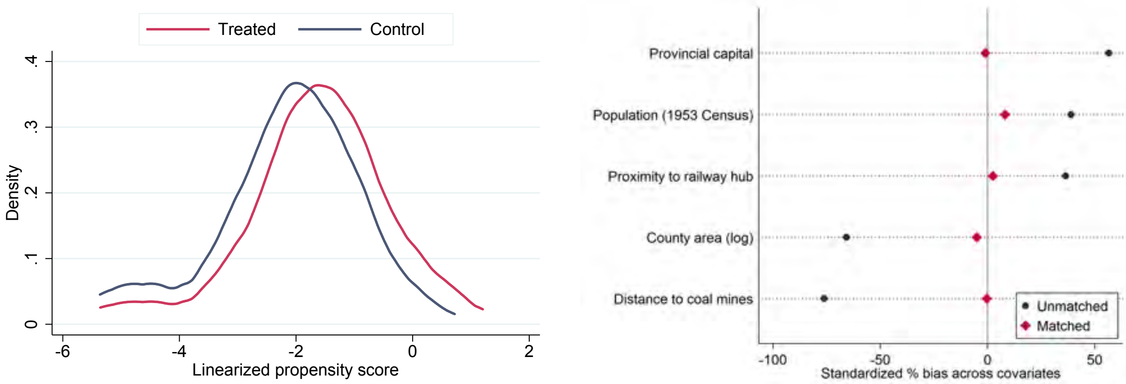
Figure 1. Transport network in 1948 and access to natural resources.



(a) Transport network in 1948. (b) Access to natural resources (coal).

Sources: The left panel is a Railroad Map of China (1948, Joint Intelligence Committee). Black lines are from the original source; red lines are inferred poly-lines using current geocoded railroad lines and cities. The right panel represents the minimum travel time to coal-bearing areas using the railroad and road networks (red: low travel time, green: high travel time). Railroads and roads are geo-located from 1948 and 1962 maps, respectively. Factory locations are indicated with black dots, coal-bearing zones are highlighted with gray areas.

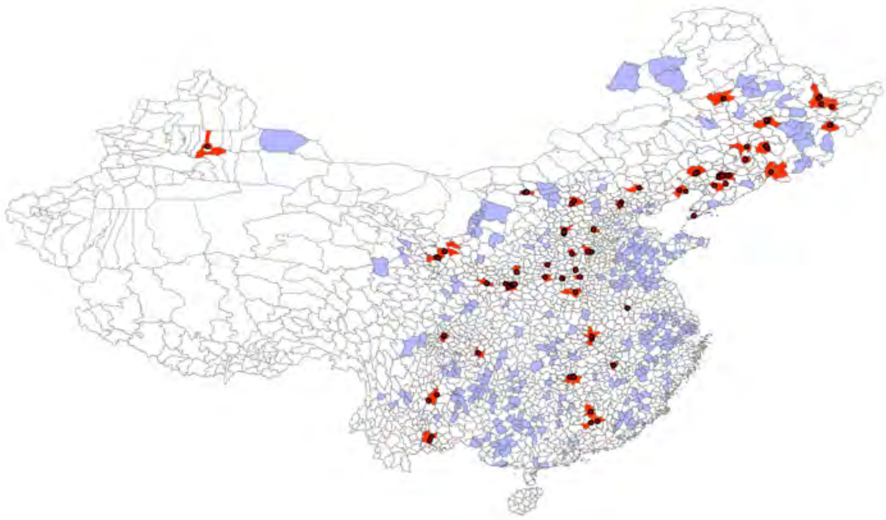
Figure 2. Matching and balance of covariates.



(a) Common support (propensity score). (b) Balance of covariates.

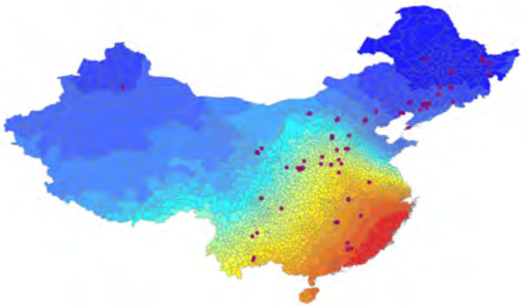
Sources: The left panel displays the distributions of the propensity score within the set of treated counties (red) and control counties (blue). The right panel shows the bias in covariates in treated counties within the whole sample and the matched sample.

Figure 3. Treated counties and the group of control counties.

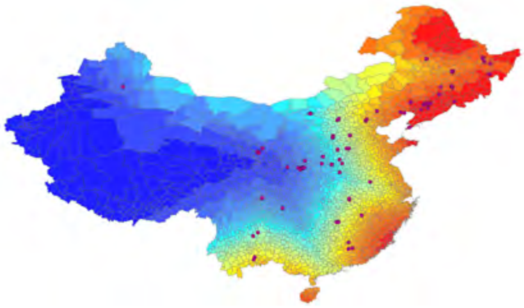


Notes: This map show counties that host at least one "156"-program factory (red) and the control group of counties (blue). The control group is selected through the matching procedure described in Section 2.

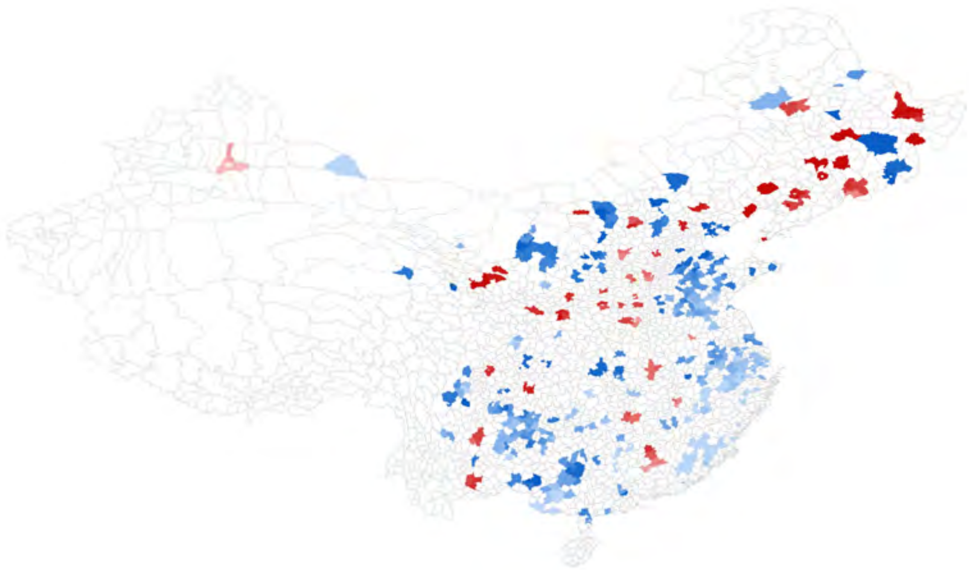
Figure 4. Vulnerability map.



(a) Pre-1960 split



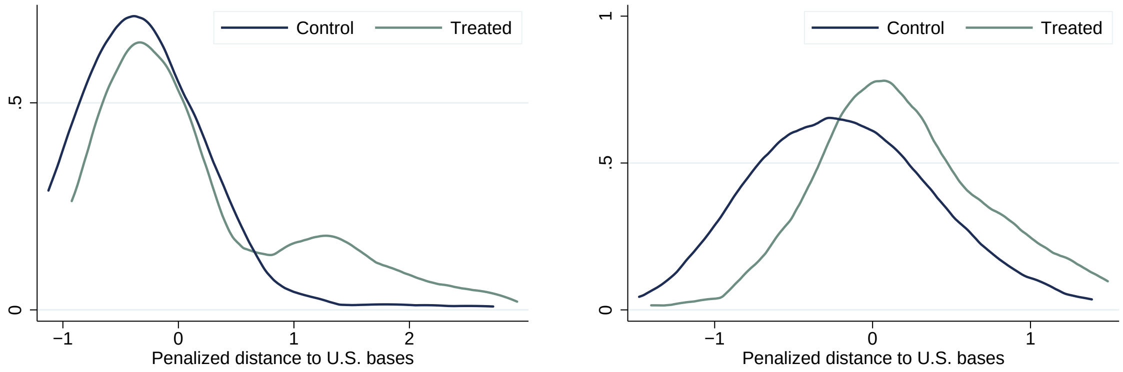
(b) Post-1960 split



(c) Exogenous variation

Notes: This map shows the variation used for identification. Panels (a) and (b), resp., represent the penalized travel time from enemy airfields (red: low travel time, blue: high travel time) before 1960 and after 1960 (1964). Panel (c) displays the residuals from the regression of the penalized travel time shown in Panel (a) on the first-stage controls (see Table 1, column 3), for the treated (red) and control counties (blue). The color gradient in all three panels correspond to deciles of the distribution of penalized travel time.

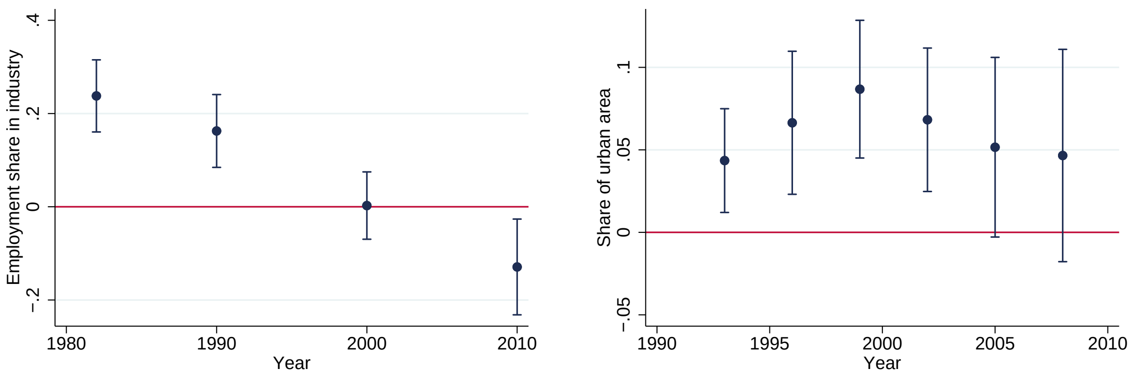
Figure 5. Vulnerability density within treated and control counties.



(a) Unconditional (b) Conditional

Notes: This Figure displays the density of the unconditional and conditional vulnerability measure. *Penalized distance to U.S. bases* is the standardized distance to the main military U.S. or Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. Treatment is defined as a dummy equal to 1 if a county centroid lies within 20 km of a factory and 0 otherwise. The control group is selected through the matching procedure described in Section 2, and the extended controls are those of Table 1, column 3.

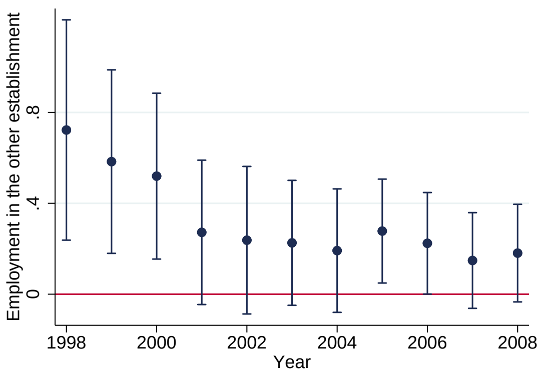
Figure 6. Illustration of the treatment effect over time (employment share in industry and share of urban area)).



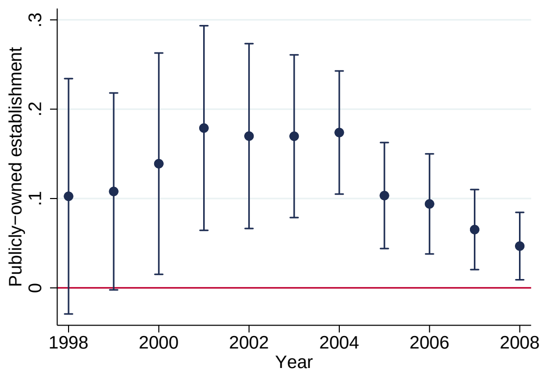
(a) Employment share in industry (b) Share of urban area

Notes: This Figure displays the treatment effect for the employment share in industry (1982, 1990, 2000, 2010) and the share of urban area in the county, as computed using impervious surface recognition (1993, 1996, 1999, 2002, 2005, 2008).

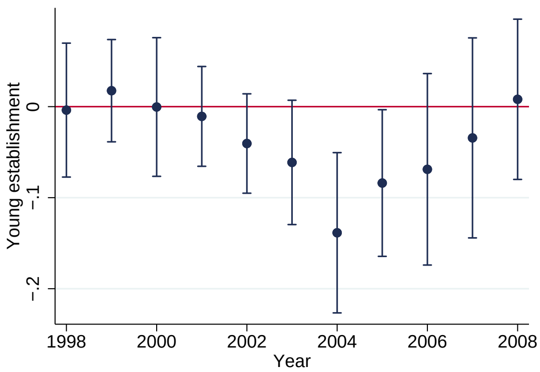
Figure 7. Illustration of the treatment effect over time (employment, public ownership, share of young firms, number of utility patents).



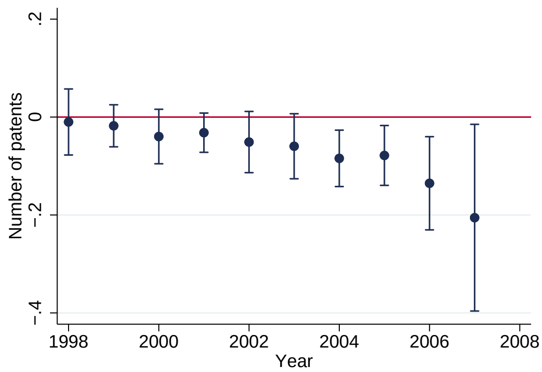
(a) Employment



(b) Public



(c) Young



(d) Utility patents

Notes: This Figure displays the treatment effect for establishments size and characteristics (1998–2008), and patenting behavior (1998–2007).

Figure 8. Illustration of spillovers with treatment heterogeneity.

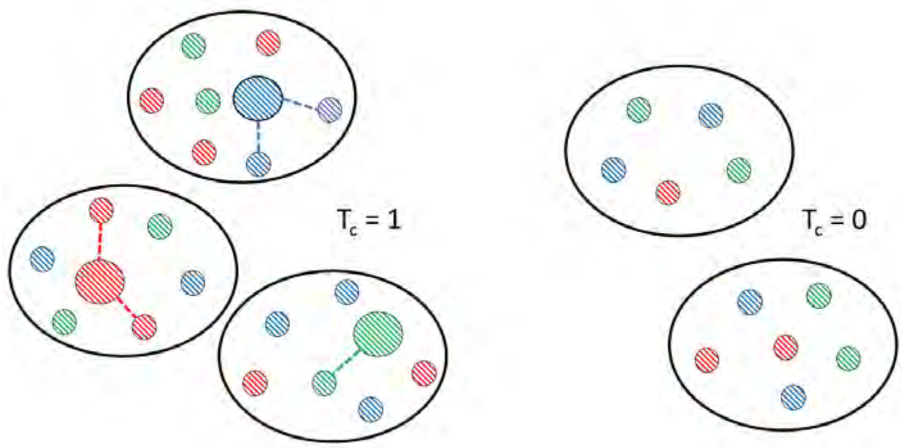


Table 1. Factories and penalized distance to U.S./Taiwanese airfields and bases.

Factory	(1)	(2)	(3)
Penalized distance	0.143	0.148	0.261
	(0.039)	(0.039)	(0.044)
Observations	430	430	430
Propensity bins	No	Yes	Yes
Extended controls	No	No	Yes

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a county (Administrative level 3). *Penalized distance* is the normalized distance to the main military U.S. and Taiwanese airfields penalized by proximity to U.S.S.R. and North Korean airfields. Extended controls include all matching controls, i.e., travel cost to resources (coal, coke, ore), proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log), county area (log), and additional controls, i.e., travel cost to major ports (through the river network), proximity to Ming-dynasty courier stations, cities in 1900, distance to military airfields) and penalized distance to enemy airfields in 1964.

Table 2. The 156 Million-Rouble Plants: sector, construction period and initial investment.

Sector	Number	Construction		Investment	
		Start	End	Planned	Actual
Aviation	14	1953.9	1957.3	7271	7204
Chemical	7	1955.3	1958.4	15291	15474
Coal mining	25	1954.3	1958.5	5323	5832
Electronic	10	1955.5	1957.9	5661	4752
Iron and Steel	7	1953.9	1959.0	78361	84586
Machinery	23	1954.8	1958.2	9972	10336
Nonferrous Metals	13	1955.1	1959.0	15018	15451
Powerplants	23	1954.0	1957.9	13039	9023
Weapons	16	1955.1	1958.4	13533	12262
Other	12	1955.3	1959.3	11751	12513

Notes: Other industries are shipbuilding, pharmaceutical and paper-making industries. The average planned investment by factory was about 100,000,000 yuan, which amounts to 15,000,000 Soviet roubles in 1957 ($120,000,000 in 2010 U.S. dollars). Note that some projects were not completed in 1960, and thus abandoned. Some planned projects had not yet been awarded a definitive location, which prevents us from using them as a control group.

Table 3. Descriptive statistics (control and treated counties, weighted by matching weights).

VARIABLES	Mean	Std dev.	With factory	No factory
Vulnerability to air strikes				
Penalized distance (1953)	0.151	1.139	0.522	-0.219
Penalized distance (1964)	-0.282	0.806	-0.262	-0.302
Population				
Population (1953, log)	12.19	1.023	12.24	12.14
Population (1964, log)	12.55	0.910	12.69	12.40
Population (1982, log)	12.94	0.845	13.08	12.81
Population (1990, log)	13.07	0.817	13.20	12.94
Population (2000, log)	13.18	0.879	13.33	13.03
Population (2010, log)	13.27	0.930	13.42	13.13
Urban registration				
Share non agr. (1964)	0.272	0.259	0.368	0.177
Share non agr. (1982)	0.365	0.264	0.444	0.287
Share non agr. (1990)	0.405	0.279	0.481	0.330
Share non agr. (2000)	0.337	0.243	0.412	0.261
Share non agr. (2010)	0.355	0.236	0.432	0.279
Matching controls				
Travel cost to coal mines (log)	13.20	0.750	13.18	13.22
Travel cost to coke (log)	13.06	0.809	12.98	13.15
Travel cost to ore (log)	14.88	0.887	14.78	14.98
Proximity to rail hub	0.011	0.107	0.017	0.005
Province capital	0.275	0.447	0.267	0.283
Area (log)	7.23	0.762	7.24	7.22
Additional controls				
Proximity to city (1900)	0.816	0.387	0.919	0.714
Proximity to Ming stations	0.366	0.482	0.455	0.278
Proximity to rivers	0.558	0.497	0.428	0.689
Distance to military airfields (log)	10.41	1.038	10.28	10.54
Travel cost to major ports (log)	13.88	0.881	14.03	13.73
Observations	430		110	320

Notes: Penalized distance is standardized (mean 0 and variance 1 over all counties in China).

Table 4. Factories and employment, output and urbanization in 1982.

VARIABLES	Population (1)	Share urban (2)	GDP p.c. (3)	Share industry (4)
Panel A: OLS specification				
Factory	.139	.130	.291	.097
	(.046)	(.022)	(.070)	(.017)
Observations	430	430	430	430
Panel B: IV specification				
Factory	.216	.349	.850	.237
	(.103)	(.060)	(.190)	(.039)
Observations	430	430	430	430
F-Stat. (first stage)	34.52	34.52	34.52	34.52

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a county (Administrative level 3). The instrument is the distance to the main military U.S. and Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. All specifications include (i) propensity score bins, (ii) matching controls, i.e., travel cost to resources (coal, coke, ore), proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log), county area (log), and (iii) the additional controls, i.e., travel cost to major ports (through the river network), proximity to Ming-dynasty courier stations, cities in 1900, distance to military airfields) and penalized distance to enemy airfields in 1964. *Population* is the logarithm of total population in the county and *Share of urban* the share of the population that has a non-agricultural household registration (*hukou*).

Table 5. Factories and employment, output and urbanization in 2010.

VARIABLES	Population (1)	Share urban (2)	GDP p.c. (3)	Share industry (4)
Panel A: OLS specification				
Factory	.144	.125	-.104	.023
	(.063)	(.019)	(.079)	(.013)
Observations	430	430	335	430
Panel B: IV specification				
Factory	.253	.336	.074	-.129
	(.129)	(.043)	(.218)	(.052)
Observations	430	430	335	430
F-Stat. (first stage)	34.52	34.52	31.22	34.52

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a county (Administrative level 3). The instrument is the distance to the main military U.S. and Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. All specifications include (i) propensity score bins, (ii) matching controls, i.e., travel cost to resources (coal, coke, ore), proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log), county area (log), and (iii) the additional controls, i.e., travel cost to major ports (through the river network), proximity to Ming-dynasty courier stations, cities in 1900, distance to military airfields) and penalized distance to enemy airfields in 1964. *Population* is the logarithm of total population in the county and *Share of urban* the share of the population that has a non-agricultural household registration (*hukou*).

Table 6. Structure of firm production (average treatment effect).

VARIABLES	Employment	Capital	Labor cost	MPL	MPK	TFP
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Firm size, labor cost and productivity						
Factory	.281	.363	-.329	-.252	-.376	-.319
	(.107)	(.144)	(.087)	(.120)	(.122)	(.109)
Obs.	432,202	432,202	432,202	432,202	432,202	432,202
VARIABLES	Public	Small	Young	Emp. share (bach.)	Emp. share (skilled)	Emp. share (senior)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Firm characteristics (public ownership, unions, employment structure)						
Factory	.080	-.120	-.070	.057	.141	.107
	(.021)	(.027)	(.020)	(.014)	(.026)	(.024)
Obs.	908,276	908,276	908,276	30,138	30,138	30,138
VARIABLES	Subsidies	Liabilities	Cash inflow (fin.)	Investment ST	Investment LT	R&D expenses
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Financing, Investment, R&D and technology						
Factory	-.022	.029	.031	-.022	-.007	.003
	(.030)	(.029)	(.030)	(.010)	(.016)	(.016)
Obs.	338,165	338,165	338,165	256,240	256,240	256,240
VARIABLES	Human capital	Physical capital	Land			
	(1)	(2)	(3)			
Panel D: Factor intensity						
Factory	.064	.193	.041			
	(.016)	(.043)	(.019)			
Obs.	847,234	847,234	847,234			

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects, except in Panel D. *Employment* is the logarithm of the number of workers; *Capital* is the logarithm of real capital; *Labor cost* is the logarithm of total compensation per employee; *MPL* (resp. *MPK*, *TFP*) is the logarithm of firm-specific labor productivity (resp. capital, total factor productivity) as computed in Imbert et al. (2018). *Public*, *Small* and *Young* are dummies equal to 1 if the firm is a state-owned enterprise, is smaller than 100 employees and younger than 3 years. All variables of Panel C are dummies equal to 1 if the associated accounting variable is positive. Factor intensities are the (log) factor intensity, as predicted by the 4-digit product code (following the classification of Shirotori et al., 2010).

Table 7. Patenting in treated and control counties.

Patents	Design (1)	Invention (2)	Utility (3)
Panel A: Number of patents			
Factory	-.026	-.018	-.081
	(.045)	(.028)	(.027)
Observations	604,992	604,992	604,992
Panel B: At least one patent			
Factory	-.011	-.006	-.007
	(.003)	(.003)	(.003)
Observations	604,992	604,992	604,992

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects. *Patents* are the number of patent applications registered by the firm; we distinguish three categories: design, invention and utility.

Table 8. Treatment heterogeneity along county characteristics and treatment type.

New patent	Design (1)	Invention (2)	Utility (3)
Panel A: Province capital			
Factory	-.0129	-.0048	-.0044
	(.0053)	(.0027)	(.0052)
Factory × **X**	.0035	-.0027	-.0054
	(.0069)	(.0041)	(.0077)
Observations	604,992	604,992	604,992
Panel B: Heavy industry			
Factory	-.0092	-.0067	-.0038
	(.0032)	(.0035)	(.0041)
Factory × **X**	-.0035	.0021	-.0084
	(.0057)	(.0043)	(.0021)
Observations	604,992	604,992	604,992
Panel C: I/O intensity			
Factory	-.0098	.0061	.0149
	(.0105)	(.0080)	(.0140)
Factory × **X**	.0000	-.0049	-.0090
	(.0046)	(.0037)	(.0060)
Observations	554,324	554,324	554,324
Panel D: Position downstream/upstream			
Factory	-.0103	-.0049	-.0045
	(.0024)	(.0024)	(.0032)
Factory × **X**	.0022	.0041	.0028
	(.0022)	(.0018)	(.0029)
Observations	554,324	554,324	554,324
Panel E: Number of different products (2-digits)			
Factory	-.0155	-.0172	-.0165
	(.0049)	(.0047)	(.0065)
Factory × **X**	.0035	.0087	.0072
	(.0029)	(.0026)	(.0040)
Observations	604,992	604,992	604,992
Panel F: Number of different products (4-digits)			
Factory	-.0126	-.0172	-.0125
	(.0036)	(.0047)	(.0055)
Factory × **X**	.0041	.0087	.0033
	(.0014)	(.0026)	(.0024)
Observations	604,992	604,992	604,992

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects. *New patent* is a dummy equal to 1 if there is at least one patent application registered by the firm; we distinguish three categories: design, invention and utility.

Table 9. Production linkages with the 156 factories.

VARIABLES	Downstream	Upstream	Same product
	(1)	(2)	(3)
Panel A: Production linkages			
Factory	.113	.025	.040
	(.034)	(.052)	(.012)
Observations	908,276	908,276	908,276
VARIABLES	More H-intensive	More K-intensive	More T-intensive
	(1)	(2)	(3)
Panel B: Factor demand			
Factory	-.055	-.083	.031
	(.067)	(.056)	(.080)
Observations	551,667	551,667	551,667
VARIABLES	Tech. clos.	Tech. clos. (Mah.)	
	(1)	(2)	
Panel C: Technology closeness			
Factory	.372	.271	
	(.214)	(.188)	
Observations	908,276	908,276	

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include population in 1953 (log), county area (log), proximity to major ports (through the river network), proximity to Ming-dynasty courier stations, distance to the coast, distance to military airfields and market access (population of neighboring counties normalized by the inverse of distance) as controls. The instrument is the distance to the main military U.S. and Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. *Downstream* (resp. *Upstream*) is a dummy equal to one if the firm is down (resp. up) the supply chain with respect to one of the 156 factories; *Same product* is a dummy equal to one if the firm is in the same product market as one of the 156 factories (see Section 4 for a description of the empirical strategy and the definition of these dummies in control counties). *More F-intensive* is a dummy equal to 1 if the revealed factor intensity of factor F (using product codes) is higher than that of the average associated MRP.

Table 10. Patenting in establishments along the production chain of the 156 factories.

New patent	Design (1)	Invention (2)	Utility (3)
Panel A: Downstream			
Factory	-.0106	-.0048	-.0057
	(.0029)	(.0027)	(.0031)
Factory × Downstream	-.0055	-.0086	-.0100
	(.0025)	(.0036)	(.0034)
Observations	604,992	604,992	604,992
Panel B: Upstream			
Factory	-.0104	-.0048	-.0053
	(.0030)	(.0030)	(.0033)
Factory × Upstream	-.0033	-.0071	-.0102
	(.0034)	(.0037)	(.0053)
Observations	604,992	604,992	604,992
Panel C: Same product			
Factory	-.0108	-.0056	-.0069
	(.0029)	(.0028)	(.0033)
Factory × Same product	-.0133	-.0285	-.0191
	(.0108)	(.0103)	(.0115)
Observations	604,992	604,992	604,992
Panel D: Technology closeness			
Factory	-.0125	-.0034	-.0059
	(.0041)	(.0031)	(.0046)
Factory × Tech. clos.	.0027	-.0050	-.0032
	(.0054)	(.0049)	(.0075)
Observations	604,992	604,992	604,992

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects. *New patent* is a dummy equal to 1 if there is at least one patent application registered by the firm; we distinguish three categories: design, invention and utility. *Downstream* (resp. *Upstream*) is a dummy equal to one if the firm is down (resp. up) the supply chain with respect to one of the 156 factories; *Same product* is a dummy equal to one if the firm is in the same product market as one of the 156 factories (see Section 4 for a description of the empirical strategy and the definition of these dummies in control counties).

Table 11. Characteristics of establishments along the production chain of the 156 factories.

VARIABLES	Public (1)	Subsidized (2)	Young (3)
Panel A: Downstream			
Factory	.069	-.060	-.066
	(.021)	(.025)	(.019)
Factory × Downstream	.097	.064	-.012
	(.056)	(.087)	(.036)
Observations	908,276	908,276	908,276
Panel B: Upstream			
Factory	.074	-.056	-.074
	(.022)	(.028)	(.021)
Factory × Upstream	.045	.013	.034
	(.028)	(.066)	(.029)
Observations	908,276	908,276	908,276
Panel C: Same product			
Factory	.080	-.050	-.067
	(.021)	(.027)	(.020)
Factory × Same product	.020	-.212	-.154
	(.067)	(.142)	(.061)
Observations	908,276	908,276	908,276
Panel D: Technology closeness			
Factory	.038	-.040	-.063
	(.034)	(.036)	(.029)
Factory × Tech. clos.	.103	-.024	-.017
	(.066)	(.083)	(.058)
Observations	908,276	908,276	908,276

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects. *New patent* is a dummy equal to 1 if there is at least one patent application registered by the firm; we distinguish three categories: design, invention and utility. *Downstream* (resp. *Upstream*) is a dummy equal to one if the firm is down (resp. up) the supply chain with respect to one of the 156 factories; *Same product* is a dummy equal to one if the firm is in the same product market as one of the 156 factories (see Section 4 for a description of the empirical strategy and the definition of these dummies in control counties).

ONLINE APPENDIX—not for publication

A Additional figures and tables

Table A1. Description of control variables.

VARIABLES	Description
Population	
Population (1953)	Total population of the county in the First Chinese Population Census (1953).
Access to resources	
Travel cost to coal mines	Distance to coal mines following the 1948 railroad network.
Travel cost to ore	Distance to ore deposits following the 1948 railroad network.
Travel cost to coke	Distance to coke deposits following the 1948 railroad network.
Topographic controls	
Slope (degrees)	Average slope in the county.
Strong slope	Dummy equal to 1 if the average slope is greater than 10 degrees.
Elevation (mean; m)	Average elevation in the county (in meters).
Elevation (st. dev.; m)	Standard deviation of elevation in the county (in meters).
Market access controls	
Travel cost to ports	Dummy equal to 1 for a county whose centroid is lying within 500 km of a port following navigable waterways, and 0 otherwise.
Proximity to courier stations	Dummy equal to 1 if the county centroid is located within 10 kms of the closest Ming-dynasty courier station.
Proximity to 1900 city	Dummy equal to 1 if the county centroid is located within 10 kms of the closest city as of 1900.
Proximity to rivers	Dummy equal to 1 if the county centroid is located within 10 kms of a major river.
Proximity to railway hub	Dummy equal to 1 if the county centroid is located within 5 kms of a railway hub.
Dist. to the coast	Minimum distance to the coast.
Province capital	Dummy equal to 1 if the county belongs to the capital of the province.
Geomorphic controls	
Lake plain	Share of the county's area that consists of lacustrine plains.
Sand hills	Share of the county's area that consists of sand hills.
Tidal marsh	Share of the county's area that consists of tidal marshes.
Agricultural controls	
Expected yield: maize	Average potential yield (kg/ha) of maize under the high-input scenario (GAEZ model-based).
Expected yield: rice	Average potential yield (kg/ha) of rice under the high-input scenario (GAEZ model-based).
Expected yield: wheat	Average potential yield (kg/ha) of wheat under the high-input scenario (GAEZ model-based).
Other geographic controls	
Area	Total land area of the county.
Dist. to military airfields	Minimum distance to a Chinese military airfield.

Table A2. Sensitivity to the empirical specification.

VARIABLES	Population (1982)	GDP p.c. (1982)	Population (2010)	GDP p.c. (2010)
Panel A: Local identification				
Factory	.032	.420	.105	.040
	(.075)	(.097)	(.088)	(.108)
	[1,540]	[1,540]	[1,540]	[1,336]
Panel B: Matching with extended variables				
Factory	.067	.793	.183	-.282
	(.107)	(.202)	(.084)	(.193)
	[407]	[407]	[407]	[312]
Panel C: Matching with fewer variables				
Factory	.137	.753	.113	.066
	(.113)	(.229)	(.107)	(.373)
	[426]	[426]	[426]	[327]
Panel D: One-to-one matching				
Factory	.223	.764	.288	.002
	(.098)	(.205)	(.134)	(.186)
	[222]	[222]	[222]	[158]
Panel E: Matching with larger exclusion zone				
Factory	.114	.641	.197	-.305
	(.083)	(.267)	(.143)	(.196)
	[236]	[236]	[236]	[173]

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells, and are reported between parentheses. The number of observation is reported between brackets. The unit of observation is a county (Administrative level 3). The instrument is the distance to the main military U.S. and Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. All specifications include (i) propensity score bins (except Panel A which includes province-fixed effects instead), (ii) matching controls, i.e., travel cost to resources (coal, coke, ore), proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log), county area (log), and (iii) the additional controls, i.e., travel cost to major ports (through the river network), proximity to Ming-dynasty courier stations, cities in 1900, distance to military airfields) and penalized distance to enemy airfields in 1964. *Population* is the logarithm of total population in the county. In Panel B, we use proximity to Ming stations, distance to military airfields and access to the main trading ports as matching variables in order to select the group of control counties. In Panel C, we drop access to ore and coke from the set of matching variables.

Table A3. Sensitivity to the choice of weights, sample and control variables.

VARIABLES	Population (1982)	GDP p.c. (1982)	Population (2010)	GDP p.c. (2010)
Panel A: No weights				
Factory	.249	.906	.230	-.013
	(.106)	(.185)	(.135)	(.272)
	[430]	[430]	[430]	[335]
Panel B: Excluding closed and displaced factories				
Factory	.178	.747	.142	-.244
	(.106)	(.192)	(.124)	(.213)
	[417]	[417]	[417]	[332]
Panel C: Excluding a buffer around the Pearl river delta				
Factory	.358	1.26	.644	.081
	(.194)	(.360)	(.271)	(.196)
	[391]	[391]	[391]	[302]
Panel D: Excluding the South of China				
Factory	.137	.753	.113	-.120
	(.113)	(.229)	(.107)	(.308)
	[316]	[316]	[316]	[236]
Panel E: Controls for distance to the coast				
Factory	.191	.770	.195	.232
	(.135)	(.259)	(.177)	(.270)
	[430]	[430]	[430]	[335]
Panel F: Controls for unfavorable environment (elevation etc.)				
Factory	.247	.591	.202	-.265
	(.140)	(.198)	(.162)	(.165)
	[353]	[353]	[353]	[282]
Panel G: Controls for other policies (Third Front, SEZs etc.)				
Factory	.127	.908	.152	.154
	(.100)	(.220)	(.123)	(.214)
	[430]	[430]	[430]	[335]
Panel H: Controls for vulnerability to U.S.S.R. strikes (1972)				
Factory	.598	.890	.685	-1.22
	(.211)	(.317)	(.253)	(.404)
	[430]	[430]	[430]	[335]

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells, and are reported between parentheses. The number of observation is reported between brackets. The unit of observation is a county (Administrative level 3). The instrument is the distance to the main military U.S. and Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. All specifications include (i) propensity score bins (except Panel A which includes province-fixed effects instead), (ii) matching controls, i.e., travel cost to resources (coal, coke, ore), proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log), county area (log), and (iii) the additional controls, i.e., travel cost to major ports (through the river network), proximity to Ming-dynasty courier stations, cities in 1900, distance to military airfields) and penalized distance to enemy airfields in 1964.

Table A4. Sensitivity to other measures of economic development.

VARIABLES	Participation	Illiteracy rate	Male/female ratio
Panel A: Additional variables (1982)			
Factory	-.040	-.163	-.015
	(.022)	(.041)	(.017)
	[430]	[430]	[430]
VARIABLES	Agriculture	Industry	Services
Panel B: Precise sectoral decomposition (employment shares, 1990)			
Factory	-.267	.126	.136
	(.067)	(.039)	(.034)
	[430]	[430]	[430]
VARIABLES	Agriculture	Industry	Services
Panel C: Precise sectoral decomposition (employment shares, 2010)			
Factory	.042	-.129	.086
	(.060)	(.052)	(.033)
	[430]	[430]	[430]
VARIABLES	Nightlights (1993)	Nightlights (2012)	Urban (1993)
Panel D: Satellite data			
Factory	1.21	.524	.043
	(.336)	(.258)	(.016)
	[430]	[430]	[423]

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells, and are reported between parentheses. The number of observation is reported between brackets. The unit of observation is a county (Administrative level 3). The instrument is the distance to the main military U.S. and Taiwanese airfields penalized by the proximity to U.S.S.R. and North Korean airfields. All specifications include (i) propensity score bins (except Panel A which includes province-fixed effects instead), (ii) matching controls, i.e., travel cost to resources (coal, coke, ore), proximity to a rail hub, whether the county is a provincial capital, population in 1953 (log), county area (log), and (iii) the additional controls, i.e., travel cost to major ports (through the river network), proximity to Ming-dynasty courier stations, cities in 1900, distance to military airfields) and penalized distance to enemy airfields in 1964.

Table A5. Sensitivity analysis—not controlling for industry (4-digit) and controlling for ownership.

VARIABLES	Labor cost (1)	TFP (2)	Patent (inv.) (3)	Patent (uti.) (4)	Downstream (5)	Tech. clos. (6)
Panel A: No 4-digit industry fixed effects						
Factory	-.281	-.350	-.0010	-.0000	.156	.374
	(.096)	(.127)	(.0029)	(.0043)	(.040)	(.202)
Observations	592,847	451,922	628,082	628,082	628,082	628,082
Panel B: Ownership fixed effects						
Factory	-.293	-.297	-.0060	-.0059	.127	.398
	(.093)	(.101)	(.0029)	(.0029)	(.037)	(.211)
Observations	572,182	451,860	604,992	604,992	604,992	604,992
Panel C: Subsidized-firm fixed effects						
Factory	-.302	-.334	-.0018	-.0015	.113	.367
	(.093)	(.105)	(.0026)	(.0029)	(.034)	(.214)
Observations	572,182	451,860	604,992	604,992	604,992	604,992
Panel D: Young-firm fixed effects						
Factory	-.323	-.324	-.0060	-.0071	.113	.372
	(.093)	(.107)	(.0027)	(.0030)	(.034)	(.214)
Observations	572,182	451,860	604,992	604,992	604,992	604,992

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4), and 4-digit industry × year fixed effects in Panel B. *Patent* is a dummy equal to 1 if there is at least one patent application registered by the firm; we distinguish three categories: design, invention and utility. *Labor cost* is the logarithm of total compensation per employee; *TFP* is the logarithm of total factor productivity as computed in Imbert et al. (2018).

Table A6. Sensitivity analysis—structure of production in establishments along the production chain of the 156 factories.

VARIABLES	Employment (1)	Capital (2)	Labor cost (3)	TFP (4)
Panel A: Downstream				
Factory	.241	.334	-.311	-.310
	(.105)	(.153)	(.081)	(.107)
Factory × Downstream	.253	.169	-.195	-.098
	(.207)	(.333)	(.187)	(.207)
Observations	432,202	432,202	432,202	432,202
Panel B: Upstream				
Factory	.292	.399	-.343	-.344
	(.113)	(.158)	(.092)	(.112)
Factory × Upstream	-.065	-.206	.062	.145
	(.188)	(.265)	(.078)	(.157)
Observations	432,202	432,202	432,202	432,202
Panel C: Same product				
Factory	.283	.370	-.336	-.333
	(.109)	(.146)	(.089)	(.111)
Factory × Same product	.003	-.016	.092	.431
	(.263)	(.374)	(.142)	(.311)
Observations	432,202	432,202	432,202	432,202
Panel D: Technology closeness				
Factory	.254	-.045	-.361	-.062
	(.143)	(.225)	(.149)	(.183)
Factory × Tech. clos.	.083	1.00	.048	-.645
	(.304)	(.542)	(.301)	(.407)
Observations	432,202	432,202	432,202	432,202

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects. *Labor cost* is the logarithm of total compensation per employee; *TFP* is the logarithm of total factor productivity as computed in Imbert et al. (2018). *Downstream* (resp. *Upstream*) is a dummy equal to one if the firm is down (resp. up) the supply chain with respect to one of the 156 factories; *Same product* is a dummy equal to one if the firm is in the same product market as one of the 156 factories (see Section 4 for a description of the empirical strategy and the definition of these dummies in control counties).

Table A7. Sensitivity analysis—patenting across establishments (public, subsidized, young).

New patent	Design	Invention	Utility
	(1)	(2)	(3)
Panel A: Public establishment			
Factory	-.0124	-.0059	-.0059
	(.0036)	(.0039)	(.0045)
Factory × Public	.0084	.0006	-.0009
	(.0039)	(.0044)	(.0063)
Observations	604,992	604,992	604,992
Panel B: Subsidized establishment			
Factory	-.0065	-.0036	-.0031
	(.0024)	(.0022)	(.0025)
Factory × Subsidized	-.0039	.0053	.0047
	(.0033)	(.0058)	(.0058)
Observations	604,992	604,992	604,992
Panel C: Young establishment			
Factory	-.0116	-.0074	-.0077
	(.0028)	(.0030)	(.0033)
Factory × Young	.0029	.0064	.0028
	(.0023)	(.0030)	(.0025)
Observations	604,992	604,992	604,992

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and 4-digit industry × year fixed effects. *Patent* is a dummy equal to 1 if there is at least one patent application registered by the firm; we distinguish three categories: design, invention and utility.

Table A8. Sensitivity analysis—dispersion, concentration and entry/exit at the county-level.

VARIABLES	Labor cost	MPL	MPK	TFP
	(1)	(2)	(3)	(4)
Panel A: Dispersion in labor cost and productivity				
Factory	.137	.160	-.024	.041
	(.050)	(.103)	(.120)	(.103)
Observations	2,786	2,462	2,462	2,462
	Herfindahl		Large firms	
VARIABLES	Employment	Output	Employment	Output
	(1)	(2)	(3)	(4)
Panel B: Concentration in employment and output				
Factory	.018	.054	.283	.212
	(.036)	(.045)	(.097)	(.090)
Observations	3,729	3,729	3,729	3,042
	Number of entrants		Number of exiters	
VARIABLES	All	Outside	All	Outside
	(1)	(2)	(3)	(4)
Panel C: Entry & exit				
Factory	-.010	-.011	.015	.034
	(.014)	(.030)	(.020)	(.041)
Observations	3,729	3,729	3,729	3,729

Notes: Standard errors are clustered at level of 4-degree × 4-degree cells. The unit of observation is a firm × year. We exclude the MRPs from the sample. All specifications include the baseline controls (Table 4) and year fixed effects.

B Description of the "156" program

In this section, we provide additional information about the "156" program. First, we summarize the historical context and geopolitical background. Second, we present the characteristics of the Sino-Soviet cooperation during the First Five-Year Plan. Third, we describe the characteristics of the plants built under the program and discuss how the sites were selected. Finally, we review the evolution of the Million-Rouble plants after the end of the First Five-Year Plan and describe the data used to check the robustness of the results to later events and policies.

B.1 Leaning to one side

When the People's Republic was established in 1949, World War II and the civil war had left China a poverty-stricken agrarian country. The new Communist regime was isolated, as the Western world recognized Chiang Kai-shek's Taiwan-based power as the legitimate representative of China. The wars in Korea and then Vietnam further reinforced the Communists' sentiment of being besieged. The leaders in Beijing thus had two main goals in mind: ensuring national security and economic prosperity. To achieve these goals, they planned to industrialize the economy rapidly, prioritizing heavy industry as the basis of production.[29]

China lacked resources to develop its industry, and turned to the U.S.S.R. Despite ideological proximity, economic cooperation with the Soviet Union was not obvious. Pre-1949 economic relationships between the two countries were thin, and the Komintern had repeatedly talked the Chinese Communists into supporting the Nationalists, which they then saw as the only political force able to rule China. The Soviet Union was however the only advanced economy China could turn to in the 1950s. Washington and its allies imposed an embargo that prevented Communist China from importing the technology and resources needed to develop its industrial base (Zhang, 2001). The subsequent alliance with the U.S.S.R., which Chairman Mao called "leaning to one side" (June 30, 1949), was further reinforced by the Korean War, which the U.S.S.R. fought vicariously through a Chinese "People's Volunteer Army" of 250,000 men.

B.2 Sino-Soviet cooperation and the "156" program

On February 14, 1950, the Treaty of Friendship and Alliance was signed between China and the U.S.S.R. A series of agreements ensued, paving the way for a com-

[29] In the words of future Premier Zhou Enlai, "without heavy industry, there will be no foundation for the national industry" (January 1942).

prehensive economic and scientific cooperation that spanned China's First and half of its Second Five-Year Plans (1953–1957 and 1958–1962, respectively).

The cooperation between Communist China and the Soviet Union assumed two main aspects: scientific and economic, both embodied in the "156" program. Soviet experts would be dispatched to China to advise Chinese planners. At the peak of the Sino-Soviet alliance, 20,000 experts were present in China (Zhang, 2001; Wang, 2003). Although Soviet experts were involved in all aspects of central planning, in particular during the First Five-Year Plan, their presence was the most crucial for the "156" program. They were responsible for the design and construction of the plants, and they also trained Chinese cadres and workers to run the factories and operate and maintain equipment. To ensure the sustainability of the program, 80,000 Chinese students were sent to Soviet universities and technological institutes, with the perspective of a position in one of the plants upon return.

Economic cooperation involved technology and financial transfers. Technology transfer was a major component of the "156" program in particular. The equipment supplied by the U.S.S.R. was among the most advanced at the time (Lardy, 1987).[30] Blueprints and technical documents for production were shared with Chinese engineers free of charge,[31] allowing China to gradually absorb and adapt Soviet technologies (Xiao, 2014). In the agreements that created the "156" program, the Soviet Union committed to carrying out all the design work, from choosing the sites to implementing the design, providing the required equipment and supervising construction, as well as overseeing new product manufacturing and training ordinary workers, technicians and all necessary cadres.[32]

The financial resources provided to China by the U.S.S.R. mostly consisted of loans. During his first visit to the U.S.S.R., Chairman Mao negotiated a $300,000,000 loan at the preferential rate of 1% per annum, which financed part of the "156" program. China was also to reimburse the Soviet Union for the construction of the plants by providing 160,000 tons of tungsten concentrate, 110,000 tons of tin, 35,000 tons of molybdenum concentrate, 30,000 tons of antimony, 90,000 tons of rubber, and other produce including wool, rice or tea (Dong, 1999). Some low-skilled workers were also sent to Siberia. Besides loans, Soviet cooperation did however involve an

[30] The last 15 projects agreed on in 1954 as part of the "156" program benefited from state-of-the-art equipment that few Soviet factories enjoyed (Goncharenko, 2002).

[31] See "Agreement on aid from the U.S.S.R. government to the P.R.C. government to develop the Chinese national economy" (May 15, 1953).

[32] The U.S.S.R. provided between 50% and 70% of the total value of the equipments necessary to build the plants (Dong, 1999). The remainder could be produced locally and was thus not covered by Soviet cooperation. See Chinese Academy of Social Sciences and State Archives Administration (1998).

aid component. Technological cooperation implied free transfers of blueprints and documents, the monetary value of which should not be downplayed. The U.S.S.R. also granted China product manufacturing patents that alone represented a value of about 3–3.5 million roubles (Dong, 1999).

B.3 Implementation of the "156" program

Chronology The "156" program was decided through three agreements. The first 50 plants were negotiated during Chairman Mao's first visit to the U.S.S.R. (December 1949–February 1950). On May 15, 1953, Li Fuchun and Anastas Mikoyan signed the "Agreement on aid from the U.S.S.R. government to the P.R.C. government to develop the Chinese national economy." The parties agreed on building 91 additional industrial projects, and the 141 plants were to be built between 1953 and 1959.[33] In October 1954, Khrushchev visited Beijing and signed with his Chinese counterpart a protocol to build 15 additional industrial plants, completing the Soviet-sponsored "156" program.

A total of 150 plants were complete and operational by 1960 (Dong and Wu, 2004). Because 156 projects had initially been touted and this program was held up as the cornerstone of Chinese economic development, speeches and reports continued to refer to the "156" program.

Characteristics of the plants The industrial cooperation focused on heavy industry but nonetheless spanned a wide range of sectors. Table 2 summarizes the distribution of the plants by industrial sector. A majority of plants operated in the heavy, extractive and energy sectors. China had the experience and capacity to build most light-industry factories, so that Soviet cooperation concentrated on sectors that China lacked the skills and wherewithal to develop. Military industries made up a fifth of the plants, reflecting China's two main concerns in the 1950s: economic development and national security. Final goods were also produced, in particular aircraft, machinery and weapons. The "156" program was China's first big push in the electronic industry.

The Million-Rouble plants brought about a large technological shift. The sheer size of the investments and their focus on industry was meant to transform China from a subsistence-farming to an industrial economy. The average plant constituted an investment of 130,000,000 yuan or 19,500,000 Soviet roubles in 1957, which is the equivalent of $156,000,000 in 2010 U.S. dollars. Some plants "produced many new

[33]Construction work began on average in 1954 and was completed in 1958. Mean start and end dates by sector are provided in Table 2.

products that China had never produced in history" (Li, 1955a), e.g., the Luoyang Truck Factory which produced China's first truck. Figure B1 shows a view of what is now YTO Group Corporation.

Figure B1. Contemporary view of the Luoyang Truck Factory.

Note: This figure reproduces a contemporary view of the Luoyang Truck Factory, now YTO Group Corporation. In the foreground, we can see the buildings of the Luoyang Truck Factory, constructed as part of the "156" program. Source: YTO Group Corporation website [http://www.yituo.com.cn/; accessed September 11, 2018].

Location decisions One of the main tasks of the Soviet experts was to help determine the optimal location for the plants (Li, 1955b).

Bo Yibo, a prominent leader personally involved in the design of the "156" program, outlines four main criteria guiding the location decision process (Bo, 1991). Plants had to be built close to natural resources to reduce transportation costs and avoid waste. Places easily accessible through the road and railway network should be favored, so as to reach down- and upstream firms and end-consumer markets at a lower cost. Regions with no pre-existing industrial base would be given priority. Conditional on meeting these first criteria, state-of-the-art Soviet-sponsored plants were to be built out of the reach of U.S. and Taiwanese bombers.

The first two criteria were meant to select optimal locations from an economic point of view. A lot of effort was put at the time into ensuring that plant sites made economic sense. Numerous Soviet textbooks on factory location choice were translated and adapted in 1950s China, and the text of the First Five-Year Plan contains a whole section on rational plant location based on geography. A Russian-Chinese thesaurus with a special focus on factory location choice was also published. Soviet plant location textbooks emphasized the importance of pre-selecting several locations, comparing them based on a list of objective criteria and making field trips to the short-listed sites. Among the main criteria were easy access to natural resources, transportation network and markets.

The third criterion does not appear as a goal in its own right in other sources.

A significant share of the "156" plants were built in previously agrarian regions, but possibly because the threat of U.S. and Taiwanese air strikes called for industrializing the hinterland. This third criterion is however a common feature of place-based policies, as policy makers are often willing to correct perceived inequalities in the spatial distribution of economic activity.

Soviet experts recommended, in order to minimize costs, that priority be given to expanding existing plants. Stalin expressed this idea himself in a 1952 conversation with Zhou Enlai,[34] although he also advised the Chinese to build *new* plants, in particular defense industry factories, far away from the coast and borders, a lesson the U.S.S.R. had bitterly learnt in World War II. Chairman Mao was apparently responsible for making military security a major tenet of the "156" program, only a few days before the First Five-Year Plan was officially adopted (Xia, 2008).[35] An example of the attention paid to military security is the Rehe Vanadium and Titanium Factory, originally located at Nü'erhe, near Jinzhou, Liaoning province. On May 16, 1955, the Heavy Industry Department issued a report arguing that this location, about 10 kilometers from the Gulf of Bohai, did not follow closely enough the "not building, not expanding in coastal areas" principle. They instead recommended that Soviet experts reconsider the site. The plant was eventually built in Shuangtashan, near Chengde, Rehe (today, Hebei) province, 100 kilometers away from the sea (Chinese Academy of Social Sciences and State Archives Administration, 1998). Most Million-Rouble plants were constructed along this "Second Front".

In 1953, China's aviation was non-existent, which explains the importance of Soviet military protection[36] The People's Liberation Army only developed an aviation thanks to Soviet support and because of the pressing needs of the Korean War. One of its pioneer pilots and later vice-commander of the Nanjing Air Command, recalled that "when Chairman Mao declared that China would join the Korean War, the Chinese air force did not have one operational unit that could [be] put into the air" (Bergin, 2013). Even after the Korean War, China's air force was recognized as woefully inadequate.[37] The Chinese government would thus shelter the brand new

[34] "Minutes of Conversation between I.V. Stalin and Zhou Enlai," September 03, 1952, History and Public Policy Program Digital Archive, APRF, f. 45, op. 1, d. 329, ll. 75-87. Translated by Danny Rozas. Available at http://digitalarchive.wilsoncenter.org/document/111242.

[35] The concern with enemy attacks of the new plants can also be seen from the pages of the *Russian–Chinese Technical Thesaurus: with reference to factory location choice* (1954): "Shelter, air-raid dugout" unexpectedly features among the characteristics that a factory must have.

[36] Whatever was left from World War II was either taken to Taiwan or sabotaged by the Nationalists before their exile. Chongqing's Baishiyi airfield, for instance, fell victim to such scorched-earth policy and could not be used between 1949 and 1959, when it was eventually rebuilt.

[37] Another of China's first pilots interviewed by Bergin, and later chief pilot of China's first indigenous aircraft, recounts that "Soviet Premier Nikita Khrushchev said that without Soviet help, the Chinese air force would become a Chinese ground force in three months" (Bergin, 2013).

"156" plants close to allied airbases. The 1950 Treaty of Friendship and Alliance indeed assured them that the Soviet Union would defend China in case of foreign aggression. Bo, who was personally involved in plant location decisions, reports that senior military officials took part in the deliberations: "when examining plant locations, [they] would place plant sites on a map", along with all U.S. bases in Taiwan, South Korea and Japan, to determine "which types of American planes could attack which sites" (Bo, 1991).

B.4 Evolution of the plants

This paper studies the effect of the Million-Rouble plants over the long run; it is thus critical to understand what they became after the end of the First Five-Year Plan (1953–1957). In what follows, we describe the evolution of the MRPs through the end of the First Five-Year Plan, the Sino-Soviet split, the Cultural Revolution and the introduction of economic reforms.

End of the First Plan and Sino-Soviet split The Sino-Soviet cooperation survived beyond the First Five-Year Plan: 102 of the "156"-program plants became operational during the Second Five-Year Plan. This was not so much due to delays as to the original agreements between Beijing and Moscow, most of the plants were to be completed after 1957. Two similar agreements were signed on August 8, 1958 and February 7, 1959 to expand Sino-Soviet cooperation and build 125 additional large plants, which were to be built during the Second and Third Five-Year Plans. The 1960 split however severely curtailed this second wave of investments. The "156" plants thus constitute the only complete, large-scale industrialization program carried out in China thanks to Soviet cooperation.

Sino-Soviet relations were strained in the late 1950s by rapid ideological divergence. After Stalin's death, ideological and political tensions started to rise with Khrushchev's condemnation of his predecessor's crimes in 1956 and his policy of "peaceful coexistence with the West." As China kept encouraging a Stalin-like cult of Mao's personality, experimented with disastrous grass-roots industrialization during the Great Leap Forward—the polar opposite of orthodox Soviet central planning,—and pursued aggressive foreign policy, the normalization of the Soviet regime and prospect of *détente* between the two superpowers could only worry Chinese leaders.

The Sino-Soviet split materialized in 1960 when Soviet experts and Chinese students were suddenly repatriated. Incomplete projects that were not viable were abandoned, while future investments were canceled. Six of the "156" plants were not operational and could not be completed without Soviet support and were closed.

The split induced a dramatic shift in China's alliances and conception of national security. The sites that had been carefully selected because they could benefit from Soviet or North Korean protection now appeared vulnerable. Subsequently, Mao launched in 1964 the "Third Front Movement" (*Sanxian jianshe*), a new wave of industrial investments (mostly in heavy industry) directed at remote inland areas.

Third Front Movement The Third Front Movement, which covers the period 1964–1980, is notorious for the costly moving of plants and workers, from sensible locations to places "close to mountains, dispersed and hidden" (*kaoshan, fensan, yinbi*). Such spectacular moves were however the exception rather than the norm: they should be restricted to strategic military industries, remain exceptional and not be carried out on a large scale.[38] "First-front" industries (on the coast and in major cities) would be primarily affected, as they were deemed the most vulnerable to foreign attacks, while the "second-front" industries, to which the "156" factories belong, had been recently built. The motto for the "156" plants was therefore to continue developing them as previously planned. Three plants built under the "156" program were however entirely or partly moved. A first check of the robustness of the rise and fall pattern observed in the paper is to exclude these displaced investments (see Appendix Table A3, Panel B). In this exercise, we also exclude 15 Million-Rouble plants that closed down during the reform era; almost all of them operated in the extractive sector and went into liquidation because of the depletion of the natural resource they exploited.

A concern with the Third Front Movement is that, although second-front industries, and the "156" plants in particular, were largely unaffected, massive investments were directed toward other provinces, which may have hurt the economic environment of the Million-Rouble plants. To check whether Third Front investments diverted resources away from the treated counties and explain their decline in the second period, we use the list of Third Front province from Fan and Zou (2015). Table A3, Panel G, controls for concurrent policies and includes an indicator variable equal to 1 if a county belongs to a such a province and 0 otherwise. We find that this control does not alter the results.

The Third Front Movement and "156" program both incorporated military imperatives in plant location decisions, but they were designed in different geopolitical situations. We show the induced variation in vulnerability in Figure 4, and we condition for the later vulnerability in our baseline specification.[39]

[38] *Comrade Fuchun's summary report to the National Planning Meeting*, October 20, 1964.

[39] In the right panel of Figure 4, we measure vulnerability in 1964, at the onset of the Third Front Movement. The effects are similar if we control for a milder version of 1964 vulnerability,

Cultural Revolution A few years after the construction of the Million-Rouble plants had been achieved, Chairman Mao launched the "Great Proletarian Cultural Revolution." This movement, which officially lasted between 1966 and 1976, triggered a period of political turmoil that mostly affected urban areas and large enterprises. Industry valued added dropped from 44.6 to 12.6 million Chinese yuan (in constant 1990 prices) between 1966 and 1967, and it would not recover until 1980 (Dong and Wu, 2004). Because they were more industrialized, the counties treated under the "156" program may have suffered disproportionately from the Cultural Revolution, and the disorganization of production may have affected their trajectory beyond 1976, leading to the rise-and-fall pattern that we observe.

To control for the effect of the Cultural Revolution, we use data collected from 2,213 local annals (*difang zhi*)—see Walder (2014). Information about the number of "casualties" from the Cultural Revolution was culled from the historical narratives included in the annals. "Casualties" can be divided into two categories: the number of "unnatural deaths" and number of "victims," which may refer to any type of political persecution from expulsion to public beatings. Because the county annals were encouraged but not required to publish any figures about Cultural Revolution violence, assumptions need to be made to deal with missing information. We first follow Walder (2014) and code missing values as 0 even if the narrative does refer to casualties but without stating a figure. Alternatively, we replace missing values by (i) the provincial average, (ii) the maximum in the province and (iii) the minimum in the province. Appendix Table A3, Panel G, uses the casualty data to condition for Cultural Revolution violence, distinguishing between "deaths" and "victims." Including these controls does not alter the results; the disruption created by the Cultural Revolution does not explain the decline of treated counties.

Economic reforms The transition from central planning to a more market-oriented economy may have dealt a severe blow to the state-owned "156" plants.

The Million-Rouble plants weathered the economic regime change quite well. Only 15 plants closed down, and the decline of treated counties between 1982 and 2010 is not due to Million-Rouble plants going bust (see Appendix Table A3). About a third of the "156" plants evolved into large, diversified industrial groups (*jituan*). One such *jituan* is Ansteel, which evolved from the Anshan Iron and Steel Company and is now listed on the Shenzhen and Hong Kong Stock Exchanges. Figure B2

considering U.S.S.R. and North Korean as neutral rather than as threats. We also find the same rise-and-pattern if we control for vulnerability to U.S. or Taiwanese bombings in 1990, i.e., following the collapse of the Soviet Union and using the locations of airbases in that year. (Results available upon request.)

displays a picture of the main plant in 2016.

Figure B2. Entrance of the main Ansteel group plant in 2016.

Source: Ansteel Group Corporation (2016).

We further rely on the NBS above-scale survey (1992–2008) to shed light on the evolution of the Million-Rouble plants—see Appendix D for a description of the procedure followed to match plants with firms and a comparison of the Million-Rouble plants with other firms in the same county. We find that (i) most plants are still active today (94 of the 125 Million-Rouble plants that operated in the manufacturing sector could be identified) and (ii) they are on average four times as productive as other above-scale firms (controlling for size; see Table D1 and the detailed discussion in Appendix D).

Another major feature of China's development since the 1980s is the creation of Special Economic Zones and various types of industrial parks. These may have attracted production factors because of the promise of superior returns despite treated counties being productive and still growing. To test for this factor, we use industrial parks data from Zheng et al. (2009). The data are at the prefecture level and provide us with the number of industrial parks extant in a prefecture at some point in five-year intervals, covering the period 1980–2005. Appendix Table A3 controls for the total number of industrial parks in the prefecture in and shows that the results are robust to this place-based policy.

C Vulnerability to air strikes

This paper uses two measures of vulnerability to enemy bombings: (i) at the beginning of the "156" program, as a source of exogenous variation in the locations of the Million-Rouble plants, and (ii) at the onset of the Third Front Movement, as a control for the effect of that policy.

These measures are computed in the same way, except that the 1953 vulnerability models the protection afforded by Soviet and North Korean allies, while the 1964 vulnerability considers Soviet and North Korean airbases as threats, reflecting the geopolitical environment after the Sino-Soviet split in 1960.

C.1 Vulnerability at the beginning of the "156" program (1953)

When the "156" program was being designed, China benefited from the 1950 Treaty of Friendship, Alliance and Mutual Assistance. Not only were the U.S.S.R. and North Korea friendly neighbors; China could count on their protection in case of American or Taiwanese aggression, as stipulated by the Treaty.

Flying cost We assume a constant default flying cost over the Chinese territory and model Soviet and North Korean protection as an additional cost for U.S./Taiwanese bombers. This penalty is defined as follows:

$$f(d, d') = \alpha(1 - e^{-gd'}) \cdot \frac{e^{a(\bar{x}-d)} - e^{-b(\bar{x}-d)}}{e^{a(\bar{x}-d))} + e^{-b(\bar{x}-d))}} + C,$$

where d is distance to the closest U.S.S.R./North Korean airbases and d' is distance to U.S. airbases, in kilometers. The parameter α calibrates the maximum penalty in the immediate neighborhood of U.S.S.R/North Korean bases. The dependence of the penalty to distance to U.S.S.R/North Korean bases is modeled as a hyperbolic tangent: The penalty vanishes as distance d goes to infinity, increases as d decreases, and reaches a plateau near the airbase. The parameter a (b) disciplines the curvature of the hyperbolic tangent function for low (high) values of d. The inflection points are tied to the value of $\bar{x}$. Finally, the dependence of the penalty to distance to U.S. bases is disciplined by g. This parameter determines how the cost paid by U.S. bombers for traveling near U.S.S.R/North Korean bases is mitigated by the proximity to U.S. bases.

We add $f(d, d')$ to the constant cost raster (set to 1) and compute the penalized travel time from U.S./Taiwanese airbases to every Chinese county.

Parameterization We set the key parameters based on declassified CIA technical intelligence documents from the early 1950s. Such documents show the information available to U.S. intelligence on Soviet military technology, obtained from spies and through the reverse-engineering of fighter jets downed during the Korean War. We assume that the Soviet similarly derived information about U.S. military technology, and expected the Americans to know theirs equally well. In keeping with the 1950 Treaty, Soviet military advisers shared their information with their Chinese counterparts, in particular to determine the location of the Million-Rouble plants.

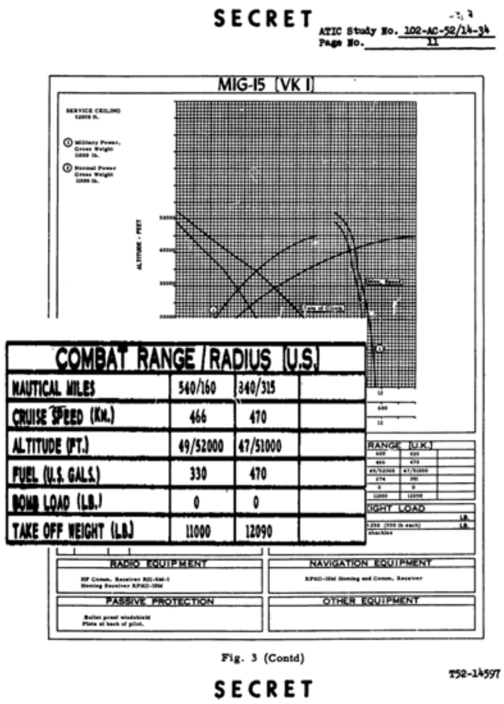
American bombers in the 1950s, like the B-52s, could technically reach any point in China without refueling. However, bombers could be neutralized by interceptors, stationed in allied airbases. Declassified CIA documents such as the one reproduced in Appendix Figure C1 provide us with information on the ranges of the main Soviet interceptor (used both in North Korea and the USSR), the MiG-15, and the main American jet fighter at the time, the F-86 Sabre. We use the maximum range of the interceptors under "military power" and we define $\bar{x}$ as half the maximum range of Soviet interceptors (840 nautical miles or 1,555.68 km—see the table in Figure C1) and determine a and b such that 95% of the decrease in flying cost occurs over that range. Similarly, g is set so that 95% of the protection enjoyed by American bombers close to their bases occurs within the maximum range of the F-86 Sabre. Finally, α and C are set equal and such that Chinese counties protected by Soviet and North Korean airbases are as safe as remote western counties.

C.2 Vulnerability at the time of the Third Front Movement (1964)

Our measure of vulnerability to U.S. and Taiwanese air strikes at the beginning of the "156" program may be correlated with vulnerability in later periods, which may have motivated spatial policies that affected our outcomes of interest. We create an alternative measure of vulnerability to air strikes after the 1960 Sino-Soviet split; we focus on 1964, which corresponds to the onset of the Third Front Movement.

The Third Front Movement was motivated by the Sino-Soviet split: China no longer enjoyed protection from Soviet and North Korean airbases against American or Taiwanese attacks. Moreover, formerly allied airbases now presented a threat. To reflect this new geopolitical situation, we alter the cost mapping in the following way. We assume that the cost of crossing a cell is constant; vulnerability is thus measured by (non-penalized) travel time for a bomber from its base. We consider not only former American and Taiwanese bases, but also Soviet and North Korean airbases as threats in addition to American airbases that were opened in Vietnam between the beginning of the "156" program and the onset of the Third Front Movement.

Figure C1. Declassified CIA technical intelligence studies—MiG 15.



Sources: CIA technical intelligence study No. 102-AC-52/14-34, "Soviet Operational Interceptor Aircraft" (3 September 1952).

The resulting vulnerability measure is mapped in the right panel of Figure 4. We see that some areas that were protected by the Soviet and North Korean allies, such as the northeast and to a lesser extent counties bordering Mongolia, are now extremely vulnerable. Central provinces, removed from both U.S./Taiwanese and Soviet bombing threats, are now the safest. This is where Third Front Movement investments were concentrated (see Fan and Zou, 2019).

We further create a vulnerability measure corresponding to the geopolitical situation after 1990. We assume that following the fall of the Soviet bloc, the U.S. became again the only military threat to China, and we calculate the vulnerability to American and Taiwanese air strikes with neutral Russian and North Korean bases.[40] As for the other scenarios, we use the locations of airbases active at the time.

[40]This last scenario can also be interpreted as a milder version of the Sino-Soviet split: Soviet and North Korean airbases do not grant China protection against American bombers but do not constitute a military threat either.

D Firm comparison within treated places

The rise-and-fall pattern experienced by treated counties could potentially reflect the experience of the Million-Rouble plants themselves. Local economies may have thrived following the physical capital investments of the "156" program and then declined as this capital depreciated. Such a co-evolution of the Million-Rouble plants and local economies may have obtained because of (i) the sheer size of the "156" plants in the local economies and (ii) spillover effects.

In this Appendix, we investigate the evolution of the Million-Rouble plants and whether they might have dragged other firms down. To this end, we identify the "legal units" (*faren danwei*) descended from the Million-Rouble plants in the annual firm survey data described in Section 2. We develop a fuzzy matching algorithm based on firm names, locations and creation dates, and check manually the quality of the results. We can match 94 or 75% of the 125 Million-Rouble plants that operated in the manufacturing sector

Size in the local economy Table D1 relies on the identification of the Million-Rouble plants in the "above-scale" firms to compute the share of the Million-Rouble plants in the economies of treated counties. Over the period 1992–2008, Million-Rouble plants accounted for a moderate share of the economic activity in treated counties: they represent 2.6% of manufacturing employment, 4.3% of the total wage bill in that sector, 6.0% of revenue, 4.4% of value added and 2.8% of profits.[41]

Table D1. Share of the "156" factories in local economies.

	Employment	Compensation	Revenue	Value added	Profits
	(1)	(2)	(3)	(4)	(5)
Share	0.026	0.043	0.060	0.044	0.028
	(0.169)	(0.273)	(0.378)	(0.304)	(1.654)
Observations	938	938	938	938	938

Notes: Standard deviations are reported between parentheses. The sample consists of all treated counties where at least one firm in the NBS annual "above-scale" surveys was identified as descended from one of the "156" factories. It covers the period 1998–2007, for which the dependent variables are available. For each variable, the table displays the share of such factories, e.g., *Employment* is the share of those factories in local manufacturing employment (1992–2008). *Revenue* refers to total sales. It is available in 1996–2007, except for 1997. *Compensation* (1996–2008, except for 1997) combines wages, housing subsidies, pension and medical insurance, and welfare payable. *Value added* is available between 1998 and 2007, 2004 excluded. *Profits* are defined as value added minus total compensation. They are available from 1998 to 2007, except for 2004. The unit of observation is a prefecture × year × industry (2-digit, Chinese Industrial Classification).

[41]Not all "156" factories have been matched to firms in the "above-scale" data. These figures are thus lower bounds.

Productivity Table D2 compares the Million-Rouble plants with other firms within treated counties along various measures of productivity. As productivity may be systematically correlated with firm size, all regressions control for employment. We further include county, year and two-digit industry fixed effects in all specifications.

Establishments descended from the "156" plants differ significantly from other establishments of similar size, and these differences are economically large. First, they exhibit a much higher share of high-skill (i.e., college-educated) employees.[42] This share is 12 percentage points higher in Million-Rouble plants, from an average of 22% among the other firms. Column 2 shows that compensation per worker is also (albeit not significantly) higher, which probably reflects the quality of the workforce.[43] Second, value added per worker is four times higher. Third, we look at factor productivity measures developed by Imbert et al. (2018). These measures, based on industry-specific CES production functions identified using an exogenous labor supply shifter, show a large and consistent productivity differential. The Million-Rouble plants are three to four times as productive as other firms in treated counties in terms of the marginal product of labor, marginal product of capital and total factor productivity. Finally, a large literature (e.g., Song et al., 2011) highlights the lower productivity of state-owned enterprises during the transition in China. Column 7 looks at an indicator variable for public ownership. We find that the Million-Rouble plants do not significantly differ from the other firms in treated counties in terms of ownership.

[42] The disaggregation of the workforce by educational attainment is available only for 2004 (year of the Economic Census, when additional variables were collected).

[43] This result also holds when looking at wages. In addition to wages, compensation includes housing subsidies, pension and medical insurance, and welfare payable.

Table D2. Comparison of MRPs and other manufacturing firms within treated prefectures.

	High-skilled	Compens.	VA per worker	MPL	MPK	TFP	Public
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MRP	0.120	0.125	1.436	1.439	1.180	1.413	-0.019
	(0.046)	(0.163)	(0.608)	(0.745)	(0.556)	(0.557)	(0.190)
Observations	12,786	77,147	77,147	77,147	77,147	77,147	77,147
County FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported between parentheses. All regressions are estimated with Ordinary Least Squares and include industry (2-digit CIC), county and year fixed effects. The main explanatory variable, *MRP*, is a dummy equal to 1 if the firm was originally founded under the "156" program, and 0 otherwise. The sample consists of all firms in the treated counties where at least one firm in the NBS annual "above-scale" surveys was identified as descended from one of the "156" plants. We further restrict the sample to observations with non-missing data on compensation, value added and factor productivity. *High-skilled* is the share of college-educated employees in the firm's work force (only available in 2004). *Compensation* (1996–2008, except for 1997) combines wages, housing subsidies, pension and medical insurance, and welfare payable, divided by total employment. We take the natural logarithm. *Value added* is available between 1998 and 2007, 2004 excluded. It is expressed in logarithms and normalized by employment. *MPL*, *MPK* and *TFP* are marginal product of labor, marginal product of capital and total factor productivity measures, respectively, estimated using a CES production function with industry-specific elasticity of substitution between capital and labor—see Imbert et al. (2018). *Public own.* is an indicator variable equal to 1 if the firm is publicly owned, and 0 otherwise. The unit of observation is a firm×year.