The Costs of Leader Biases: Evidence from Superstitious Chinese Mayors*

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Abstract

Biased and false beliefs – such as denialism and superstitions – influence human decision-making, potentially including key individuals that wield considerable economic and political power. In this paper, we document the substantial macro-level impact of leaders' misbeliefs in China, exploiting prevalent traditional beliefs that allow us to link quasi-random, leader-specific spatial biases to regional development within cities. We find that municipal zones perceived as unfavorable to mayors (i.e., subject to mayors' over-pessimism) have an average 2 percent lower GDP compared to other zones. Exploiting mayoral reports and administrative micro-level data, we show reduced policy support and public investment as the key drivers. Downstream changes in firms and households further amplify the loss, with a 6% decrease in firm entry, a 4% reduction in the productivity of remaining firms, and a small population decline. Our back-of-the-envelope calculation suggests Chinese mayors' spatial misbeliefs are associated with at least a 0.1% annual GDP loss over the past two decades. Overall, our findings highlight subjective beliefs as an important determinant of leader performance, contributing to a deeper understanding of why leaders matter for economic development.

JEL classification: D73, H70, R10, P00, Z10

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1 Introduction

Leaders matter: their individual decisions influence the performance of organizations and states (e.g., Bertrand and Schoar, 2003; Jones and Olken, 2005; Ottinger and Voigtländer, 2021; Bai, Jia and Yang, 2023). To understand organizational performance, it is therefore crucial to understand leaders' preferences and beliefs. The former is well-studied, and includes (among others) monetary gains, promotion, and social welfare. Yet their policies are also affected by their subjective beliefs over states of the world. To the extent that leaders' beliefs are biased and misspecified, they can impose substantial costs on the economy (World Bank Group, 2015).

In this paper, we provide the first systematic evidence on the macro-level impact of individual leaders' misbeliefs. We show that Chinese mayors' traditional beliefs about spaces (that some individual-specific zones are unfavorable for development according to superstitions) significantly impact regional disparities: Mayors' unfavorable zones have a 2% lower GDP relative to other areas in the same city. We further calculate that these non-factual beliefs are associated with a real GDP loss of more than 0.1% for the country overall, due to lower public investment and poorer firm outcomes in affected zones. Our findings contribute to the broader agenda of understanding why leadership matters for economic growth.

In his seminal work on European leaders, historian Frederick Adams Woods identifies a monarch's personal beliefs – apart from their capacity and networks – as an important determinant of state performance (Woods, 1913). A rich qualitative record validates this view, even in a modern context. For instance, the Reagans were known to incorporate astrology in their event planning while in the White House, and there are even claims that these beliefs played a role in shaping President Reagan's stance toward the Soviet Union. In South Africa, President Thabo Mbeki's misbelief about HIV and herbal remedies resulted in an estimated 330,000 premature deaths. In India, sitting chief ministers seldom visit Noida City, due to an age-old taboo that doing so may lead to electoral defeat.[1] However, it remains challenging to establish the causal impact of leaders' subjective beliefs on development, due to the difficulty of separating the role of beliefs from other confounders, conducting large-scale experiments involving leaders, and linking beliefs to real economic consequences. To make progress on these fronts, the ideal setting would feature a large sample of comparable leaders, with quasi-random, individual-specific variation generated by one set of beliefs that clearly map to economic or

[1] For details about these anecdotal accounts, see: https://www.nytimes.com/1988/05/04/us/white-house-confirms-reagans-follow-astrology-up-to-a-point.html, https://www.hsph.harvard.edu/news/magazine/spr09aids/, and https://www.indiatimes.com/explainers/news/assembly-elections-2022-superstitions-myths-jinxes-in-indian-politics-559729.html.

policy outcomes.

In this paper, we study the economic consequences of non-factual beliefs among high-level municipal leaders in China. The particular set of beliefs we focus on allows us to address the empirical challenges described above. Specifically, we exploit prevalent spatial superstitions in Asian societies, which enable us to link differences in regional development – an important economic outcome – to individual leadership. Broadly speaking, such beliefs persist in the population we study: An internal anonymous survey by the *National Academy of Governance* in 2007 revealed that over 52.4% of surveyed Chinese officials held superstitious beliefs in some form.[2] While such traditional beliefs remain significant in many Asian countries, the Chinese setting is particularly well-suited for two reasons. First, in China, these non-factual beliefs are individual-specific: certain directions are deemed unfavorable for specific individuals (as these zones are thought to bring unexpected bad outcomes), a determination based on their birth time and ancient astrological rules. For example, for those who were born in July 1958, southwestern and northwestern regions are considered unfavorable (using one's residence as the origin), whereas for those born in August 1958, western regions are unfavorable.[3] As such, leaders may be over-pessimistic about some certain regions within their jurisdiction, independent of other factors. Second, political leaders play an important role in China's economic growth, and their frequent turnover generates rich within-region variation in leadership for identification (Li and Zhou, 2005; Yao and Zhang, 2015).

The leaders in our study are the city leaders. A city, or prefecture, is considered the basic unit of residence and local market in China. An average city has approximately 3 million residents and includes 8.5 subordinate counties.[4] Each city is co-governed by a Party Secretary, who maintains greater political authority to set general agendas and oversee personnel work, and a Mayor, who heads the government agency and is in direct charge of formulating and administering socioeconomic policies (Fang, Li and Wu, 2022). While subordinate counties retain a degree of autonomy, critical policies and investment necessitate the endorsement of city leaders. Accordingly, city leaders' spatial misbeliefs – which can make them over-pessimistic about projects in their "unfavorable" zones – may lead to lower government inputs

[2] See https://www.reuters.com/article/lifestyle/half-of-chinas-local-officials-superstitious-idUSPEK169068/ and https://www.cas.cn/xw/zyxw/yw/200705/t20070511_1021150.shtml.

[3] Figure A1 provides a visualization of how the Chinese belief system defines different zones. In Chinese society, these beliefs are commonly referred to as *Feng-shui*. Similar traditional beliefs exist in other societies, such as *Vastu* in India and *Kumalak* in Central Asia. The Chinese tradition emphasizes individual-specific applicability, providing an ideal setting for causal identification.

[4] A city ranks below provinces and above counties as the second-level administrative division in the country. As of 2020, China is officially divided into 333 city-level divisions, consisting of 2,851 county-level divisions.

and potentially impede economic development. Moreover, firms and households may also react to government-side changes, further aggravating the economic loss in affected zones.

For our analysis, we construct a new dataset that captures the predicted spatial superstitions of all Chinese city leaders between 2000 and 2018. Combining leaders' birth-time information with the input of expert astrologists, the dataset identifies the unfavorable zones, if any, for each leader (e.g., southwest and northwest for leaders born in July 1958; west for leaders born in August 1958). We then determine whether a county falls within leader-specific unfavorable zones during a particular year, using its orientation to the city government headquarters where the leaders work and also live.

The turnover of city leaders in China generates frequent and idiosyncratic shocks among subordinate counties. These within-county shocks allow us to compare a given county's development when it is located in an unfavorable zone of its city leader versus when it is not, relative to other non-treated counties. We show that the ever-treated counties and never-treated counties in our sampled period (2000 - 2018) share similar ex-ante geographic, demographic, and economic conditions in 1999. Moreover, a county's past socioeconomic outcomes do not systematically predict its treatment status under future city leaders. These patterns collectively bolster the validity of our empirical design.

Turning to our main results, we find that leaders' misbeliefs about spaces have substantial economic consequences. Counties located in leaders' over-pessimistic zones experience a 2 to 3 percent relative decrease in GDP, compared with other counties under their governance. To put this disparity into perspective, it is about a third of the hometown favoritism effect documented in the existing literature (Hodler and Raschky, 2014). The effects are primarily driven by mayors, the officials that are in direct charge of socioeconomic affairs.[5] The impact is greater for mayors from more superstitious hometowns, as measured by the share of believers in each hometown from a representative social survey. Our results remain robust under alternative measures and specifications, and a randomization inference test corroborates our findings are not driven by outliers. To assess dynamic and longer-run implications, we further adopt an event-study framework. The results show no differential trends for to-be-treated counties, yet it takes an average of three to four years for treated counties to catch up after existing treatment status.

We then investigate the mechanisms driving the documented growth disparity. Guided by a simple theoretical framework, we document that mayors provide relatively lower policy

[5] Our findings on mayors' roles are in line with prior research (e.g., Cao, 2022; Fang, Li and Wu, 2022).

support and public investment in their over-pessimistic counties, and also that subsequent firm-side and citizen-side changes magnify the impact. A textual analysis of government work plans shows that these counties are mentioned less frequently in mayors' development plans and associated with less positive sentiment. Using government expenditure statistics and administrative land use records, we observe a consistent decline in public investment, particularly for transportation infrastructure that can likely facilitate productivity in the near term. Further disaggregating the impacts on projects by approval authority (i.e., mayors versus subordinate counties), we confirm that it is the mayors themselves who reduce inputs in their over-pessimistic zones. In addition, changes in public investment in neighboring non-treated zones are relatively modest. These patterns corroborate leader-driven shifts in government inputs as the leading mechanism.

We then show firm dynamics and household reactions as downstream mechanisms. Using 1.8 million administrative firm-year level observations, we find that industrial firms remaining in treated counties hire fewer employees and invest less, and are also less productive as measured by firm-level total factor productivity (TFP). On the extensive margin, these counties experience slower growth in the number of firms, primarily due to a decline in firm entry. We additionally provide suggestive evidence that such changes reflect worse allocative efficiency. Treated counties also see a relative decline in population and employment. Although more speculative, these patterns reflect potential labor relocation in response to deteriorating economic conditions, which can further aggravate economic losses in treated zones.

Having established substantial distributional impacts, we move to assess the aggregate output cost for China overall. We leverage two different empirical designs to account for cross-county spillovers and to benchmark the macroeconomic significance of our findings. First, we use a cleaner set of control counties (that are not adjacent to a treated one) to re-estimate the impact on treated counties. Doing so reduces the estimated coefficient on GDP from -2.3 percent to -2.1 percent, representing about an 8% decrease when accounting for within-city spillovers. This indicates that the growth disparity is mostly driven by a real economic loss in treated regions, and our baseline estimate is close to the treatment effect in absolute terms.[6] Second, we move the analysis to a higher level of aggregation – the city level, which corresponds more to the local market – to subsume inter-regional spillovers in subordinate counties (Criscuolo et al., 2019; Siegloch, Wehrhöfer and Etzel, 2024). Specifically, we leverage the different scope of

[6]It is worth noting that the number of adjacent counties is 3.5 times greater than that of treated counties, so total spillovers are likely to be spread out among these adjacent counties, a factor we account for when calculating the overall GDP loss.

treatment — measured by the share of population or area affected in a city — attributable to the pre-existing differences in city shapes. We find a lower aggregate output when a city has more shares of its area or population affected by mayors' spatial biases. Our back-of-the-envelope calculation based on either approach yields a comparable estimated aggregate cost, which is at least 0.1% of China's GDP per year. This translates to an annual cost of over 40 billion Yuan (about 6 billion USD).

We close by exploring whether there are factors that could mitigate the influence of leader biases. Consistent with cross-country evidence (Jones and Olken, 2005; Ottinger and Voigtländer, 2021), we find that institutions matter: the influence of mayor misbeliefs is diminished in regions with less interventionist governments, measured by government business-related expenditures over GDP and marketization scores (Jia, Lan and Padró i Miquel, 2020; Wang, Fan and Hu, 2018). In contrast, less-institutional factors such as ideological training have no salient impacts.

Collectively, this paper contributes to three main strands of literature. To our knowledge, we present the first causal analysis establishing the role of leaders' subjective beliefs in development, speaking to long-standing theories of leadership by scholars and the public. Our findings thus add to the broader literature on the impacts of key individuals on organizations and economies, including political leaders (Jones and Olken, 2005; Besley, Montalvo and Reynal-Querol, 2011; Easterly and Pennings, 2020; Dube and Harish, 2020; Dippel and Heblich, 2021; Ottinger and Voigtländer, 2021; Bai, Jia and Yang, 2023; Funke, Schularick and Trebesch, 2023) and firm managers (Bertrand and Schoar, 2003; Malmendier and Tate, 2005; Fenizia, 2022; Otero and Munoz, 2022). A growing body of work documents that past experiences and identity can contribute to leader performance, and a key conceptual channel through which these factors operate is their influence on personal beliefs.[7] However, it is challenging to separate the causal role of individual beliefs in politics (Levitt, 1996; Washington, 2008), and empirical evidence has largely been limited to qualitative accounts. Our setting allows us to quantify the significance of such distortions in a large and important polity. Moreover, our heterogeneity analyses add to the cross-regime evidence on the interaction between leadership and institutions (Jones and Olken, 2005; Clark, Murphy and Singer, 2014; Besley and Reynal-Querol, 2017; Ottinger and

[7] See for example: leader gender (Chattopadhyay and Duflo, 2004; Clots-Figueras, 2011; Ferreira and Gyourko, 2014; Brollo and Troiano, 2016; Besley et al., 2017; Dube and Harish, 2020; Lippmann, 2022), ethnicity (Hodler and Raschky, 2014; Burgess et al., 2015; Nye, Rainer and Stratmann, 2015; Beach and Jones, 2017; De Luca et al., 2018; Assouad, 2020; Logan, 2020), and religious identity (Bhalotra et al., 2014; Bhalotra, Clots-Figueras and Iyer, 2021; Wang, 2021). For leader experience, see for example: Göhlmann and Vaubel (2007), Washington (2008), Dreher et al. (2009), Diaz-Serrano and Pérez (2013), Jochimsen and Thomasius (2014), Mercier (2016), Van Effenterre (2020), Carreri and Teso (2021), Li, Wang and Zhang (2023), Guo, Gao and Liang (2023), and Jain et al. (2023).

Voigtländer, 2021; Martinez, 2022).

Second, we contribute to the literature on culture and development (Guiso, Sapienza and Zingales, 2006; Nunn, 2022). While prior work has shown that collective cultural practices affect growth (Campante and Yanagizawa-Drott, 2015; Schofield, 2020; Montero and Yang, 2022), we demonstrate that cultural beliefs of key individuals can generate aggregate economic impacts. The cultural aspect in our study – beliefs in supernatural forces – is also of relevance given its ubiquity and persistence across societies (Leeson, 2012, 2013; Gershman, 2015; Leeson and Suarez, 2015; Nunn and Sanchez de la Sierra, 2017). Economists have recently begun to quantify the role of religious and other non-standard beliefs in shaping individual and community behavior.[8] We contribute by adding to the very limited work in the context of politics (Lowes et al., 2023), which features high-stakes decision-making affecting millions of citizens. In addition, we expand the agenda beyond Abrahamic and African belief systems to those in Asia (Chen, Ma and Sinclair, 2022; Ciscato, Do and Nguyen, 2023; Becker, Rubin and Woessmann, 2024). The quasi-random nature of spatial biases leveraged here also opens doors to more empirical research to further understand how beliefs impact policy.

Finally, we see our findings as contributing to the flourishing work on the Chinese bureaucracy, and more generally incentives and performance in public organizations (Finan, Olken and Pande, 2017; Besley et al., 2022). Our results echo the findings of recent empirical work showing that a proportion of variation in state performance can be attributed to individual decisions (e.g., Fenizia, 2022; Otero and Munoz, 2022; Best, Hjort and Szakonyi, 2023).

2 Background

2.1 Spatial (Mis)beliefs as an Ideal Source of Variation

Traditional beliefs associating spaces with the supernatural remain prevalent across Asia (e.g., *Fengshui* in China, Singapore, and Korea; *Fusui* in Japan; *Vastu* in India; and *Kumalak* in Central Asia). These superstitions typically link good or bad to certain spaces relative to one's residence or workplace, distorting perceptions about the merits of activities or investment in specific areas. To leverage individual-specific variation for causality, this paper exploits the

[8]See for example: Clingingsmith, Khwaja and Kremer (2009), Halla, Liu and Liu (2019), Le Rossignol, Lowes and Nunn (2022), Butinda et al. (2023), Fisman et al. (2023), and Ciscato, Do and Nguyen (2023).

belief system in China. [9]

In China, such beliefs are commonly known as *Fengshui* – a traditional culture that has persisted for centuries, especially among the ruling and elite classes. It posits that surrounding environments can generate invisible forces that affect human lives (March, 1968; Feuchtwang, 1974). Factors such as the location and structure of dwellings and workplaces, along with the shapes of surrounding mountains and rivers, can all potentially affect one's fortune. The implications of these traditional beliefs are always individual-specific in China: the same place can hold different implications for individuals with different time of birth, providing quasi-exogenous variation for causal research. Historically, spatial beliefs were widely applied in the placement and design of royal buildings, spiritual structures (e.g., temples and ancestral tombs), and overall city planning. More broadly, emperors and officials used them to guide decisions on high-stakes spatially related events, such as initiating military expeditions and developing state infrastructure in specific regions (Madeddu and Zhang, 2021). Today, examples of these beliefs are also evident in the design of skyscrapers and business headquarters – from Shanghai to Hong Kong, and even in cities outside Asia, such as New York. According to the *China Family Panel Studies* in 2018 – a nearly nationally representative survey – about 47% of Chinese citizens still explicitly reported holding traditional beliefs about spaces. Figure 1 visualizes the share of believers by region based on the survey.

In relevance to our empirical design is the notion of individual-specific "unfavorable zones". This concept serves as an overarching component of the Chinese spatial belief system, providing high-level indications that guide more detailed decisions (Aylward, 2007). As demonstrated in Figure A1, taking one's residence or workplace as the origin, the space can be equally divided into eight zones by direction (N, NE, E, SE, S, SW, W, NW). Some of these zones, typically one or two, may be seen as inauspicious – as they are supernaturally too powerful and extreme – and could bring unexpected bad to one's life and career. Importantly, these zones are determined by one's birth time and exogenous astrological rules.[10] In some cases, there may be no inherent unfavorable zones for an individual (due to astrological rules). As such, leaders may be over-pessimistic about certain regions within their jurisdiction without factual basis. A simplified version of this superstition is reflected in the well-known Chinese saying: "Never disturb the

[9] While still prevalent, spatial beliefs in other contexts often produce similar predictions for most individuals. For instance, in some Indian schools, the south is generally considered less favorable due to its association with the god of death. This prevents us from separating the role of individual leaders.

[10] Specifically, each individual may have their own birth chart according to their birth time (year-month-date-hour). Spatial astrology then maps one's endowed birth chart to different zones. Generally, the inauspicious zones are the ones featuring the most powerful supernatural energy – as they are, philosophically, too powerful and extreme to be utilized and are thus unfavorable.

ground in the supernaturally unfavorable zone."

There are two additional points worth mentioning. First, when mapping local leaders' birth events to their unfavorable zones, we seek the assistance of established spatial astrologers and cross-validate their predictions. While there are simplified supernatural tips in the media and on the internet, determining one's *Fengshui* is technical and complex.[11] An established astrologer needs years of training and practice, and many well-known experts are trained via the mentoring-based system. Accordingly, most believers, especially those political elites facing high-stakes situations, will invest heavily to consult expert astrologers periodically for private advice. Second, although there are finer practices for utilizing spatial zones associated with various aspects (e.g., career, relationship, health, and even exams), these techniques primarily apply to the layout within one's house or workplace.[12] These components are less related to macro-level outcomes and are therefore not our focus.

2.2 Qualitative Evidence

There exist rich historical and contemporary accounts showcasing the significance of spatial supernatural in shaping leadership and governance in China. In Imperial China, spatial supernatural were treated seriously by rulers and elites. Examples can be seen from official historical records:

> Since the *Zhou Dynasty* (1046 BC), all rulers have maintained the *Imperial Astronomical Bureau* (or similar institutions) responsible for the study and use of astrology and supernatural. According to official *Qing Dynasty* records, the Bureau's spatial astrologers were tasked with "inspecting the placement and layout of palaces and cities, overseeing the supernatural aspects of mountains and rivers, and assisting decisions on spatially related events like military expeditions in specific directions."

> According to the "Old book of the Tang Dynasty", a work of official history, the Hua Mountains in western China had rich mineral resources; however, *Emperor Xuanzong* (685 AD - 762 AD) excluded the proposal for their development since his unfavorable zone lay to the west.

[11]The first step – producing one's birth chart – can nowadays be done with the help of computer programs. However, the second step – applying astrological rules and determining one's inauspicious zones – requires experts' input: each sub-component of the birth chart can interact with each other, and other external factors like birthplaces further add complexity.

[12]For instance, an official may be advised to place an indoor plant in some special position of their bedroom to improve health, adjust their desks to boost their career prospects, or erect a special statue in front of the government building to reduce unexpected obstacles.

In today's China, such traditional beliefs still play a substantial role in leader decisions. According to official reports in 2014, 7 out of 11 top-ranked politicians under malfeasance investigation factored superstitious beliefs into investment decisions. Although it is hard to obtain statistics for political elites on such sensitive issues, there exists one exception: a 2007 internal anonymous survey conducted by the *National Academy of Governance* suggests more than 52.4% of surveyed officials in China believe in supernatural in some form.[13] Due to the materialist nature of the Chinese polity, the survey result can likely represent a conservative lower bound. Media and official reports offer eye-opening cases that support the survey outcome:

> In 2005, a tragic incident occurred in a middle school in Qinyuan County. Du, the then-mayor, was supposed to arrive at the scene around 9 am. However, he deliberately took a detour to avoid the inauspicious region and did not arrive at the scene until noon.
>
> As demonstrated in the investigation report of Wu, the former deputy governor of Yubei District, "[he] even studied the spatial belief system for years himself and brutally determined the construction of projects by asking the supernatural."
>
> As an extreme case, Fang, the then-leader of Huainan City in 2014, resorted to explosives to destroy an ongoing hotel project, asserting that the construction in that specific zone would bring him bad fortune. This scandal led to the end of his political career.
>
> A new documentary by China Central Television in 2024 reveals that Chen, the then-leader of Zhangzhou City, relied heavily on his *Fengshui* consultant and wasted 211 million CNY (about 29 million USD) in associated projects, despite facing opposition from grassroots bureaucrats and citizens.

The above qualitative evidence suggests that, even today, traditional beliefs about spaces – though almost certainly false – still influence governors' perception and substantially shape their investment decisions.

[13] See https://www.cas.cn/xw/zyxw/yw/200705/t20070511_1021150.shtml (in Chinese).

2.3 City Leaders in China

The Chinese political structure is marked by a multi-tiered administrative hierarchy, consisting of central, provincial, city, county/district, and township-level authorities. At each level, two officials share top administrative power – the secretary of the local Communist Party committee and the head of the executive branch (e.g., the mayor at the city level). A typical division of labor emerges from this structure: the party secretary oversees personnel and political matters; and the mayor assumes responsibility for daily operations of the government, with a focus on promoting socioeconomic development (Chen and Zhang, 2021; Fang, Li and Wu, 2022). Local leaders in China exercise considerable authority over governance and public investment, and a large body of empirical research has underscored the influential role these individuals play in economic growth (Li and Zhou, 2005; Yao and Zhang, 2015). Since the city is considered the fundamental unit of residence and local markets, our analysis will focus on these city leaders.

An intriguing aspect of the Chinese polity is the frequent turnover of local leaders (Li and Zhou, 2005). This constant reshuffling is characterized by a top-down organizational framework. Typically, there are limited candidates – often only one or a few – for any given vacancy. In most cases, candidates are unlikely to refuse an appointment, as such refusal is often perceived as a direct challenge to the established leadership hierarchy. The regular movement of city leaders between localities, therefore, creates useful *within-locality* shocks for identification. It is also worth noting that, as an atheistic regime, the Communist Party of China explicitly forbids any religious or supernatural-related beliefs and activities among its leaders.[14]

3 Data and Empirical Design

3.1 Data and Sources

Leaders' Unfavorable Regions. Our measure of leaders' unfavorable zones builds on three steps. First, we collect the birth year and month of each city leader. The information, as well as other leader characteristics used in this paper, are extracted from official biographies from city yearbooks.

Second, based on leaders' birth event information, three expert astrologers help derive each

[14]See the *Chinese Communist Party Disciplinary Regulations*: https://www.12371.cn/2024/05/06/ARTI1714995665242128.shtml.

leader's supernaturally unfavorable zones separately. While obtaining an accurate prediction requires one's birth date and hour, an advantage is that *Fengshui* assigns disproportionately high weights to one's birth year and month, which enables experienced astrologers to infer. From the econometric angle, this may induce standard measurement error to our explanatory variables, which will yield more conservative estimates.

Third, we cross-validate astrologers' outputs and request them to re-check observations from which they draw different conclusions, and we iterate this process until all astrologers reach a consensus regarding the inauspicious directions of all leaders. The first-round rate of overlapping is 86%, suggesting the underlying astrological rules, though complex, can largely yield consistent predictions.

Determining County Location. With leaders' unfavorable directions identified, we determine whether a county falls within these directions of a particular leader. Following the spatial belief system, the reference point (i.e., origin) is set to be one's residence or office. In our context, this corresponds to the location of city government heads where leaders work and reside.[15]. As noted, the belief system divides a city into eight equal zones by direction, radiating from the origin point: N (337.5° - 22.5°), NE (22.5° - 67.5°), E (67.5° - 112.5°), SE (112.5° - 157.5°), S (157.5° - 202.5°), SW (202.5° - 247.5°), W (247.5° - 292.5°), NW (292.5° - 337.5°).

In our baseline analysis, we directly refer to official descriptions from local gazetteers to ascertain the orientation of each county in a city. This approach capitalizes on the common practice of local gazetteers in China, where the geographical location of each county relative to the city government is explicitly detailed. For instance, in the gazetteer of *Meizhou* City, it states that "*Da-bu* County is located in the eastern area of *Meizhou* City." These descriptions are typically determined by spatial planning authorities, making them reliable and relevant. For robustness checks, we also manually construct county locations using the Geographic Information System (GIS), computing the centroids of counties and deriving their Azimuth angles relative to the city government head.

Finally, we construct our key explanatory variable at the county-year level, which is a dummy that is 1 if a county falls within its then-leader's supernaturally unfavorable zone(s). As an example, if a county is in the southeast of the city government, and the mayor's unfavorable zone is to the southeast, then the county is viewed as treated.

Data on Economic Outcomes. Data on economic outcomes come from a variety of sources.

[15] In the Chinese setting, local leaders are to reside in designated housing areas near local government offices. As a result, their workplace and residence overlap, simplifying our analysis.

(1) *County-level data*. Our primary data on economic outcomes derive from the *China County-level Statistical Yearbook* from 2000 to 2018. The main variables include county-year level GDP, GDP sub-components (outputs from the primary, secondary, and tertiary sectors), the number of large-scale enterprises,[16] outputs of large-scale enterprises, fiscal expenditure, and population. We supplement the Yearbook data with nighttime luminosity data obtained from the Defense Meteorological Satellite Program (DMSP) operated by the National Oceanic and Atmospheric Administration (NOAA). The dataset offers a consistent measure of nighttime light intensity extending from 1992 to 2013. Although the nighttime light measure can be relatively unstable at the county level (Gibson et al., 2021), it serves as a useful proxy to corroborate what we observe reflect real changes.

(2) *Land usage data*. Our analysis also incorporates the administrative land transaction data from 2005 to 2018. Land usage is categorized into 41 distinct types according to associated projects. In China, governments are the exclusive providers of land. As many public projects include the use of land, changes in the area of specific land types may proxy changes in related government investment, which can in turn reflect changes in leader decisions. We describe the data in more detail as they become relevant for our analysis later.

(3) *Firm-level data*. We utilize administrative firm-level data between 2000 and 2007 from the Annual Surveys of Industrial Production (ASIP). The ASIP dataset covers all non-state-owned enterprises generating revenue exceeding 5 million RMB, as well as all state-owned enterprises in the Chinese manufacturing sector. Adopting the methodology of Brandt, Van Biesebroeck and Zhang (2012), we track firms over time using their unique numerical identifiers and calculate the capital stock and investment employing the perpetual inventory method. To address the dynamics of restructuring, mergers, and acquisitions, we additionally match firms using information on their names, industry classifications, addresses, and other relevant details, as a supplement to their IDs. In alignment with standard procedures (Hsieh and Klenow, 2009), we trim the 1% tails of output, capital distortions, and total factor productivity in each year to ensure our findings are robust to potential outliers. Our refined sample comprises approximately 1.8 million observations across 29 two-digit industries within the manufacturing sector. This sample includes data from 122,057 firms in 1998, expanding to 284,465 firms by 2007, and provides comprehensive information on ownership, employment, capital, and value-added. This allows us to directly compute firm-level TFP to measure productivity (Olley

[16]"Large-scale enterprises" are defined as industrial enterprises with annual revenue exceeding the size threshold established by the Chinese government, which was 5 million RMB before 2011 and 20 million RMB after 2011. The original data sources are managed vertically by the National Bureau of Statistics.

and Pakes, 1996).

(4) *Other data*. We also use additional data sources, including textual data from mayor reports, individual-level surveys, and compiled statistics and measures developed by research institutes. The use of these data is detailed as they become relevant later.

3.2 Descriptive Statistics

Table 1 presents descriptive statistics for our primary variables spanning from 2000 to 2018. **Panel A** details the economic outcomes at the county-year level, measured in 2014 CNY, along with the status of being located in local leaders' over-pessimistic (treated) zones. On average, counties in our sample have a GDP of 13.4 trillion CNY and host 137 large-scale enterprises. The term "*Treated zone*" represents the explanatory variable of interest, which is a dummy that is 1 if a county is located in its then-leader's unfavorable zones according to spatial superstitions. At the county-year level, approximately 5.8% of counties are located in an unfavorable zone of their city party secretaries, and 6.1% fall within an unfavorable zone of their city mayors. These two zones largely do not overlap: the probability of a county being located in an unfavorable zone of either the party secretary or the mayor is 11%, allowing us to separate the effects attributable to mayors from those of party secretaries.

Panel B of Table 1 shows the demographic characteristics of city leaders throughout our sample period. The majority of party sectaries and mayors are males, and they exhibit similar levels of tertiary education (inclusive of on-the-job education experience). Compared with party sectaries, mayors tend to be younger both at the inception and conclusion of their tenure in office, and they demonstrate a moderately higher propensity to serve in their native provinces.

3.3 Empirical Design

To investigate how leaders' misbeliefs about spaces shape local development, we hold constant a county and exploit the variation induced by the turnover of upper-level city leaders. Our baseline reduced-form design leverages both *within-locality* variation (comparing the same county under different city leaders) and *cross-locality* variation (comparing different counties within the jurisdiction of the same leader). For county c in city p in year t, we estimate:

$$y_{ct} = \beta \times Treated\ Zone_{ct} + \lambda_c + \mu_{pt} + \varepsilon_{ct} \tag{1}$$

The unit of observation is at the county-year level. $Treated\ Zone_{ct}$ is a dummy that is one if county c is located in a supernaturally unfavorable zone of its city leader(s) in year t. λ_c refers to county fixed effects that remove time-invariant or slow-moving differences across counties. μ_{pt} represents the city-year fixed effects, which absorb all city-wide temporal shocks (and also any leader-level differences, such as birth time). This leads to a clear interpretation of β, the key coefficient of interest: it captures the average impact on treated counties relative to other counties under the same leader in the same year. We later also explore whether significant cross-county spillovers exist, and to what extent our baseline estimate captures the absolute treatment effect. Finally, we allow the error term, ϵ_{hc}, to be correlated at the city level to obtain a more conservative inference. Figure A2 provides a visual illustration of our empirical strategy.

The main identification assumption is that, conditional on the fixed effects mentioned above, unobserved factors affecting economic outcomes are not simultaneously correlated with leaders' spatial biases. As described, a leader's over-pessimistic zones are determined by their birth event according to exogenous astrological rules, making them quasi-random. Therefore, the key remaining concern is whether the appointment of leaders is simultaneously correlated with their astrological characteristics and the development of particular subordinate zones in their cities – a scenario that seems conceptually far-fetched. An advantage of the Chinese setting is that the appointment of city leaders is top-down and mandated: chosen individuals, who are usually promoted, may not alter assignment decisions unless they would like to end their political careers.

To further buttress the validity of our empirical strategy, we present three sets of quantitative checks. First, we compare the *ex-ante* characteristics of ever-treated counties to those of non-treated counties during our sample period (2000 - 2018). Table A1 shows that the average geographical, demographic, and economic characteristics of ever-treated counties are highly comparable to those of non-treated counties in 1999.

Second, we investigate whether a county's past socioeconomic conditions can predict the astrological features of its city leader (and thus its treatment status). Specifically, we regress a county's future treatment status (under the next leader's term) on its current socioeconomic characteristics. The estimates in Table A2 suggest no significant predictors, providing additional support for our identification assumptions.

Lastly, we turn to leader-level characteristics. Notably, there is a group of city leaders that do not have cross-county variation in their jurisdiction. Two reasons may explain this: (1) there may not be inherent unfavorable zones for these leaders, determined by exogenous astrological rules, or (2) no counties are located in their unfavorable zones due to the location of the city government and the city's shape.[17] If the turnover of leaders is not predominantly associated with supernatural considerations, we should expect no significant difference between city leaders with treated counties in their jurisdiction and those without. Consistent with this notion, Table A3 finds a strong balance in terms of leaders' gender, tenure length, age, and educational background.

4 Main Results

4.1 Regional Disparities in Economic Growth

Table 2 presents the baseline results. The outcome variable is the (log) county-year level GDP.[18] As each city is co-governed by a Party Secretary and a Mayor, we investigate the impact of each leadership in different columns. Column 1 pools either leader's spatial biases into one treatment dummy. The estimate reveals that counties located in either leader's over-pessimistic zones are associated with a relative reduction in economic output by about 1.3 percent each year.

Columns 2 to 4 disaggregate the roles of party secretaries and mayors. We find the effect is largely driven by city mayors, and the impact of party secretaries is not salient. On average, counties located in mayors' over-pessimistic zones experience a 2.3 percent decrease in their GDP, compared to other counties under their governance. This pattern is consistent with most studies of the Chinese economy, in which mayors are in more direct charge of implementing socioeconomic policies and administering local projects (Chen and Zhang, 2021; Cao, 2022; Fang, Li and Wu, 2022). Accordingly, our later analysis focuses on city mayors. During our sample period (2000 – 2018), the estimated output gap translates to approximately 39 USD million in annual GDP or about 135 USD per capita (deflated to 2014). To put this disparity into perspective, the effect is about 1/3 of the hometown favoritism documented in the existing literature (Hodler and Raschky, 2014).[19]

Table A4 extends by examining the impact on GDP sub-components. This may help us gain a broad sense of which aspects of the local economy drive the overall change. The statistics

[17]For instance, a mayor's unfavorable zone is the southeast, while the city government head is located in the southeast of the city. In this case, there will be no treated counties.

[18]In the spirit of Easterly and Pennings (2020), we use the level of GDP rather than its growth rate to partially assuage the volatility issues associated with growth rate measures.

[19]Hometown favoritism refers to a new leader's hometown gains excess economic growth compared to other regions, which can result from favor-exchange, informational advantage, and social preferences (Hodler and Raschky, 2014; Persson and Zhuravskaya, 2016; Do, Nguyen and Tran, 2017).

follow a standard three-sector decomposition: the primary sector (agriculture, forestry, animal husbandry, and fishery), the secondary sector (manufacturing, mining, and construction), and the tertiary sector (services, commerce, and others). We see that while all GDP subcomponents decline, the secondary sector is most affected. This aligns with China's growth mode over the past decades, where the secondary sector acts has acted as the main driver of the local economy and has been heavily affected by government intervention (Naughton, 2007; Chow, 2015).

Event Studies. To further understand the dynamic effects of leader biases, we adopt an event-study framework, allowing β in Equation 1 to vary by each relative year. For comparability, we restrict the analysis to status transition observed over at least an 8-year window (4 years before/after the treatment).

Panel A of Figure 2 presents visual evidence for the year-by-year differences in GDP for counties entering the treatment status compared to non-treated counterparts. The differences beyond 4 years before the treatment are omitted as the benchmark. The estimated coefficients show that ahead of being in mayors' over-pessimistic zones (due to leader turnovers), there is no differential output trend of to-be-treated counties. After entering the treatment status, we see a gradual and significant reduction in GDP relative to other non-treated counties. Additionally, **Panel B** of Figure 2 investigates the effect of exiting the treatment status. The differences beyond 4 years after the treatment ends are omitted as the benchmark. Conceptually, whether the impact persists or dissipates is uncertain and may depend on factors like the strength of agglomeration forces (Allen and Donaldson, 2020). The results shows that the relative GDP gap does not immediately vanish once a new leader assumes office but steadily declines over time. This suggests that, while the effect is not persistent, our baseline may still understate due to omitting lagged impacts.

To better understand the lagged pattern over a longer time span, we adopt an augmented specification that considers all pre-treatment, under-treatment, and post-treatment observations, with pre-treatment units serving as as the benchmark. We pool all under-treatment units into a binary indicator, as our interest is in assessing the pace at which a county catches up following an average mayoral bias shock. In our sample, an average duration for treatment is about three years. To increase statistical power, we allow the post-treatment effects to vary across three-year bins. Figure A3 presents the estimates. Consistent with the "partial" event-study plot above, the output gap does not close immediately. The effect persists for about three additional years and dissipates within four to six years. Over the longer term, treated and non-treated counterparts resume similar trends.

4.2 Robustness and Extensions

We conduct various additional analyses to strengthen our baseline results.

Treatment Measures. Our baseline uses pre-packaged official descriptions to determine the location of a county. Table A5 defines county orientations based on Azimuth angles relative to corresponding city government heads calculated by the GIS. The estimates are virtually unchanged.

Relatedly, a small proportion of city government heads have moved during our sample period. Conceptually, this is not likely to threaten our finding as re-allocating a government head is extremely costly in the Chinese setting, requiring approval by the central government and usually years of administrative coordination. Table A6 excludes leaders experiencing government head moves, which decreases county-year observations by only 1.97%. The empirical patterns remain stable.

Outcome Measures. To corroborate what we observe reflects real changes, Table A7 replicates the exercise using the nighttime light intensity as the dependent variable. Conceptually, the issue of data reporting is not particularly problematic in our context: as county-level economic statistics are gathered and reported by county-level governments from the outset, if any, treated counties may have greater incentives to compensate for their growth loss via exaggeration, which may drive our estimates toward zero.[20] Moreover, we do not find a difference in nightlight-GDP elasticity between treated and untreated counties, suggesting data falsification is not a chief factor in our setting. We later also use industrial outputs collected independently by the National Bureau of Statistics to further validate.

Inference and Permutation Test. Our baseline allows the error term to be correlated at the city level. Table A8 uses standard errors clustered by county, by leader, and two-way clusters by city and leader. All results remain significant. To attenuate the concern that our results might be driven by outliers or high-leverage observations (Young, 2019), we further conduct a randomized permutation test. Specifically, we randomly permute the unfavorable zones of mayors and re-estimate the impact using this placebo treatment, with 1,000 iterations. Figure A3 presents the placebo estimates. Comparing the empirical distribution of the permuted coefficients to the baseline, we find that the likelihood of the original estimate being a result of coincidence is close to zero.

Additional controls. Our identification essentially exploits the interaction of two sources

[20]As discussed by Gibson et al. (2021), when down to county and more local level, the indication of nighttime light luminosity can be ambiguous and unstable; we therefore only use it for robustness checks.

of variation: leaders' birth times and counties' directional locations. Table A9 introduces a stringent set of controls along these two dimensions. To ensure that our results are not influenced by leaders from specific cohorts, Column 2 includes fixed effects at the county $\times$ mayor birth year level. The empirical pattern remains consistent. Column 3 further controls for baseline county characteristics' impacts, allowing them to vary by mayor. To capture this variation, we calculate the principal component of all county characteristics available in 1999 (before our sample period) and interact it with the full vector of mayor fixed effects.[21] The robustness suggests that other mayoral biases toward certain types of counties (e.g., developing already affluent counties) do not threaten our baseline results.

Heterogeneity by Mayor Hometown and Workplace. The cultural aspect of the treatment allows us to further corroborate the role of individual leadership. In theory, individuals may hold their identity and beliefs shaped during their formative young ages in later life, even in a new environment. Therefore, mayors grown up in more superstitious hometowns may held spatial misbeliefs to a greater extent in their workplace. Empirically, we use the province-specific share of believers as a proxy for the strength of related culture (as shown in Figure 1), and link this measure to each mayor based on their hometown province.[22]

Table 3 presents the heterogeneity results. Consistent with our hypothesis, Column 2 shows that the impact of spatial biases is more pronounced among mayors who originate from regions with a more entrenched supernatural culture. As a comparison, Column 3 instead uses the spatial supernatural culture in the current province of work as the mediator. The estimate for the interaction term is small and insignificant, implying our finding is driven by the inherent subjective beliefs held by mayors themselves.

Further Results on Longer-run Implications. Apart from the substantial effects observed during a leader's term, one might wonder whether the short-run disparities could be fully "washed out" over time, given the quasi-random nature of the treatment and the catching-up pattern observed in the event study plot. We here discuss the longer-run implications of our findings.

First, we examine the distribution of treated zones by direction in detail. Although the mapping between birth times and over-pessimistic zones is exogenous, factors like city shape

[21]The county characteristics include latitude, longitude, number of subordinate towns, county area, population, distance to coast, primary schooler share, rural worker share, GDP, sectoral GDP shares (primary, secondary, tertiary), fiscal expenditure, and revenue.

[22]As culture tends to remain relatively stable in the short run, utilizing measures in 2018 may not pose a significant endogenous threat.

and the distribution of leaders' birthdates may cause certain directions to be disproportionately treated.[23] According to Table A10, western to northern counties are the most affected ones. Consequently, for an average city, these zones may be more under-developed in the past two decades, suggesting that mayors' spatial misbeliefs have longer-run distributional implications.

Second, we complement by estimating the cumulative impact of being located in mayors' unfavorable zones. Empirically, we investigate the current cross-county GDP differences as a function of the cumulative treated years throughout our sample period. The outcome variable is the logarithm of a county's average GDP in 2017 and 2018.[24] Figure A5 visualizes the estimated coefficients across four categories: counties located in mayors' over-pessimistic zones for 1 - 3 years, 4 - 6 years, 7 - 9 years, and over 10 years, spanning the period from 2000 to 2016. The estimated coefficients show that counties subjected to over-pessimistic treatment for a longer period exhibit relatively lower GDP levels today.

Finally, as shown in our later analysis, the disparity is primarily driven by real output losses in mayors' over-pessimistic zones. This suggests that, regardless of whether short-run disparities persist for the longer-run, mayors' misbeliefs still entail substantial economic costs for the economy.

5 Mechanisms

5.1 Conceptual Framework

Having established the robust causal effect, we now turn to probe through which channels mayors' individual beliefs translate into macro-level consequences. We consider three main actors in the local economy: government, firms, and households.

As mayors head the local government, shifts in their decision-making can directly affect government inputs in subordinate counties, including policy support and public investment. Mayors' over-pessimism may lead to a relative reduction in these inputs in treated counties. This can not only lower the demand for local goods and services but also potentially undermine productivity. For instance, transportation and communication infrastructure can boost efficiency by facilitating firm interactions and reducing commuting times for workers (Henderson et al., 2022).

[23] Figure A4 shows the distribution of city mayors' birth time during our sample period.

[24] We average the outcomes of two years to reduce the volatility. The results remain similar when averaging the outcomes of three years (2015 -2018).

Accordingly, there will be downstream effects on firms and households that can further amplify economic losses. As noted, reduced government investment can lead to lower productivity among remaining firms, while firms may also adjust their employment and capital investment decisions. On the extensive margin, limited policy support and poorer facilities in affected regions may discourage the entry of new firms and influence existing firms' decisions to exit. Finally, as public amenities and economic conditions worsen in these regions, local households may adjust labor supply or relocate to other counties with better amenities and opportunities. This could further reduce consumption and impede production, negatively impacting economic growth in the affected counties.

In summary, mayors' spatial misbeliefs can impact the local economy by directly shrinking government inputs and triggering a series of firm and household adjustments. In Appendix B, we present a standard spatial model incorporating these notions.

5.2 Government-side Changes

To probe government-side changes, we investigate mayors' work plans and public investment. The former enables us to more directly establish the role of individual mayors' decisions, and the latter reflects corresponding real inputs.

Mayor Decisions and Government Investment. At the start of each year, local mayors release government reports summarizing the previous year's work and outlining major development plans for the new year. Though preliminary and coarse, mayors' development plans signal policy support and help guide public investment in subordinate regions. This setting provides a window for us to more directly observe leader-specific changes. Combining hand-collected report data with machine learning techniques, we use the frequency of mentioning a county and the associated sentiment score as proxies of leaders' perception toward a county. In the Chinese context, governmental development plans will outline major projects and the regions associated with them, avoiding any use of negative terms. Accordingly, the variation in mayors' sentiment mostly arise from the adverbs they use to describe each project. For instance, they might use terms such as "unconditionally," "vigorously," or "steadily" when discussing the promotion of public infrastructure. While all these adverbs reflect leaders' commitment to investment, the first two are perceived as more positive than the third. For the sentiment measure, we use the Generative Pre-trained Transformer's (GPT) evaluation of the report content, with 0 representing the most negative and 1 the most positive.

Columns 1 and 2 of Table 4 present the results. Counties supernaturally unfavorable to mayors are mentioned significantly fewer times in their work plans, compared to non-treated counterparts. Moreover, though less precise, we find a less positive sentiment of mayors toward projects in their treated counties. These combined results suggest Chinese mayors are affected by their spatial misbeliefs in governance decisions, leading to lower policy support toward their over-pessimistic zones.

Next, we use changes in government investment to corroborate the shift in mayor decisions. Column 3 of Table 4 examines changes in the overall public spending. We find that treated counties have on average 1% lower annual public spending, compared to their non-treated counterparts. A caveat is that we do not have systematic statistics of finer investment entries at the county level. To further understand which aspects mayors affect, we complement by investigating land usage records. This approach takes advantage of two administrative features in China: (1) major public projects of a county – which require final approvals of city mayors – usually involve related land usage, and (2) governments are the exclusive providers of land. Accordingly, changes in the area of different types of land can serve as a proxy for changes in associated economic activities. To this end, we use 1.9 million administrative land transaction records. The sample period starts from 2005, when nationwide administrative records are formally established. We categorize these records by type of land usage according to official classifications and collapse them to county-year level. For each category, we normalize its land usage area by the total county area and use this share as the dependent variable.

Figure 3 visualizes the impacts on different categories of public investment. To ensure comparability, we standardize each coefficient by the sample average of its corresponding dependent variable. **Panel A** of Figure 3 presents the overall effects, pooling projects approved by city and county governments. In line with the decreased public expenditure, we see negative estimates across most types of public investment. Row 1 looks at changes in transport infrastructure, which has been shown to be essential for promoting economic growth (Fernald, 1999). Compared to other public projects, transport-related projects are typically large in scale, involve complex administrative processes and coordination costs, and offer large room for leader intervention. Therefore, it is plausible that such projects are more strongly influenced by mayors' spatial misbeliefs. Rows 2 and 3 show similar declining patterns for other public facilities, such as expansion/updates of hydraulic structures, power grids, and piping systems. For categories in Rows 4 and 5 – state organizations, education, health, and social welfare projects – of which county governments have more discretion or projects are relatively small-scale, we obtain insignificant coefficients.[25] Though suggestive, it can be seen that the estimated magnitudes are positively associated with the scale of related projects and the extent of city governments' involvement.

Panel B of Figure 3 further decomposes the outcome variables into two categories: land usage associated with projects approved by city governments (i.e., mayors) *versus* subordinate county governments.[26] These features enable us to better separate changes in mayors' behavior. Two patterns emerge. First, consistent with the above evidence, public projects managed by city mayors decrease significantly across almost all categories. Second and in contrast, treated county governments do not exhibit a similar pattern. Though the estimate is imprecise, it appears that they may promote more projects under their discretion in response, such as education, health, and social security facilities. Although changes in land usage only partially capture shifts in government investment, these combined results corroborate the central role of individual mayors in shaping the observed macro-level consequence.

Government Investment in Non-treated Zones. As a complementary step in understanding leader-driven changes, we assess whether and to what extent mayors further reshape investment in non-treated counties under their governance. Conceptually, the extent of such spillovers remains an open empirical question, depending on the marginal benefits *versus* costs of reallocating projects as perceived by mayors, as well as the externalities of under-investment in certain zones affecting others.

To evaluate the role of spillovers in government inputs, we leverage a unique advantage of our setting: some cities have none of their subordinate counties treated during our sample period.[27] Using these counties as a stringent set of "cleaner" controls, we can re-estimate the impact on treated counties, while excluding those non-treated counterparts in the same city that might be indirectly affected. Specifically, for each county that has ever been treated, we pair it with all "cleaner" control counties; we then stack all these comparisons into a single regression to re-estimate the average treatment impact (Cengiz et al., 2019; Deb et al., 2024;

[25]Subordinate counties have generally had more discretion over investment in public education and health since 2001, as these projects are numerous yet relatively small-scale. See http://www.moe.gov.cn/jyb_xwfb/s5147/201909/t20190926_401046.html (in Chinese).

[26]The analysis leverages that we can observe the entity responsible for approval. For projects where subordinate counties can have more discretion, county governments generally serve as the approval authority. However, for large-scale projects requiring city-level support and oversight, the approval authority typically falls to city mayors.

[27]As noted in Section 3.3, two reasons underpin why some mayors do not have treated counties in their cities: (1) there may not be inherent unfavorable directions for these leaders, determined by exogenous astrological rules, or (2) no counties are located in their unfavorable directions due to the location of the city government head and the city's shape.

Wing, Freedman and Hollingsworth, 2024). This estimate thus avoids the potential spillovers into non-treated counterparts under the same leaders. As reported in Table A11, the average change in public investment for each non-treated counterpart is relatively modest (about 8% of the prior estimate).[28]

Collectively, our combined results suggest that reduced government support and investment in mayors' over-pessimistic zones act as a key mechanism driving the observed growth disparity.

5.3 Downstream Changes in Firms and Households

As described, the disparity can be magnified by subsequent changes in firm and household outcomes. That is, leaders' individual decisions not only impact the government they oversee but also create ripple effects for broader actors in the local economy.

Firm Outcomes. We begin by examining firm-related outcomes from county statistical yearbooks. The data provide the number and output of large-scale industrial enterprises at the county-year level. The statistics of these enterprises, with a minimum annual revenue threshold of 5 million CNY (0.7 million USD) before 2011 and 20 million CNY (2.8 million USD) afterward, are considered essential indicators of local economic growth. Table 5 presents the results. Column 1 shows that mayors' unfavorable zones are associated with a 5% relative decrease in the economic output of large-scale industrial enterprises. In theory, the observed decline in firm output can result from a combination of reduced firm numbers and lower output of an average firm. Columns 2 and 3 explore these two perspectives. Column 2 finds that treated counties have 3% fewer large-scale enterprises on average, translating to roughly four fewer firms meeting the "large-scale" threshold compared to non-treated counterparts. Although the estimate is less precise, Column 3 indicates a 2.6% relative decrease in output per remaining firm in treated counties.

To understand micro-level changes in firm behavior, we use firm-level data from the *Annual Surveys of Industrial Production* (ASIP), which covers the universe of large-scale industrial firms between 2000 and 2007.[29] Table 6 reports the results. Columns 1 and 2 examine input-related measures, reflecting how firms adjust their production in response to mayors' spatial biases. We find that remaining firms in mayors' over-pessimistic counties hire fewer employees and invest

[28] Non-treated counterparts constitute 21.1% of our sample – 3.5 times the share of treated county-year observations (6.1%) – suggesting that the total spillovers are likely dispersed, rendering them insignificant for an individual county. Taking this into account, about 28% of the under-investment would be relocated to other counties.

[29] After 2007, the ASIP dataset no longer provided information on firm value-added.

less in capital assets. These findings suggest lower firm inputs, which would naturally lead to reduced output levels, as shown in Table 5. Column 3 then examines firm-level productivity by comparing the TFP of a given firm when its county is unfavorable to mayors *versus* when it is not. The estimate indicates a moderate yet significant loss in firm production efficiency (producing less with the same amount of input). It is worth noting that, since the ASIP firm census only surveys firms meeting the 5 million revenue threshold, the decline in firm productivity can likely represent a conservative lower bound, as less productive firms may not be covered by the ASIP survey or may exit the market.[30] The finding speaks to the role of public infrastructure in enhancing regional economic efficiency.

To gain a better understanding beyond these leading enterprises, we complement our analysis with firm registration data from the State Administration for Industry and Commerce of China (SAIC). The SAIC data allow us to observe the numbers of all new and exited firms at the county-year level. According to Columns 4 - 5 in Table 6, firm entry rates in treated counties are 1.42 percentage points lower than in other counties. The exit rate is slightly higher, but the estimate is statistically insignificant. Finally, we also explore the potential spillovers in neighboring non-treated counties in Table A12. The results suggest that the relative decrease in firm numbers is primarily due to reduced new establishments in treated counties (about 80% of the magnitude), rather than a sharp relocation across counties in the short run.

Taking stock of the above analyses, we see that firms in mayors' over-pessimistic zones not only produce less but also do so less efficiently. On the extensive margin, these zones experience slower growth in the number of firms, attributed to a decrease in firm entry. These firm-side changes may collectively exacerbate the economic loss of affected areas. While more suggestive, Appendix C shows additionally that such changes might be associated with worse allocative efficiency.

Household-side changes. The remaining key actor in our analysis is local households. In response to deteriorating public amenities and economic prospects, households may adjust their labor supply and/or relocate themselves accordingly. Given China's rigid household registration system, we expect the contribution of these channels may be relatively modest in magnitude over the short term.

Table 7 presents the related results. As shown in Column 1, mayors' unfavorable counties show no significant difference in the number of formally registered households compared to

[30] Consistent with this notion, we find that a pre-existing firm is 6.7% more likely to be excluded from the ASIP survey when its county is treated. At the time of this study, we do not have data on whether an ASIP firm exits the market.

non-treated counterparts. However, Column 2 indicates that the population in treated counties has experienced a moderate relative decrease (about 0.3%). In China, formally switching one's household registration (i.e., *Hukou*) from one county or city to another can be costly, requiring substantial inputs from households, such as a sufficient period of work in the destination and sometimes even purchasing a house.[31] Accordingly, many migrant workers and temporary residents – though part of a county's population – do not have their households formally registered in that county. Therefore, this relative decrease in population might speculatively suggest a small reallocation of mobile labor. Column 3 of Table 7 further examines changes in the number of secondary and tertiary sector employees reported by county yearbooks. The estimate suggests a consistent decline in employment in treated counties, partially confirming our speculation. Notably, as in many developing countries, migrant workers and informal-sector employees are often difficult to track in Chinese statistics. Given these data limitations, we refrain from drawing further quantitative conclusions here.

6 Economic Significance and Discussion

6.1 Estimated Aggregate Output Costs

Our previous results have established that Chinese mayors' non-factual beliefs lead to significant disparities in regional development. To better benchmark the economic significance, we move toward assessing the aggregate output cost at the country level. This question cannot be directly answered by our baseline estimate, which essentially quantifies the relative difference between treated and untreated counties under the same leaders. Equilibrium effects may arise from negative externalities related to under-investment in public infrastructure, shifts in firm entries, and labor relocation within the same local market. The overall extent of spillover effects is thus ambiguous (Siegloch, Wehrhöfer and Etzel, 2024). We adopt two different strategies for a back-of-the-envelope calculation, with a discussion on the potential bias in our calculation.

Approach 1: Addressing Regional Spillovers. Since a city acts as the basic unit of local market, we focus on cross-county spillovers within a city (Dingel, Miscio and Davis, 2021; Chen, Gu and Zou, 2022). Similar to the strategy used earlier, we take advantage that some cities have none of their subordinate counties treated during our sample period. Using these counties as a

[31] During the period of study, only formally registered households (i.e., those with *Hukou*) had full access to amenity benefits like health care, education, and social security provided by the city or county government (Song, 2014; Zhuge and Lang, 2023). For example, many migrant workers in Beijing or Shanghai still have their *Hukou* in their remote hometowns, meaning their children have to remain in hometown schools. Therefore, a county's total population will not perfectly correlate with its number of registered households.

stringent set of "cleaner" controls, we can re-estimate the impact of mayors' spatial biases on treated counties, while excluding those non-treated counterparts in the same city that may be indirectly affected.

We find that excluding regional spillovers reduces our baseline estimate by 8%, with statistically similar magnitudes (from -2.3 to -2.1). The result suggests that the observed disparity is largely driven by the economic loss in treated counties. Built upon these estimates, we conduct a back-of-the-envelope calculation on the aggregate output change. Specifically, we multiply the average annual loss under treatment (-2.1 percent) and the share of treated county-year observations in our sample period (6.1%). For a more conservative estimate, we may consider the compensation gain dispersed among non-treated counterparts, subtracting them from our calculation (0.2 percent $\times$ 21.1%). In this framework, the estimated annual output loss would be 0.09% – 0.13% of the country's GDP.

Approach 2: Aggregating to the City-level. An alternative approach is to examine output changes at a more aggregate level, so agglomeration or spillover effects across subordinate counties can be subsumed (Criscuolo et al., 2019; Siegloch, Wehrhöfer and Etzel, 2024). In our setting, the city-level aggregation serves as an ideal level of aggregation: it corresponds to the whole jurisdiction of city mayors under our study, and, as described, it also serves as the common definition for local market in China. To identify plausibly causal effects, we measure the extent a city is affected. The explanatory variable is the share of population or area located in unfavorable zones of the then mayor. As an illustration of our identification strategy, consider two hypothetical cities: City A, where 50% of its population resides in southern counties, and City B, which has only 10% of its population situated in southern counties. Should both cities be administered by mayors who perceive the south as unfavorable, City A would experience a more pronounced effect of such leader bias. This variation in treatment intensity stems exclusively from pre-existing differences in the city shape and is, plausibly, presumed to be orthogonal to other potential confounders. In this way, we can estimate the impact of city mayors' misbeliefs on city-level output.

Table A13 presents the results. To assuage endogeneity, we construct independent variables based on the population and area at the end of the previous leader's term. We see cities that are more affected by mayors' spatial biases have lower economic output. This is consistent with our county-level analysis, which similarly shows a significant real GDP loss in treated counties. Assuming no significant spillovers beyond local markets, we can use the city-level estimate to compute the overall output cost for the whole country. Using this approach, the average annual loss would be 0.11% - 0.26% of the country's GDP. Compared to the estimated loss from our county-level analysis, the number here is larger yet still comparable in terms of the order of magnitude.

Potential Bias of Calculation. Several factors suggest that the above calculation may understate the actual aggregate cost of Chinese mayors' misbeliefs about spaces. First, GDP and recorded firm output do not fully capture informal sectors and non-registered businesses, which can constitute a significant portion of the economy in emerging markets like China. Omitting these unlisted outputs leads to an understatement of the true economic costs.

Second, the magnitude of the estimated impact in treated counties can likely be a conservative lower bound. Our empirical design relies solely on the birth year and month of city leaders, while private supernatural advice is often based on more precise date and time information. As the exogenous astrological rules determine treated zones quasi-randomly, using only year-month data to predict spatial biases will introduce a standard measurement error, which can bias our estimates toward zero.

Third, the share of affected regions can be greater. Even leaders without significant, inherent unfavorable zones can receive year-by-year advice from their spatial astrologers. Although these shocks are idiosyncratic and orthogonal to our explanatory variables, the actual share of regions affected by mayors' misbeliefs can therefore be greater than the number used by us. Accordingly, the estimated macroeconomic costs are, again, likely understated.

6.2 Interaction with Institutional Factors

Considering the substantial cost of leaders' misbeliefs, one may wonder what factors could be useful in mitigating their negative influence. Motivated by the cross-country evidence (e.g., Jones and Olken, 2005; Ottinger and Voigtländer, 2021), this section explores the role of institutional factors to offer some suggestive implications. The Chinese setting features rich cross-region differences in institutional quality. We exploit prominent measures of institutional quality, and also examine less-institutional shocks aimed at curbing leaders' malfeasance.

Government Intervention in Local Economy. While Chinese governments generally play highly active roles in economic development, there still exist discernible cross-province differences in government interventionism (i.e., marketization).[32] We hypothesize that in places with heavy political intervention and thus more room for local leaders to sway socioeconomic

[32] In an emerging economy, the extent of marketization can be a potentially useful measure that captures, at least partially, institutional quality and thus the constraint on political powers. For instance, the provincial marketization indexes constructed by Wang, Fan and Hu (2018) are widely used as local institutional indicators.

trajectories, leaders' personal beliefs matter more. The heterogeneity analysis takes advantage of two province-year level measures: one is the share of government business-related expenditures over GDP, and the other is the pre-packaged marketization score by the National Economic Research Institute (NERI) (Wang, Fan and Hu, 2018).[33] As shown by Jia, Lan and Padró i Miquel (2020), these two measures serve as useful proxies for the extent of political intervention in the local economy. Leveraging provincial-level variation can help attenuate concerns about endogenous institutions at the city level, as a province acts as the first-level administrative division above its cities.

Table 8 presents the results. An increase in government intervention in the local economy by a standard deviation is associated with an additional -2.2% change in treated counties' GDP. Column 3 further controls provincial GDP per capita and mayoral hometown culture, and the interaction term for government intervention remains virtually unchanged. The null mediating effect of GDP per capita additionally suggests that power abuse and institutional weakness may not necessarily decline with prosperity. Finally, Column 4 uses the pre-packaged marketization score as an alternative indicator, which produces the same result.

Ideological Training and Anti-corruption Campaigns. The past decade has seen intensive top-down efforts within Chinese bureaucracies to curb leaders' misbehavior. Theses shocks provide opportunities for us to examine whether such less-institutional factors can be effective. Columns 2 and 3 of Table 9 investigate the two most prominent efforts under Xi's term – ideological training and anti-corruption inspections. Column 2 looks at the Chinese Communist Party's ideological training of city leaders. The ideological training of Party members gains particular emphasis in Xi's agenda, aiming at reinforcing the Marxist and socialist ideology (including materialism and anti-supernatural). For city leaders, the most common approach is that the provincial government initiates a short-term and intense campaign, gathering leaders for seminar-style training. Based on provincial yearbooks, we construct a province-year-specific dummy for whether a province conducts ideological training of its local leaders. The estimated coefficient for the interaction term is relatively smaller without statistical significance, suggesting that such treatment has no salient impact (at least in the short run).

In Column 3, we construct a province-year-specific dummy with an assigned value of 1 if an anti-corruption inspection takes place in a particular province in a particular year (Chen

[33]The NERI index quantitatively assesses marketization progress based on five dimensions: the interplay between the government and market, the growth of the private sector, the development of product markets, the development of factor markets, and the development of market intermediaries. Conceptually, a higher marketization index score indicates that the market plays a more fundamental role in resource allocation.

and Kung, 2019).[34] The estimate suggests no significant differences between mayors who face anti-corruption deterrence and those who do not.[35] At any rate, these findings rise to the speculation that campaign-style treatment, compared to institutional constraints, may not be highly effective in assuaging the cost of embedded leader biases.

Overall, the above analyses speak to the notion of Clark, Murphy and Singer (2014) – "leaders matter most when ownership and governance structures correspond with a weak or ambiguous institutional logic." Compared to the existing literature, our results move by showing that even in an overall weak institutional regime, an increment in institutional quality can likely be useful.

6.3 Why Do Supernatural Biases Preserve Among Leaders?

Finally, a separate yet intriguing question is why traditional (mis)beliefs, despite their substantial macro costs, are preserved among highly capable elites? As shown in Column 5 - 6 of Table A13, it appears that mayors' promotion prospects are weakened by their spatial biases, suggesting that such beliefs are also objectively costly for themselves.[36]

There exist at least two prominent explanations. First, it is possible that leaders might not fully realize the counter-factual of removing their non-factual beliefs. This perspective can be reconciled with cultural and behavioral models, where biased beliefs persist through endogenous socialization processes (Bisin and Verdier, 2011). While we cannot directly test this notion, our heterogeneity analysis offers partial evidence: spatial biases are more pronounced among mayors from hometowns where traditional beliefs about spaces are more prevalent (Table 3).

Second, traditional beliefs may help leaders mitigate perceived uncertainty in governance. This explanation speaks to the functionality view of costly misbeliefs and traditions (Leeson and Suarez, 2015; Nunn and Sanchez de la Sierra, 2017): as political leaders make complex decisions while managing substantial resources, supernatural forces may serve as a tool to regulate

[34]This variable is constructed based on the *Central Commission for Discipline Inspection*'s reports of its inspection activities, where the central government dispatches inspection teams to conduct intense audits and ferret out corrupt officials. Between 2013 and 2018, 14 waves of inspections took place, with each wave targeting 4 to 10 provinces and lasting for approximately two to three months.

[35]It is worth noting that the underlying explanation here can be complicated, as anti-corruption inspections may yield multi-faceted changes. On the one hand, it may deter power abuse and the revelation of individual biases. On the other hand, it may induce career uncertainty that increases leaders' demand for the supernatural (Dudley, 1999).

[36]For a long time, economic growth has been an important determinant of local governors' promotion in China (e.g., Li and Zhou, 2005; Yao and Zhang, 2015).

perceived threats toward the unknown and gain a sense of control. Testing this perspective is beyond the scope of this paper, yet there exists rich qualitative evidence – both from China and other contexts – in support of it. For instance, after encountering unexpected obstacles during a major project, Li Chun-Cheng, the Deputy Governor of Sichuan Province, turned to spatial supernatural advice seeking relief and support. Similarly, the White House once confirmed that the Reagans' belief in astrology was partially driven by uncertainty about their welfare, particularly following the assassination attempt in 1981. An editorial in Legal Daily – a state-owned newspaper under Chinese authority – also highlights that uncertainty about careers and stress for high-stakes tasks are plausible drivers of the prevalence of supernatural beliefs among leaders.[37]

7 Conclusion

Individual leaders influence firm and state performance. Economists have recently moved toward causal analysis of *why* different leaders produce different outcomes, highlighting determinants such as their ability and networks (e.g., Dube and Harish, 2020; Ottinger and Voigtländer, 2021; Bai, Jia and Yang, 2023). This paper contributes by showing subjective beliefs of individual leaders – many of which may be biased and false – as an important determinant. This has broader conceptual relevance, as a large body of literature demonstrates that individual identity and experiences are associated with leader performance, with a key mechanism being their potential impact on leaders' own beliefs over the state of the world.

To our knowledge, we provide the first causal quantification on the macro-level impact of leaders' (mis)beliefs. We study this question in China, which features the largest polity and a sizeable number of local leaders. Our empirical strategy leverages enduring traditional beliefs about spaces and the supernatural, which define individuals' unfavorable zones based on one's birth time and exogenous astrological rules. This setting thus provides a unique opportunity to link quasi-random differences in leader-specific beliefs to regional development. We show that subordinate counties subject to mayors' over-pessimism exhibit significantly lower economic output. These changes are driven by reduced government investment from mayors, accompanied by lower firm entry, decreased productivity, and moderate household relocation. By incorporating additional empirical designs to account for potential spillovers, we calculate the overall economic cost of Chinese mayors' spatial misbeliefs. We estimate

[37] See https://www.nytimes.com/2013/05/11/world/asia/feng-shui-grows-in-china-as-officials-seek-success.html and https://www.thepaper.cn/newsDetail_forward_1464972 (in Chinese).

at least a 0.1% annual GDP loss between 2000 and 2018, amounting to over 40 billion Yuan (approximately 6 billion USD) each year – which is equivalent to the output of 2.8 average Chinese counties, or that of a country like Rwanda or Mongolia.

Overall, we view our findings as a novel contribution to the study of individual leaders. We extend the agenda by highlighting the importance of strongly-held subjective beliefs in shaping leader decisions. Our analysis not only establishes the existence of such effects but also quantifies the associated macro costs in a relevant context. Finally, by examining the real consequences of traditional beliefs in politics, this paper further bridges the rich literature on culture and political leadership.

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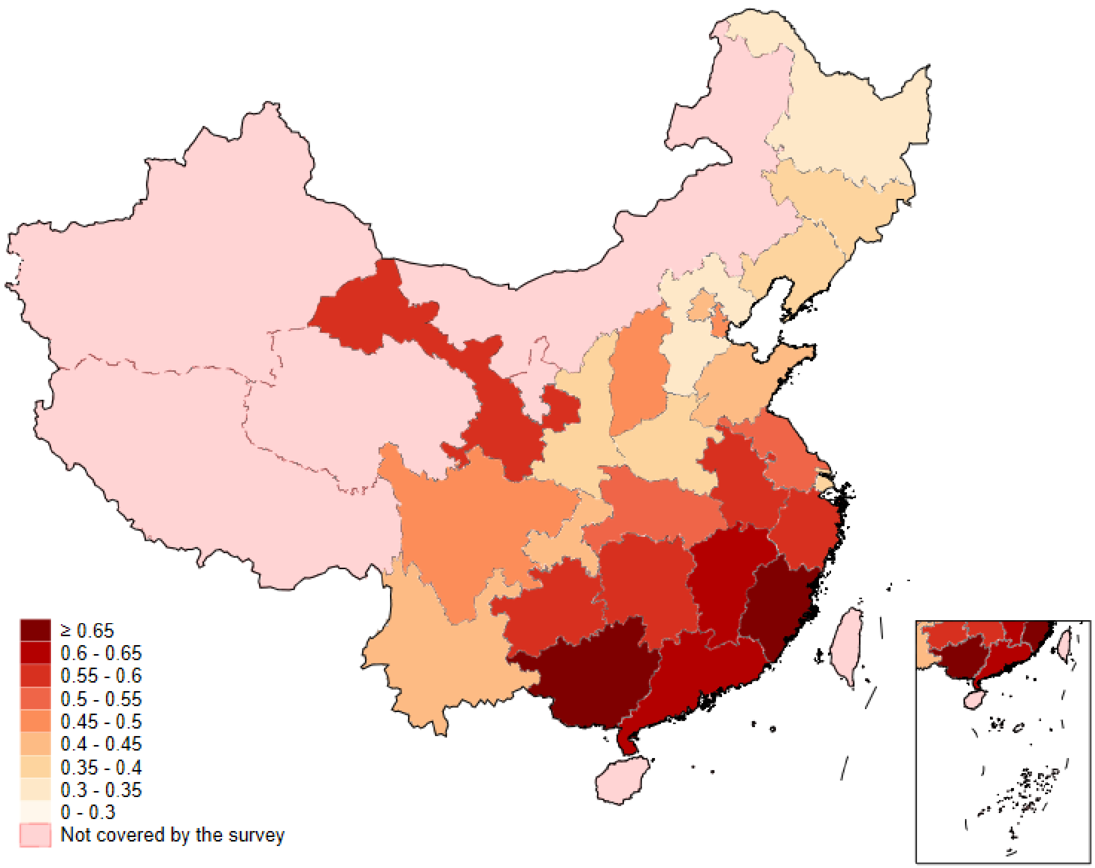
Figures

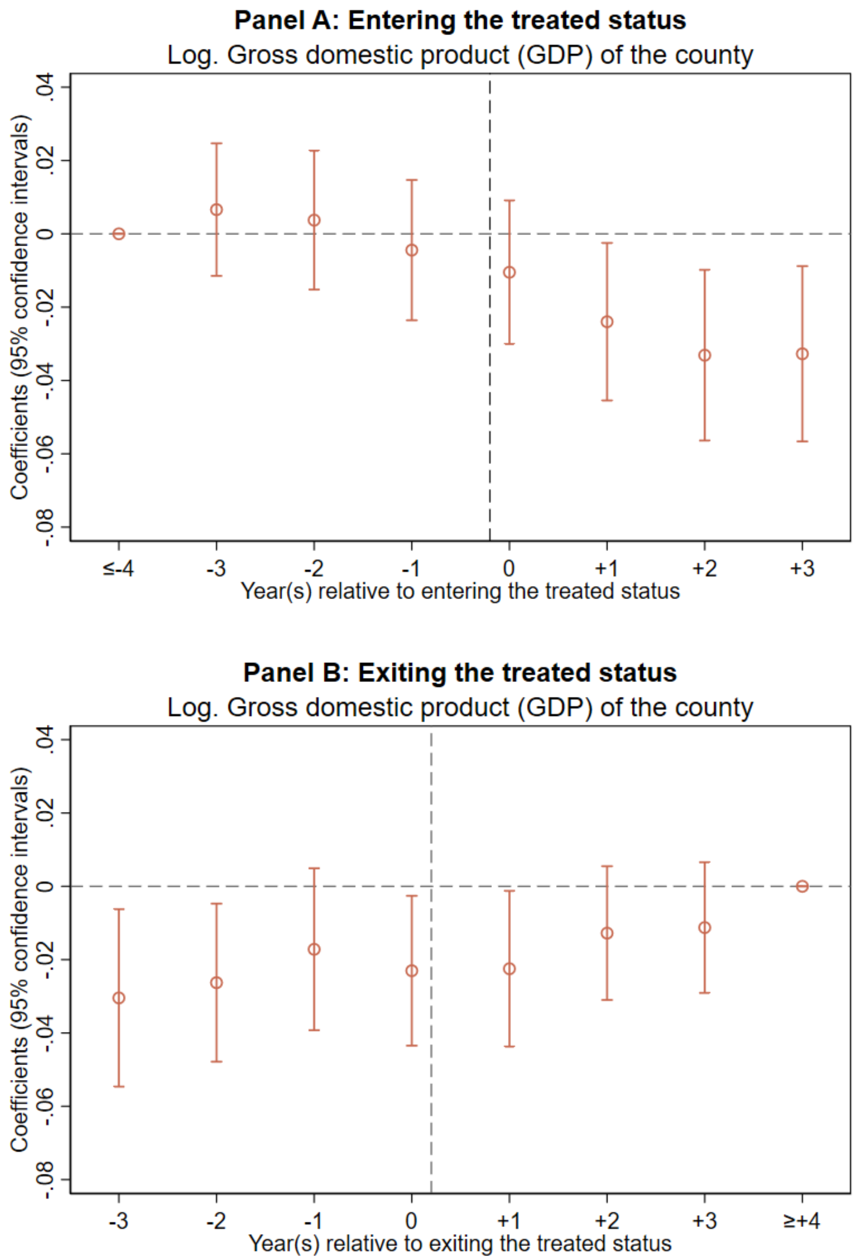
Figure 1: Share of people with traditional beliefs about spaces in China



Notes: The map visualizes the share of surveyed individuals who reported holding spatial superstitions, broken down by province. The data are from the 2018 wave of the China Family Panel Studies, a nearly nationally representative survey with about 95% representativeness. The survey question is "Do you believe in *Feng-shui* (i.e., spatial supernatural)?" with responses recorded in a binary format (yes/no).

[Back to Page 7] [Back to Page 18]

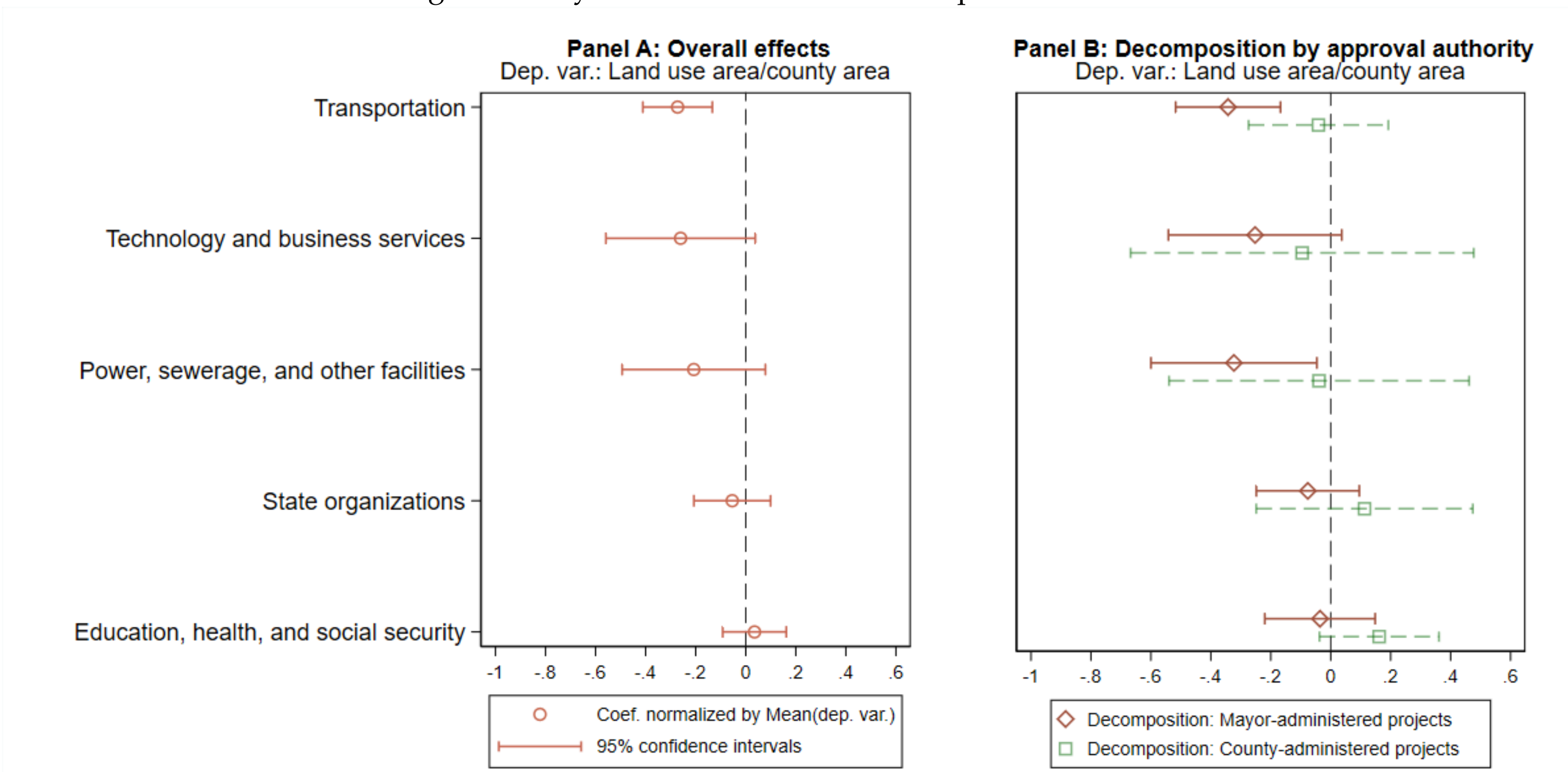
Figure 2: Event study plots



Notes: Unit of observation: county-year. Sample period: 2000 - 2018. Each panel presents the estimates from one augmented event-study-type regression, with county fixed effects and city-year fixed effects (same as the baseline specification). For comparability, we restrict the analysis to status transition observed over at least an 8-year window (4 years before/after the change). Standard errors are clustered at the city level, and 95% confidence intervals are used for the figures.

[Back to Page 16]

Figure 3: Mayors' unfavorable zones and public investment



Notes: The graph depicts the estimated impacts of being located in mayors' supernaturally unfavorable zones on land use area (normalized by the county's area), categorized by type of public investment. In China, governments are the sole providers of land, so changes in land use can serve as a proxy for changes in associated investment. **Panel A** shows the overall effects, while **Panel B** decomposes these effects by approved authority (the mayor vs. subordinate county). Each dot presents the estimate from one regression, with county fixed effects and city-year fixed effects. For comparability, each coefficient is normalized by the mean of its corresponding outcome variable. Unit of observation: county-year. Sample period: 2005 - 2018. Standard errors are clustered at the city level, and 95% confidence intervals are used for the figures.

[Back to Page 21]

Tables

Table 1: Descriptive statistics of main variables

	Mean	Standard deviation	Observations
Panel A: County-Year			
GDP (10,000 CNY in 2014)	2,000,979	6,175,405	42,736
Log. GDP	13.459	1.393	42,736
Log. Primary-sector output	11.684	1.103	42,671
Log. Secondary-sector output	12.503	1.705	42,663
Log. Tertiary-sector output	12.375	1.474	42,559
Number of large enterprises	137.237	369.649	40,631
Log. Output of large enterprises	12.920	2.138	36,692
Log. Fiscal expenditure	11.750	1.344	42,402
Treated zone: Secretary	0.058	0.234	39,990
Treated zone: Mayor	0.061	0.239	39,937
Treated zone: either leader	0.110	0.313	40,567
Panel B: Individual leader			
Secretary: Female (binary)	0.041	0.199	1,628
Secretary: Age of taking office	50.684	3.751	1,521
Secretary: Age of leaving office/turnover	53.990	3.778	1,521
Secretary: Work in native province (binary)	0.664	0.473	1,531
Secretary: Any tertiary education	0.959	0.197	1,479
Mayor: Female (binary)	0.058	0.234	1,821
Mayor: Age of taking office	48.167	4.218	1,730
Mayor: Age of leaving office/turnover	50.215	4.214	1,730
Mayor: Work in native province (binary)	0.730	0.444	1,719
Mayor: Any tertiary education	0.948	0.223	1,628

Notes: Sample period: 2000 - 2018. In **Panel A**, all output and expenditure related outcomes are measured in 2014 CNY. "*Large enterprises*" refer to industrial enterprises with annual revenue exceeding the size threshold established by the Chinese government, which was 5 million RMB before 2011 and 20 million RMB after 2011. Data on the annual output value of large enterprises are available for the years 2000 to 2016. "*Treated zone*" is the explanatory variable of interest, which is a dummy that is 1 if a county is located in its then leader's unfavorable zone according to traditional beliefs about spaces. In **Panel B**, leaders' tertiary education includes on-the-job experience.

[Back to Page 13]

Table 2: Leaders' spatial biases and regional development

	Log. County GDP			
	(1)	(2)	(3)	(4)
Mean of dep. var	13.612	13.612	13.612	13.612
Treated zone (either leader)	-0.013*			
	(0.007)			
Treated zone (Secretary)		-0.007		-0.006
		(0.008)		(0.008)
Treated zone (Mayor)			-0.023***	-0.023***
			(0.008)	(0.008)
County FEs	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y
Observations	37,854	37,854	37,854	37,854
Adjusted R-squared	0.986	0.986	0.986	0.986

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city leader(s). Each city is co-governed by a Party Secretary and a Mayor. The Secretary has more bearing on the general political agenda and personnel decisions; the Mayor heads the government agency responsible for formulating and implementing socioeconomic policies and their administration. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 15]

Table 3: Heterogeneity by mayor hometown and workplace

	Log. County GDP		
	(1)	(2)	(3)
Mean of dep. var	13.612	13.610	13.610
Treated zone (Mayor)	-0.023***	-0.021**	-0.021**
	(0.008)	(0.009)	(0.009)
× Spatial belief prevalence in mayor hometown province (centered)		-0.145**	
		(0.060)	
× Spatial belief prevalence in workplace province (centered)			-0.018
			(0.012)
× Other province characteristics (centered)		Y	Y
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	37,854	37,387	37,387
Adjusted R-squared	0.986	0.986	0.986

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. "*Spatial belief prevalence*" is a province-specific continuous variable, constructed by calculating the share of individuals who hold supernatural beliefs about spaces; the individual belief holding (as a binary) is obtained from the China Family Panel Studies (2018), a nearly-representative survey of Chinese individuals. A province acts as the first-level administrative division above cities in China. Standard errors in parentheses are clustered at the city level. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

[Back to Page 18]

Table 4: Mayor decisions and public spending

	Textual analysis of mayors' annual development plans		Log. Public expenditure
	Frequency	Sentiment (0, negative – 1, positive)	
	(1)	(2)	(3)
Mean of dep. var	3.557	0.602	11.910
Treated zone (Mayor)	-0.375**	-0.018*	-0.011*
	(0.172)	(0.011)	(0.006)
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	32,028	32,028	37,715
Adjusted R-squared	0.800	0.873	0.969
Sample period	2004 – 2018 (due to availability)		2000 – 2018

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. The outcomes in Columns 1 and 2 are elicited from development plans detailed in annual government reports by local mayors. These plans outline major initiatives for the upcoming year. Column 1 examines how often a county is mentioned. Column 2 examines the textual sentiment when mayors describing projects of a county, using sentiment analysis based on GPT's textual evaluation of the report content (where 0 represents the most negative and 1 the most positive). Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 20]

Table 5: Leaders' spatial biases and industrial firm outcomes

	Log. Total output of large enterprises (1)	Log. Number of large enterprises (2)	Log. Output per large enterprise (3)
Mean of dep. var	13.110	3.883	9.103
Treated zone (Mayor)	-0.048**	-0.030**	-0.026
	(0.023)	(0.015)	(0.017)
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	33,996	33,194	31,437
Adjusted R-squared	0.953	0.959	0.935

Notes: Unit of observation: county-year. Sample period: 2000 - 2016. The county yearbooks did not collect firm output data after 2017. "Large enterprises" refer to industrial enterprises with annual revenue exceeding the size threshold established by the Chinese government, which was 5 million RMB before 2011 and 20 million RMB after 2011. "*Treated zone (Mayor)*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 23]

Table 6: Firm-level changes, entry, and exit rates

	Outcomes of remaining ASIP firms			Firm entry and exit	
	Log. Employees (#) (1)	Log. Capital stock (2)	Log. TFP (3)	Entry rate (%) (4)	Exit rate (%) (5)
Mean of dep. var	4.681	8.360	0.522	21.973	2.443
Treated zone (Mayor)	-0.009**	-0.015**	-0.037***	-1.420*	0.131
	(0.004)	(0.006)	(0.007)	(0.720)	(0.119)
Unit of Obs.	Firm-Year	Firm-Year	Firm-Year	County-Year	County-Year
Firm FEs	Y	Y	Y	-	-
County FEs	-	-	-	Y	Y
City-Year FEs	Y	Y	Y	Y	Y
Observations	1,533,913	1,533,913	1,533,913	37,854	37,854
Sample	ASIP (2000 - 2007): Large-scale industrial firm census			SAIC (2000 - 2018): Universe firm registration records	

Notes: ASIP refers to the *Annual Surveys of Industrial Production*; it contains all non-state-owned enterprises generating revenue exceeding 5 million RMB, as well as all state-owned enterprises in the Chinese manufacturing sector. SAIC refers to the *State Administration for Industry and Commerce of China*. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 23]

Table 7: Leaders' spatial biases and household-side changes

	Log. Formally registered households (1)	Log. Population (2)	Log. Employment of secondary and tertiary sectors (3)
Mean of dep. var	11.558	12.978	10.758
Treated zone (Mayor)	-0.001	-0.003***	-0.014*
	(0.003)	(0.001)	(0.008)
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	37,760	37,760	11,263
Adjusted R-squared	0.996	0.988	0.942
Sample period	2000 - 2018	2000 - 2018	2012 - 2018

Notes: Unit of observation: county-year. Employment-related statistics are available only for the secondary and tertiary sectors from 2012 to 2018. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 24]

Table 8: Heterogeneity by institutional environments

	Log. County GDP			
	(1)	(2)	(3)	(4)
Mean of dep. var.	13.576	13.576	13.576	13.576
Treated zone (Mayor)	-0.023***	-0.022**	-0.022**	-0.023**
	(0.009)	(0.009)	(0.009)	(0.009)
× Government intervention (standardized)		-0.022**	-0.023**	
		(0.011)	(0.011)	
× Alternative measure: Marketization index (standardized)				0.028**
				(0.011)
× Provincial GDP per capita (standardized)			-0.003	-0.011
			(0.008)	(0.009)
× Spatial belief prevalence in mayor hometown (standardized)			-0.021**	-0.026***
			(0.011)	(0.012)
County FEs	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y
Observations	38,800	38,800	38,800	38,800
Adjusted R-squared	0.986	0.986	0.986	0.986

Notes: Unit of observation: county-year. For consistency, we keep observations for which all explanatory variables are available. "*Treated zone (Mayor)*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. "*Spatial belief prevalence in mayor hometown*" is a province-specific continuous variable, constructed by calculating the share of individuals who hold supernatural beliefs about spaces; the individual belief holding (as a binary) is obtained from the China Family Panel Studies (2018), a nearly-representative survey of Chinese individuals. All other mediator variables are at the province-year level. "*Government intervention*" is the share of provincial government business-related expenditures over GDP (Jia, Lan and Padró i Miquel, 2020), and "*Marketization index*" is the pre-packaged score constructed by Wang, Fan and Hu (2018). Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 28]

Table 9: The role of less-institutional factors

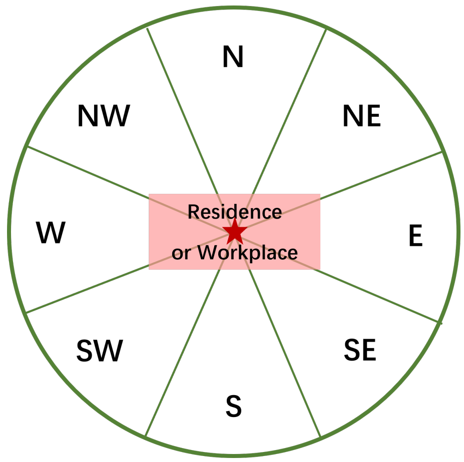
	Log. County GDP		
	(1)	(2)	(3)
Mean of dep. var.	13.612	13.612	13.612
Treated zone (Mayor)	-0.023***	-0.023***	-0.021***
	(0.008)	(0.009)	(0.008)
× Party's ideological training of leaders		0.010	
		(0.007)	
× Anti-corruption			-0.018
			(0.018)
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	37,854	37,854	37,854
Adjusted R-squared	0.986	0.986	0.984

Notes: Unit of observation: county-year. "*Treated zone (Mayor)*" is a dummy that is 1 if the county is supernaturally unfavorable to its city mayor. Each intermediate variable is a binary. "*Party's ideological training*" is a province-year specific dummy that is 1 if the Provincial Party Committee gathers local city leaders for an intensive materialist ideological training. "*Anti-corruption*" is a province-year specific dummy that is 1 if the province is targeted by the central anti-corruption inspection team in the particular year. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 28]

Appendix A Additional Figures and Tables

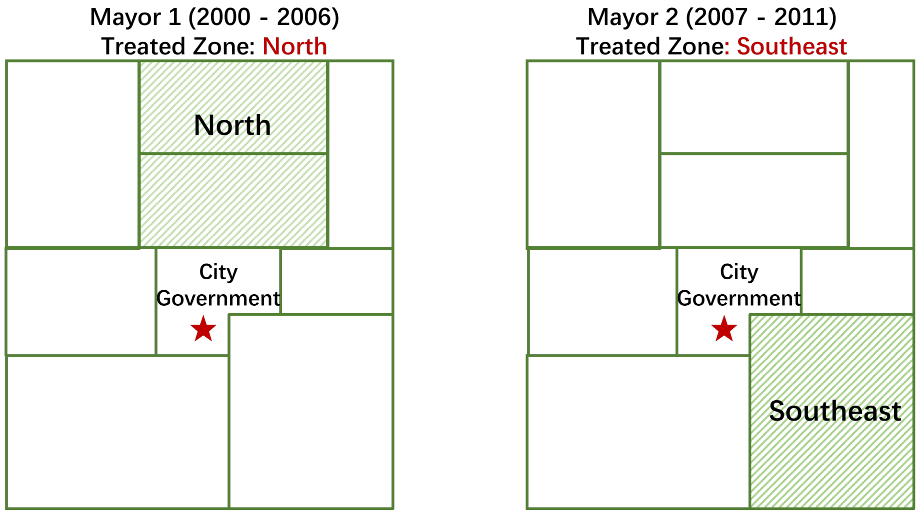
Figure A1: Zones defined by traditional spatial beliefs



Notes: The figure visualizes how the spatial belief system in China defines zones. Taking one's residence or workplace as the origin, there can be eight equally divided zones by direction: N (337.5° - 22.5°), NE (22.5° - 67.5°), E (67.5° - 112.5°), SE (112.5° - 157.5°), S (157.5° - 202.5°), SW (202.5° - 247.5°), W (247.5° - 292.5°), NW (292.5° - 337.5°).

[Back to Page 2] [Back to Page 7]

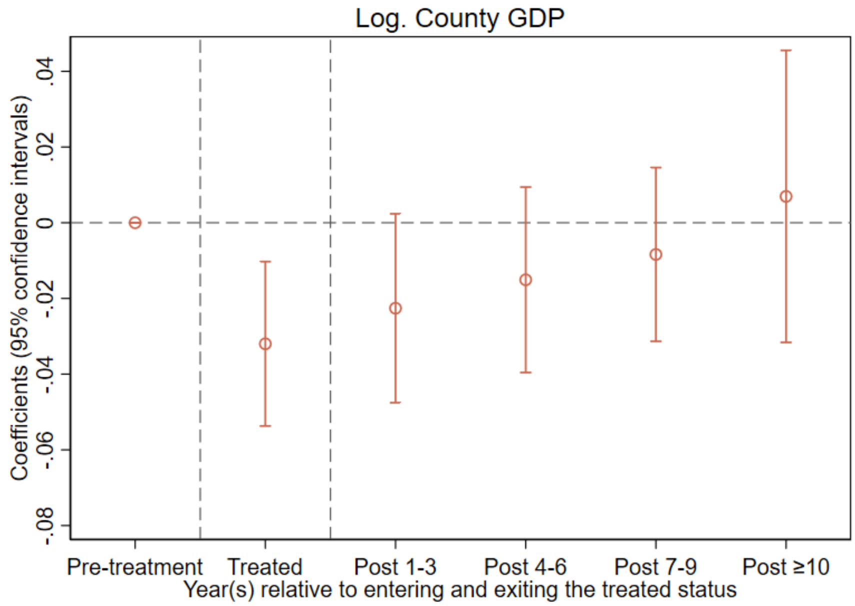
Figure A2: Illustration of the baseline empirical strategy



Notes: This figure illustrates our baseline empirical strategy graphically. Each sub-block represents a county. The city government is where the city leader lives and works. Given a city, the left panel represents Mayor 1's governance period (whose unfavorable zone is North), and the right panel represents Mayor 2's governance period (whose unfavorable zone is Southeast). Shaded counties represent regions that were treated. Each county is oriented according to its geometric center's azimuth angle to the city government. There are two sources of variation. First is the *within-locality* variation – for a given county, whether it is treated or not varies by the year depending on the city leader in office. Second is the *cross-locality* variation – in the same year, the treatment status varies across counties (i.e., under the jurisdiction of a leader, there are both treated and untreated counties).

[Back to Page 14]

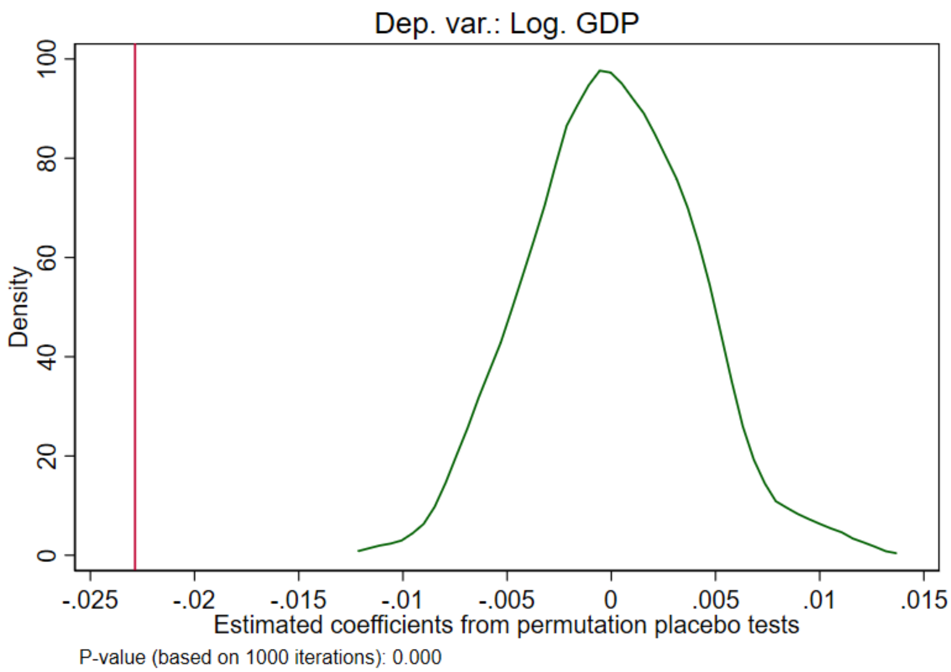
Figure A3: Further analysis on longer-run effects



Notes: Unit of observation: county-year. Sample period: 2000 - 2018. The figure presents the estimates from one augmented event-study-type regression, with county fixed effects and city-year fixed effects (same as the baseline specification). We pool all observations and allow the impact to vary by three-year bins following a county's exit from treatment status. Standard errors are clustered at the city level, and 95% confidence intervals are used for the figures.

[Back to Page 16]

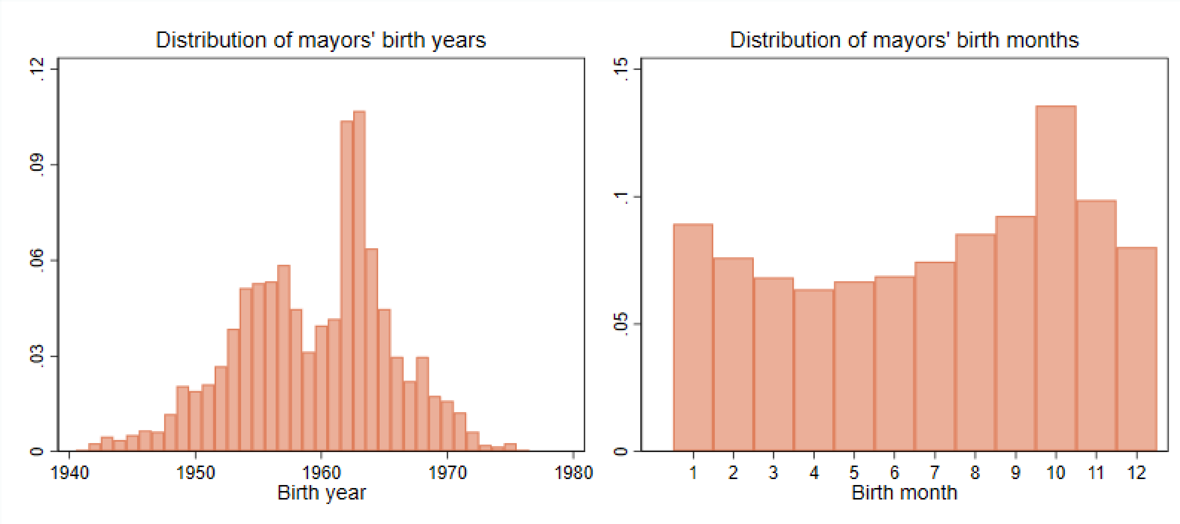
Figure A3: Permutation exercise – Placebo treatment



Notes: The figure presents the distribution for the estimated coefficient for the permutation exercise. Specifically, we conduct 10,000 simulations where we randomly permute whether or not a county is supernaturally unfavorable to its then mayor and use this placebo treatment to re-estimate our main specification. The vertical line represents the baseline estimated coefficient.

[Back to Page 17]

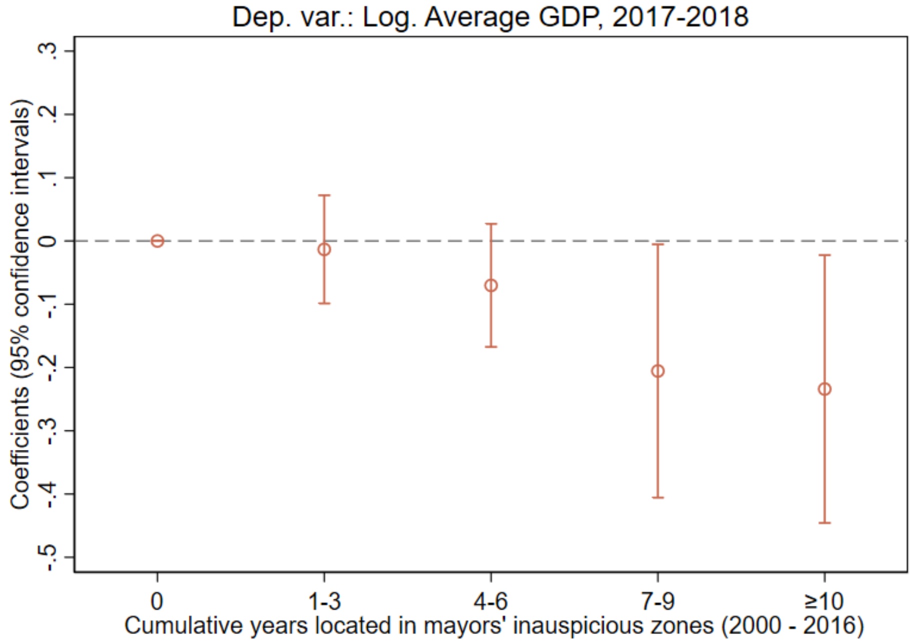
Figure A4: Distribution of mayors' birth years and months



Notes: The figure depicts the distribution of Chinese mayors' birth years and months during the sample period from 2000 to 2018.

[Back to Page 18]

Figure A5: Cumulative impacts of locating in mayors' unfavorable zones



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Notes: Unit of observation: county. Sample period for outcome average: 2017 - 2018. The figure presents the estimates from one augmented cross-sectional regression:

$$y_c = \Sigma\beta_K \times \mathbf{1}[Past\ treated\ years = K]_c + \mu_p + \Gamma x_c^{'} + \varepsilon_c$$

where μ_p are city fixed effects; $x_c^{'}$ are county-level geographic and socioeconomic controls in 1999. Geographic controls comprise the logarithm of county's area, longitude, latitude, the logarithm of the distance to the nearest coast, and the number of subordinate districts/townships in 1999. Socioeconomic controls comprise the logarithm of the population, the share of rural workers, the logarithm of total GDP, the shares of primary/secondary/tertiary-sector GDP, the logarithm of fiscal expenditure, and the logarithm of fiscal revenue in 1999. For comparability, we also hold constant the latest treated year cohort. Standard errors are clustered at the city level, and 95% confidence intervals are used for the figure.

[Back to Page 18]

Table A1: Balance checks – county characteristics in 1999

	Mean (standard deviation)		Mean difference: (2)−(1)	
	Non-treated counties	Ever-treated counties	Raw	Conditional
Variable	(1)	(2)	(3)	(4)
Latitude	33.421	32.850	0.571	-0.010
	(0.458)	(0.505)	(0.464)	(0.021)
Longitude	110.377	111.252	-0.874	-0.046
	(0.750)	(0.739)	(0.795)	(0.031)
Log. Area (km^2)	7.763	7.716	0.047	0.023
	(0.062)	(0.057)	(0.060)	(0.032)
Log. Distance to coast (km)	6.058	5.946	0.112	-0.006
	(0.079)	(0.089)	(0.086)	(0.020)
Number of subordinate towns	17.593	18.331	0.738	0.026
	(8.745)	(8.488)	(0.477)	(0.036)
Log. Population (10 thousand)	3.422	3.484	0.062	-0.019
	(1.006)	(0.867)	(0.077)	(0.032)
Primary schooler share	0.112	0.111	-0.001	0.003
	(0.029)	(0.034)	(0.003)	(0.002)
Rural worker share	0.414	0.421	0.007	-0.001
	(0.113)	(0.099)	(0.007)	(0.003)
Log. GDP (10 thousand)	11.669	11.724	0.055	-0.039
	(1.283)	(1.139)	(0.095)	(0.037)
Primary-sector GDP share	0.355	0.366	0.011	-0.002
	(0.154)	(0.147)	(0.008)	(0.006)
Secondary-sector GDP share	0.341	0.338	-0.003	0.002
	(0.142)	(0.142)	(0.008)	(0.007)
Tertiary-sector GDP share	0.304	0.296	-0.008	-0.001
	(0.088)	(0.072)	(0.005)	(0.004)
Log. Fiscal expenditure (10 thousand)	9.257	9.267	0.010	-0.022
	(0.739)	(0.623)	(0.054)	(0.022)
Log. Fiscal revenue (10 thousand)	8.473	8.526	0.053	-0.031
	(1.194)	(1.025)	(0.093)	(0.037)
Observations	1,346	948	2,295	2,295

Notes: Unit of observation: county (in 1999). "*Non-treated counties*" refer to counties that have not been in city leaders' unfavorable zones from 2000 to 2018. Mean differences in Column 4 are obtained by regressions with city fixed effects and county orientation fixed effects (N, NE, E, SE, S, SW, W, NW). For mean differences, standard errors in parentheses are clustered at the city level. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

[Back to Page 14]

Table A2: County characteristics and future treatment status

	Treated under the next city leader (binary)		
	Party Secretary	Mayor	Either leader
	(1)	(2)	(3)
Mean of dep. var	0.056	0.058	0.106
Log. Area	-0.048	0.011	-0.032
	(0.041)	(0.040)	(0.066)
Log. Population	-0.018	-0.039	-0.020
	(0.030)	(0.033)	(0.044)
Log. GDP	0.025	0.022	0.041
	(0.030)	(0.032)	(0.046)
Log. Primary-sector output	-0.008	-0.035	-0.038
	(0.021)	(0.025)	(0.033)
Log. Secondary-sector output	0.015	0.015	0.007
	(0.017)	(0.018)	(0.023)
Log. Tertiary-sector output	-0.008	0.002	-0.027
	(0.013)	(0.013)	(0.020)
Log. Large-scale enterprises (#)	0.003	0.003	-0.005
	(0.004)	(0.005)	(0.007)
Log. Fiscal expenditure	0.009	-0.005	-0.007
	(0.014)	(0.015)	(0.021)
Log. Fiscal revenue	-0.018	-0.005	0.006
	(0.010)	(0.012)	(0.015)
Log. Beds per hospital (#)	0.008	-0.001	-0.008
	(0.011)	(0.012)	(0.015)
Log. Social welfare institutions (#)	0.005	0.013	0.007
	(0.005)	(0.007)	(0.007)
Log. Primary and middle schoolers	-0.031	-0.031	-0.025
	(0.020)	(0.023)	(0.030)
Log. Total loans	-0.012	-0.014	0.000
	(0.008)	(0.009)	(0.012)
Log. Household saving	0.011	-0.003	0.002
	(0.011)	(0.011)	(0.015)
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	37,322	34,160	32,875
F-test of overall significance (P value)	0.483	0.247	0.845

Notes: Unit of observation: county-year (2000 - 2018). The outcome variable is a dummy for the future treatment status, which is 1 if the county is located in its succeeding city leader's supernaturally unfavorable zones. Each city is co-governed by a Party Secretary and a Mayor. There can be vacancies for the positions of Secretary or Mayor in some transition years. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 14]

Table A3: Balance checks – city leader characteristics

	Mean (standard deviation)		Mean difference
	Within-leader variation >0	Within-leader variation = 0	Raw: (2)-(1)
	(1)	(2)	(3)
Panel A: Party Secretaries			
Secretary: Female (binary)	0.040	0.045	-0.004
	(0.005)	(0.012)	(0.013)
Secretary: Age of taking office	50.722	50.651	0.071
	(0.112)	(0.230)	(0.247)
Secretary: Age of stepping down/turnover	53.982	54.023	-0.041
	(0.131)	(0.235)	(0.264)
Secretary: Work in native province (binary)	0.660	0.680	-0.020
	(0.016)	(0.028)	(0.029)
Secretary: Bachelor degree (binary)	0.242	0.267	-0.025
	(0.012)	(0.024)	(0.028)
Secretary: Master degree (binary)	0.550	0.513	0.037
	(0.014)	(0.026)	(0.030)
Secretary: Doctorate degree (binary)	0.169	0.173	-0.004
	(0.011)	(0.021)	(0.024)
Observations	1,315	313	1,628
Panel B: Mayors			
Mayor: Female (binary)	0.059	0.054	0.005
	(0.006)	(0.012)	(0.014)
Mayor: Age of taking office	48.232	48.076	0.156
	(0.119)	(0.218)	(0.246)
Mayor: Age of stepping down/turnover	50.252	49.981	0.271
	(0.134)	(0.242)	(0.259)
Mayor: Work in native province (binary)	0.725	0.745	-0.020
	(0.014)	(0.024)	(0.025)
Mayor: Bachelor degree (binary)	0.208	0.230	-0.022
	(0.012)	(0.022)	(0.025)
Mayor: Master degree (binary)	0.560	0.581	-0.021
	(0.015)	(0.028)	(0.031)
Mayor: Doctorate degree (binary)	0.176	0.151	0.025
	(0.011)	(0.019)	(0.022)
Observations	1,451	370	1,821

Notes: Unit of observation: city leader (2000 - 2018). "*Within-leader variation*" refers to the presence of any unfavorable zones within the city governed by a leader, according to spatial superstitions. For mean differences, standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 14]

Table A4: Leaders' spatial biases and GDP subcomponents

	Log. GDP sub-components		
	Primary sector	Secondary sector	Tertiary sector
	(1)	(2)	(3)
Mean of dep. var	11.552	12.226	12.060
Treated zone (Mayor)	-0.018**	-0.044***	-0.020**
	(0.007)	(0.015)	(0.009)
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	37,461	37,461	37,461
Adjusted R-squared	0.967	0.974	0.980

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 15]

Table A5: Robustness to GIS-defined county locations

	Log. County GDP			
	(1)	(2)	(3)	(4)
Mean of dep. var	13.612	13.612	13.612	13.612
Treated zone (either leader)	-0.010*			
	(0.005)			
Treated zone (Secretary)		-0.009		-0.008
		(0.008)		(0.008)
Treated zone (Mayor)			-0.022***	-0.022***
			(0.008)	(0.007)
County FEs	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y
Observations	37,854	37,854	37,854	37,854
Adjusted R-squared	0.986	0.986	0.986	0.986

Notes: In this table, we define the orientation of a county (relative to its city government) by its geometric center and associated Azimuth angle. Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city leader(s). Each city is co-governed by a Party Secretary and a Mayor. The Secretary has more bearing on the general political agenda and personnel decisions; the Mayor heads the government agency responsible for formulating and implementing socioeconomic policies and their administration. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 17]

Table A6: Excluding moves of city government heads

	Log. County GDP			
	(1)	(2)	(3)	(4)
Mean of dep. var	13.607	13.607	13.607	13.607
Treated zone (either leader)	-0.011			
	(0.007)			
Treated zone (Secretary)		-0.006		0.004
		(0.008)		(0.008)
Treated zone (Mayor)			-0.021**	-0.021**
			(0.008)	(0.008)
County FEs	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y
Observations	37,108	37,108	37,108	37,108
Adjusted R-squared	0.986	0.986	0.986	0.986

Notes: In this table, we exclude leaders who have experienced a move of city government heads. Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city leader(s). Each city is co-governed by a Party Secretary and a Mayor. The Secretary has more bearing on the general political agenda and personnel decisions; the Mayor heads the government agency, responsible for formulating and implementing socioeconomic policies. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 17]

Table A7: Robustness to nighttime light measures

	Log. County GDP		Log. Nighttime light (mean)	Log. Nighttime light (maximum)
	(1)	(2)	(3)	(4)
Mean of dep. var	13.612	13.406	4.670	8.120
Treated zone (Mayor)	-0.023***	-0.018**	-0.059**	-0.076*
	(0.009)	(0.009)	(0.027)	(0.043)
County FEs	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y
Observations	39,291	28,277	27,987	24,516
Adjusted R-squared	0.986	0.987	0.980	0.731
Sample period	2000 - 2018	2000 - 2013	2000 - 2013	2000 - 2013
Data source	County statistical yearbooks		NOAA DMSP (1992-2013)	

Notes: Unit of observation: county-year. "*Treated zone (Mayor)*" is a dummy that is 1 if a county is supernaturally unfavored to its then city mayor. A city oversees an average of 8.5 subordinate counties in China. "*NOAA DMSP*" refers to the nighttime luminosity data sourced from the Defense Meteorological Satellite Program (DMSP) by National Oceanic and Atmospheric Administration (NOAA), offering comparable nighttime light measures spanning from 1992 to 2013. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to page 17]

Table A8: Robustness to alternative clusters for inference

	Log. County GDP			
	(1)	(2)	(3)	(4)
Mean of dep. var	13.612	13.612	13.612	13.612
Treated zone (Mayor)	-0.023***	-0.023***	-0.023***	-0.023***
	(0.008)	(0.008)	(0.007)	(0.009)
Clusters for standard errors	City (baseline)	County	Mayor	Two-way: city and mayor
County FEs	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y
Observations	37,854	37,854	37,854	37,854
Adjusted R-squared	0.986	0.986	0.986	0.986

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city leader(s). Each city is co-governed by a Party Secretary and a Mayor. The Secretary has more bearing on the general political agenda and personnel decisions; the Mayor heads the government agency responsible for formulating and implementing socioeconomic policies and their administration. A city oversees an average of 8.5 subordinate counties in China. Standard errors using various clusters are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 17]

Table A9: Robustness to additional controls

	Log. County GDP		
	(1)	(2)	(3)
Mean of dep. var	13.612	13.612	13.612
Treated zone (Mayor)	-0.023**	-0.030***	-0.027**
	(0.008)	(0.009)	(0.013)
County FEs	Y	Y	Y
City $\times$ Year FEs	Y	Y	Y
County $\times$ Mayor birth year FEs		Y	Y
Mayor FEs $\times$ County characteristics in 1999			Y
Observations	37,854	37,854	36,493
Adjusted R-squared	0.986	0.986	0.987

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. In Column 3, we calculate the principal component of all county characteristics available in 1999 (before our sample period) and interact it with the full vector of mayor fixed effects. The county characteristics include latitude, longitude, number of subordinate towns, county area, population, distance to coast, primary schooler share, rural worker share, GDP, sectoral GDP shares (primary, secondary, tertiary), fiscal expenditure, and revenue. A city oversees an average of 8.5 subordinate counties in China. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 17]

Table A10: Relative share of treated zones by direction

	Relative share of leaders' over-pessimistic zones		
	(1) Party Secretary	(2) City Mayor	(3) Either leader
Northeast	8.80%	8.12%	8.58%
East	11.86%	14.09%	12.60%
Southeast	5.91%	8.33%	7.18%
South	17.29%	13.34%	15.08%
Southwest	9.10%	11.52%	10.38%
West	17.29%	14.21%	15.78%
Northwest	11.21%	12.23%	11.74%
North	18.54%	18.15%	18.66%
Total	100%	100%	100%

Notes: Sample period: 2000 - 2018. Each column displays the composition of the corresponding leader's over-pessimistic zones.

[Back to Page 18]

Table A11: Assessing spillovers in government inputs

	Baseline estimate	Excluding spillovers to non-treated counterparts under the same leaders	Spillovers: (2) - (1)
	(1)	(2)	(3)
Panel A: Mayor report analysis – Frequency			
Treated zone (Mayor)	-0.375**	-0.344**	0.031
	(0.172)	(0.168)	(0.048)
Panel B: Mayor report analysis – Sentiment			
Treated zone (Mayor)	-0.018*	-0.018*	0.000
	(0.011)	(0.010)	(0.010)
Panel C: Log. Public expenditure			
Treated zone (Mayor)	-0.012*	-0.011**	0.001
	(0.006)	(0.006)	(0.003)

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone (Mayor)*" is a dummy that is 1 if the county is supernaturally unfavorable to its then city mayor. Column 1 reports the baseline estimates (comparing treated counties to non-treated counties governed by the same leaders). In Column 2, we use a "cleaner" set of controls – counties within cities where none of the subordinate counties have ever been treated. The outcome variables are defined as those of Table 4. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 22]

Table A12: Assessing spillovers in firm-level outcomes

	Baseline estimate	Excluding spillovers to non-treated counterparts under the same leaders	Spillovers: (2) - (1)
	(1)	(2)	(3)
Panel A: Remaining ASIP firms – Log. Employees (#)			
Treated zone (Mayor)	-0.009**	-0.007	0.002
	(0.004)	(0.004)	(0.003)
Panel B: Remaining ASIP firms – Log. Capital stock			
Treated zone (Mayor)	-0.015*	-0.018***	-0.003
	(0.006)	(0.006)	(0.006)
Panel C: Remaining ASIP firms – Log. TFP			
Treated zone (Mayor)	-0.037***	-0.034***	0.003
	(0.007)	(0.006)	(0.003)
Panel D: Entry rate (%)			
	-1.420*	-1.233*	0.187
	(0.720)	(0.645)	(0.525)
Panel E: Exit rate (%)			
Treated zone (Mayor)	0.131	0.181	0.050
	(0.119)	(0.178)	(0.133)

Notes: "*Treated zone (Mayor)*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. Column 1 reports the baseline estimates (comparing treated counties to non-treated counties governed by the same leaders). In Column 2, we use a "cleaner" set of controls – counties within cities where none of the subordinate counties have ever been treated. The outcome variables are defined as those of Table 6. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 24]

Table A13: City-level aggregate outcomes

	Log. City GDP		Log. Nighttime light (mean)		Mayor promotion (binary)	
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of dep. var	15.107	15.107	1.235	1.235	0.224	0.224
Share of treated area	-0.025		-0.047***		-0.097**	
	(0.016)		(0.015)		(0.038)	
Share of treated population		-0.052*		-0.032**		-0.081*
		(0.030)		(0.015)		(0.043)
Mean of explanatory var.	0.059	0.055	0.058	0.054	0.059	0.055
City FEs	Y	Y	Y	Y	Y	Y
Province-Year FEs	Y	Y	Y	Y	Y	Y
Mayor characteristics	Y	Y	Y	Y	Y	Y
Observations	4,323	4,323	3,518	3,518	4,309	4,309
Data source	City statistical yearbooks (2000 - 2018)		NOAA DMSP (2000 - 2013)		Local yearbooks and official websites (2000 - 2018)	

Notes: Unit of observation: city-year. A city oversees an average of 8.5 subordinate counties in China. "*Share of treated area*" is calculated by $\frac{\text{Area of counties in mayors' unfavorable zones}}{\text{Total area of the city}}$. "*Share of treated population*" is calculated by $\frac{\text{Population in mayors' unfavorable zones}}{\text{Total population of the city}}$. To avoid endogeneity, we construct independent variables based on the population and area at the end of the previous leader's term. Mayor characteristics include the full set of fixed effects for mayor tenure, age, gender, education attainment, and hometown province. "*NOAA DMSP*" refers to the nighttime luminosity data sourced from the *Defense Meteorological Satellite Program* (DMSP) by the *National Oceanic and Atmospheric Administration* (NOAA), offering comparable nighttime light measures spanning from 1992 to 2013. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to page 26]

Table A14: Perceived uncertainty and leaders' supernatural biases

	Log. County GDP	
	(1)	(2)
Mean of dep. var	13.584	13.584
Treated zone (Mayor)	-0.028***	-0.028***
	(0.010)	(0.010)
× City industrial sector share × Lag. # Safety accidents (centered)	-0.003**	-0.002*
	(0.001)	(0.001)
Sector share measure	GDP	Worker (population)
County FEs	Y	Y
City-Year FEs	Y	Y
Lower-order interaction terms	Y	Y
Observations	39,291	38,976
Adjusted R-squared	0.986	0.986

Notes: Unit of observation: county-year. Sample period: 2000 - 2018. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. "*City industrial sector share*" is the industrial output or population share in 2000. "*Lag. # Safety accidents*" is the number of one-year-lagged industrial safety accidents in all other Chinese cities. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[Back to Page 29]

Appendix B Conceptual Framework

Here, we present a simple theoretical framework to motivate our mechanism analysis. The model is not meant to provide a comprehensive theoretical exploration; instead, it intends to help articulate how leaders' over-pessimistic spatial biases influence local GDP through changes in three key actors: the government, firms, and households. Like most contexts, we assume leaders directly impact government investment (e.g., policy support and public infrastructure), which can enhance productivity and stimulate demand. Using a partial spatial equilibrium framework (e.g., Henderson et al., 2022; Jia, Ma and Xie, 2022), we analyze how exogenous, regional-specific shocks driven by mayors affect local economic output.

To incorporate firm entry and household allocation in a tractable manner, we consider the following timeline. Upon assuming office, mayors make development plans that signal potential governmental support to subordinate counties. Firms then decide on entry, while households make decisions regarding location and labor supply.[38] Once government investment is realized, production and consumption take place.

Consider a local economy with M regions. Let G_m denote the government inputs in region m, decided by its mayors. We treat G_m as exogenous here for simplicity, as we are interested in how an exogenous shift in it – consistent with our empirical setting – affects firm and household dynamics.

Production side. Regional economic production is similar to that of the canonical framework by Krugman et al. (1980). In each region, the final output is determined by the CES technology:

$$Y_m = \left(\int_{\omega \in \Omega_m} y(w)^{\frac{\sigma-1}{\sigma}} dw \right)^{\frac{\sigma}{\sigma-1}} \tag{B.1}$$

where Ω_m is the set of varieties produced in region m. The price index is:

$$P_m = \left(\int_{\omega \in \Omega_m} p(w)^{1-\sigma} dw \right)^{\frac{1}{1-\sigma}} \tag{B.2}$$

Establishing a firm in region m requires f_m units of labor (i.e., fixed labor input), and each firm is engaged in monopolistic competition. To produce output, each firm employs l_m^d units of

[38] This setup is largely in line with how Chinese local governments promote regional growth (Jin, 2023).

labor, with a constant-returns-to-scale production technology:

$$y_m = A_m l_m^d \tag{B.3}$$

The productivity level is $A_m(G) = \overline{A}_m \cdot e^{\delta G_m}$. The parameter δ captures the extent to which firm productivity is affected by government input determined by mayors. Following the standard approach, we assume there is an exogenous rate of firm exit prior to production: $\kappa = \overline{k} \cdot e^{-\delta_k G_m}$, with δ_k capturing the extent to which a portion of firms that fail due to poorer governmental support.

Let W_m be the wage rate. In a world of monopolistic competition, the optimal price charged by a firm in region m will be:

$$\frac{\sigma}{\sigma - 1} \frac{W_m}{A_m} = \tilde{\sigma} \frac{W_m}{A_m} \tag{B.4}$$

Accordingly, a firm's total profit will be:

$$\pi_m = \frac{1}{\sigma} \left(\tilde{\sigma} \frac{W_m}{A_m} \right)^{1-\sigma} P_m^{\sigma} Y_m = \frac{W_m l_m^d}{\sigma - 1} \tag{B.5}$$

In equilibrium, the expected cost of establishing a firm should equal the expected profit of a firm in each region:

$$W_m f_m = (1 - \kappa)\pi_m \tag{B.6}$$

Household side. Households' utility is given by:

$$\begin{aligned} U_m &= v_m B_m \left(c_m l_m - \psi_m \frac{l_m^{1+1/\phi_L}}{1 + 1/\phi_L} \right) \\ \text{s.t.} \quad & P_m c_m \leq W_m \end{aligned} \tag{B.7}$$

c_m represents consumption per labor. v_m represents location preferences for households in region m, following a standard i.i.d. Frechet distribution $F(v) = e^{-v^{-\phi_M}}$. B_m represents amenities, with $B_m = \overline{B}_m^{\frac{1}{\psi_M}} e^{\eta G_m}$. The parameter $\eta > 0$ captures the extent to which local amenity is positively affected by government inputs. We allow a positive labor supply elasticity $\phi_L > 0$. That is, changes in local employment are not solely due to households' relocation but also their endogenous labor supply. As noted, we assume each household selects its location and labor supply to maximize its utility after mayors signal their policies:

$$\text{Max}_{m,l_m} U_m \tag{B.8}$$

In equilibrium, we have the population share Λ_m and the optimal labor supply l_m:

$$l_m = \left(\frac{W_m}{\psi_m P_m}\right)^{\phi_L} \tag{B.9}$$

$$\Lambda_m = \frac{\left(B_m \psi_m l_m^{1+1/\phi_L}\right)^{\phi_M}}{\sum_{m'} \left(\psi_{m'} B_{m'} l_{m'}^{1+1/\phi_L}\right)^{\phi_M}} \tag{B.10}$$

The total labor supply in region m is then given by $L_m = \Lambda_m l_m \overline{L} = \Lambda_m l_m$ (we normalize the total number of households $\overline{L}$ to 1 without loss of generality).

Equilibrium. The market clearing for final goods in region m requires that households' consumption and government investment equal the total production:

$$P_m L_m c_m + P_m G_m = P_m Y_m \tag{B.11}$$

Let N_m^0 be the number of firm entrants in region m before leader shocks occur, and let $N_m = N_m^0(1-\kappa)$ be the number of actively operating firms, reflecting the effects of firm exits. The labor market clearing requires:

$$N_m^0 f_m + N_m l_m^d = L_m \tag{B.12}$$

Combining this with Equations (B.5) and (B.6), we have:

$$N_m^0 = \frac{L_m}{\sigma f_m} \tag{B.13}$$

$$l_m^d = \frac{(\sigma-1) f_m}{1-\kappa} \tag{B.14}$$

Comparative statics. Combining the above equilibrium conditions, we have:

$$\text{Labor supply:} \quad d\hat{l}_m = F\left(\phi_L, \phi_M, \frac{1}{\sigma-1}, \bar{\kappa}\delta_\kappa, \delta, \eta, G_m\right) dG_m, \tag{B.15}$$

$$\text{Population share:} \quad d\hat{\Lambda}_m = \phi_M \left[(1 + 1/\phi_L)\, d\hat{l}_m - \eta dG_m\right], \tag{B.16}$$

$$\text{Employment:} \quad d\hat{L}_m = d\hat{l}_m + d\hat{\Lambda}_m, \tag{B.17}$$

$$\text{Firm count:} \quad d\widehat{N}_m = d\hat{L}_m + \bar{\kappa}\delta_k dG_m, \tag{B.18}$$

$$\text{Output:} \quad d\widehat{Y}_m = \delta dG_m + d\hat{L}_m + \frac{1}{\sigma-1} d\widehat{N}_m, \tag{B.19}$$

We see that changes in output result not only from shifts in productivity and demand driven by government investment, but also from firm entry and labor dynamics. The latter two components are influenced indirectly by mayors' government inputs.[39]

[Back to Page 20]

[39] Without imposing additional structure, $d\hat{l_m}$ does not have a closed-form in our model, so we leave it as $F(.)$ in Equation (B.15). This does not affect the main takeaway regarding output changes.

Appendix C Further Results on Firm Outcomes

C.1 Heterogeneity Analyses

We present additional findings to further characterize firm-level consequences in mayors' unfavorable zones. Table C1 examines the heterogeneity by firm ownership. Columns 1 - 2 indicate that the reduction in hiring is primarily driven by private firms. This finding speaks to the well-known personnel rigidity of SOEs. Meanwhile, state-owned enterprises (SOEs) also experience a less significant decline in capital accumulation (Columns 3 - 4). In line with these patterns, Columns 5 - 6 show a greater productivity decline among SOEs in treated regions.

Table C1: Changes in remaining ASIF firms (by ownership)

	Log. Employees (#)		Log. Capital stock		Log. TFP	
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of dep. var	4.656	4.852	8.333	8.543	0.563	0.240
Treated zone (Mayor)	-0.011**	-0.004	-0.016**	-0.011	-0.030***	-0.041***
	(0.005)	(0.013)	(0.007)	(0.011)	(0.007)	(0.016)
Ownership	Private	SOE	Private	SOE	Private	SOE
Firm FEs	Y	Y	Y	Y	Y	Y
City-Year FEs	Y	Y	Y	Y	Y	Y
Observations	1,339,107	194,806	1,339,107	194,806	1,339,107	194,806
Sample	ASIP (2000 - 2007): Large-scale industrial firm census					

Notes: The unit of observation is at the firm-year level. ASIP refers to the *Annual Surveys of Industrial Production*; it contains all non-state-owned enterprises generating revenue exceeding 5 million RMB, as well as all state-owned enterprises in the Chinese manufacturing sector. "*Treated zone (Mayor)*" is a dummy that is 1 if a county is supernaturally unfavorable to its then city mayor. "*SOE*" refers to state owned enterprises. Standard errors in parentheses are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We also break down the impact by industry type to assess whether the effects are concentrated in industries with specific characteristics. Table C2 presents the estimates. Nearly all manufacturing industries in mayors' unfavorable counties experience a decline in productivity. However, the most significant drop is observed in high-tech firms, likely because their development often depends heavily on local government support, such as public facilities and subsidies. Overall, the results indicate a broad impact of mayors' decisions on local firms.

Table C2: Changes in remaining ASIF firms (by industry type)

Dep. var.: Log. TFP		
Industry type	Classification code	Estimate
Food and beverage	13, 14, 15, 16	-0.030*
		(0.019)
Textile and leather	17, 18, 19	-0.042***
		(0.013)
Wood processing, furniture, and paper	20, 21, 22	-0.079***
		(0.025)
Art and sport	23, 24	-0.086***
		(0.031)
Petroleum and chemistry	25, 26	-0.045**
		(0.021)
Medicine	27	0.026
		(0.051)
Non-metal products	28, 29, 30	-0.055*
		(0.029)
Metal products	31, 32, 33	-0.038**
		(0.015)
Machinery	34, 35	-0.043***
		(0.018)
Vehicle	36, 37	-0.036
		(0.025)
Computer, communication, and high-tech	38, 39, 40	-0.110***
		(0.028)
Others	41, 42	-0.037
		(0.044)
Specification: Firm FEs + City-Year FEs		

Notes: The unit of observation is at the firm-year level. The dataset used is the *Annual Surveys of Industrial Production*, which contains all non-state-owned enterprises generating revenue exceeding 5 million RMB, as well as all state-owned enterprises in the Chinese manufacturing sector. Classification codes are based on official industry codes established by the Chinese government. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C.2 Suggestive Evidence on Allocative Efficiency

We extend our firm analysis by probing potential changes in misallocation. As mayors' spatial biases have disproportionately harmed the productivity of high-tech and SOE firms, it is conceptually plausible that such biases could distort the allocative efficiency in affected counties. Align with the literature, we estimate the revenue total factor productivity (TFPR) of industrial enterprises within each county between 2000 and 2007, positing that greater TFPR dispersion is indicative of higher resource misallocation and suggests a larger scope for improvement (Ding et al., 2018). The underlying rationale is that resource allocation among firms depends on both levels of firm-specific TFP and the distortions they encounter. In an efficient resource allocation, the marginal revenue products of capital and labor are equalized across firms. Accordingly, the extent of misallocation is worse when there is greater TFP dispersion, and higher marginal revenue products signal the presence of disincentives impacting firm performance.

Table C3: Leaders' spatial biases and misallocation

	TFPR dispersion (std. dev. of log.)		
	(1)	(2)	(3)
Mean of dep. var	1.833	0.867	0.834
Treated zone (Mayor)	0.219***	0.038**	0.024
	(0.075)	(0.017)	(0.016)
Model	Hsieh-Klenow	Levinsohn-Petrin	Ackerberg-Caves-Frazer
County FEs	Y	Y	Y
City-Year FEs	Y	Y	Y
Observations	9,124	9,124	9,124
Std. dev. of dep. var	1.129	0.220	0.218

Notes: Unit of observation: county-year. Sample period: 2000 - 2007. "*Treated zone* (*Mayor*)" is a dummy that is 1 if a county is supernaturally unfavorable to is then city mayor. We restrict to counties with more than 5 large-scale enterprises to ensure a reliable estimation of TFPR dispersion. The outcome variables are constructed based on firm-level data from the Annual Surveys of Industrial Production (ASIP). The ASIP encompasses all non-state-owned enterprises generating revenue exceeding 5 million RMB, as well as all state-owned enterprises, wherein we focus on manufacturing firms. Adopting the methodology of Brandt, Van Biesebroeck and Zhang (2012), we track firms over time and calculate the capital stock and investment employing the perpetual inventory method. Our refined firm-level sample comprises approximately 1.8 million observations across 29 two-digit industries within the manufacturing sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C3 examine the impact of being in leaders' unfavorable zones on a county's allocation efficiency (in terms of its industrial firm production). The positive coefficients suggest that mayors' spatial biases would decrease the allocation efficiency within a county, featuring an increase in the TFPR dispersion. To contextualize the magnitude of mayors' supernatural biases, we conduct a back-of-the-envelope calculation based on Hsieh-Klenow's framework as follows: Firstly, we multiply the coefficient of *Treated Zones* (*Mayor*) on TFPR dispersion by the proportion of counties treated (located in unfavorable zones of mayors) in our sample.

Subsequently, we divide this product by the disparity in TFPR dispersion between China and the United States as of 2001. Finally, we multiply this quotient by the potential TFP gain that could be realized from a hypothetical shift of China to the U.S. level of dispersion in TFPR.

The calculation indicates that removing mayors' spatial misbeliefs could contribute to a TFP gain of approximately 1.8% to 4.1%. Compared to the potential gains in China's TFP from a marketization shift, which range between 30% and 50% as documented by Hsieh and Klenow (2009). Under an assumption of hypothetically efficient reallocation of capital and labor, the effect in our context appears modest yet consequential. This comparison underscores the relevance and substantial nature of leader-driven biases in the context of overall economic efficiency.

[Back to Page 24]