State Capacity and Economic Development under Capital Mobility: Evidence from China*

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Abstract

This paper examines the effects of fiscal capacity on local states' market-supporting investment and overall economic development. We build a simple model of capital competition among units with heterogeneous tax enforcement costs, and rely on the Golden Tax Project, which obviates the need for Chinese local tax agencies to deter tax evasion through onsite inspections, as a natural experiment to test the model predictions. Exploiting the heterogeneous shocks that the reform exerts on the fiscal capacity of Chinese counties with different geographic features, we show that the causal effect of a county's fiscal capacity on its market-supporting investment and output respectively is, although positive for counties with the lowest capital mobility, significantly more negative in counties where firms face lower relocation costs. We then provide evidence for the reason why capital mobility decreases the positive economic impact of fiscal capacity: under capital mobility, firms that seek to evade taxes have relocated out of counties that experienced a bigger fiscal capacity increase after the reform. Our results imply that tax evasion was a real consideration for Chinese firms in determining where to locate. Capital mobility, which erodes the complementarity between counties' fiscal capacity and market-supporting investment, has an equalizing effect on economic outputs across counties with different fiscal capacity.

Keywords: State Capacity, Tax Evasion, Capital Mobility, Economic Development

JEL Classification: H26, H32, O17, O23

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"The steepest places have always been the asylum of liberty." - François Baron de Tott

1 Introduction

Standard economic theory often assumes sufficient state capacity not only to tax citizens, but also to commit public funds to a broad set of administrative needs to sustain markets. However, effective states, if present, are only a recent development (Tilly and Ardant, 1975; Tilly, 1992; Hoffman and Rosenthal, 1997). Even today, many developing countries confront problems of prevalent tax evasion, low revenues and unproductive expenditures. Development economists face a major task to develop theories that better incorporate state capacity into their models and provide empirical evidence for the causal effects of state capacity on economic development. This is especially the case given that scholars increasingly consider state capacity to be a vital explanation for why some countries achieve long-run economic growth while others do not.[1]

In this paper, we attempt to examine the economic effects of state capacity and illustrate some of the economic trade-offs governments face in developing state capacity. Following a pioneer theoretical work by Besley and Persson (2009), we restrict our analysis to two aspects of state capacity– a fiscal capacity to extract taxes and a market-supporting capacity which reflects governments' investments in physical infrastructure or regulative measures to sustain markets. Whereas Besley and Persson (2009) predicts that a state's investments in fiscal and market-supporting capacity are complements to each other and therefore the rise of a state's fiscal capacity likely has a positive effect on the state's market-supporting investment and economic output, we argue that these predictions only hold under capital immobility. Using a simple model of competition for capital among units with heterogeneous fiscal capacity endowments, we show that capital mobility may have an eroding effect on the complementarity between the two aspects of state capacity. More specifically, when capital is mobile, firms' incentive to evade taxes may cause them to reallocate out of states that experience a bigger fiscal capacity increase, thereby decreasing these states' returns and incentives to invest in market-supporting capacity. Therefore, the causal effects of fiscal capacity on a state's market-supporting investment and economic output are *not* unambiguously positive: the sign of these effects depends heavily on the extent of capital mobility across the state's borders.

We use panel data from the *Annual Survey of Manufacturers* (1998-2007) and the *Public Finance for Counties and Prefectures* (1996-2006) to estimate the effects of fiscal capacity and test

[1] A series of books by Johnson (1982),Wade (1990) and Evans (1995) have attributed the economic success of East Asian economies at least partially to the presence of strong states with great capacity. Herbst (2000) and Centeno (2002) also linked the economic failure of African or Latin American nations to their limited state capacity. More recently, Besley and Persson (2011) and Fukuyama (2014) begin to propose general theories on how state capacity affects economic development.

our model predictions. Previous works on the subject has been impeded by identification problems. First, states may invest in their fiscal capacity directly in response to their other policy choices or economic outcomes. Second, states with a higher fiscal capacity may have different outcomes because of other state characteristics correlated with fiscal capacity. We address these reverse causality and omitted variable bias problems by taking advantage of a centrally implemented reform in China: the Golden Tax Project. Because the Golden Tax Project introduced a technology that obviates the need for tax-enforcing agencies to verify firm sales and purchases through onsite inspections, counties in more mountainous area, where costs of traveling to local firms used to impose a bigger constraint on tax agencies' ability to enforce taxes, experienced a bigger boost in fiscal capacity from the reform. The county-specific and plausibly exogenous fiscal capacity shocks of the Gold Tax Project enable us to use a differences-in-differences (DID) strategy to identify the causal effects of fiscal capacity. We estimate the causal effects of local fiscal capacity on counties' effective tax rate, market-supporting investment and economic prosperity by comparing how the change in these outcomes before and after the reform differ across counties with different geographical features.

China provides an ideal context for our empirical exercise for several reasons. First, under a system of what Montinola, Qian, and Weingast (1995) called "federalism, Chinese style," the local governments in China not only keep a fixed proportion of the tax revenue generated within their own jurisdiction but also have primary control over how they can allocate their revenue between tax enforcement, public goods provision and market-supporting expenditures. This makes it possible to link the policy choices and economic outcomes of a local county directly with the county government's own fiscal capacity. Second, and importantly for our empirical strategy, China is large enough to offer wide variation in geographical endowments across counties. This, coupled with a new invoice cross-checking technology centrally introduced across the country, provides potential exogenous variation in local fiscal capacity that we exploit to deal with the endogeneity of fiscal capacity and isolate its causal effects.

The results show that a county's fiscal capacity positively affects the effective tax rate that counties enforce on local firms: a one standard deviation increase in a county's terrain ruggedness decreases the county's pre-reform effective value-added tax rate (relative to its post-reform value) by around 0.1 percentage points, or 3 percent of the national median. This provides evidence that tax evasion was quite prevalent among Chinese firms, at least during the pre-reform period.

Also consistent with our model, we find that the effects of a county's fiscal capacity on its market-supporting investment and output are, although positive for counties where firms face the highest relocation costs, significantly more negative in counties where capital is more mobile. This implies that capital mobility indeed has an eroding effect on the complementarity between fiscal capacity and market-supporting infrastructure investment, and the overall effect of fiscal capacity on a county's economic prosperity actually depends heavily on the extent to which firms can move their capital across a state's borders. Therefore, the Golden Tax Project, which increased the relative fiscal capacity of the counties with higher geographic ruggedness, did not necessarily improve the relative economic outcomes of all these counties.

The reason why capital mobility erodes the positive effect of fiscal capacity on market-supporting investment and GDP is that, under capital mobility, firms that seek to evade taxes have incentives to relocate out of counties that experience a more positive fiscal capacity shock. Our estimated effects of the Golden Tax Reform indeed confirm such a pattern of capital reallocation. Based on our estimates, on average, a one standard deviation increase in a county's terrain ruggedness decreases its post-reform number of firms and the fixed assets held by its remaining firms respectively by about 2%. This negative effect of fiscal capacity on capital stock is also significantly higher among counties where capital is more mobile. The results imply that the feasibility of tax evasion was a serious consideration for firms in determining where to locate and how much capital to invest.

Our paper speaks to the growing literature on tax design and tax enforcement in low and middle income countries. By presenting evidence of prevalent tax evasion by Chinese firms, our paper supplements an expanding empirical literature that documents the weak enforcement environment and large evasion rates in developing countries (Pomeranz, 2015; Naritomi, 2015; Kleven, Knudsen, Kreiner, Pedersen, and Saez, 2011). Our results also add to a very limited empirical literature examining the role of technology in improving developing country public sector performance (see, e.g., Lewis-Faupel, Neggers, Olken, and Pande 2016; Muralidharan, Niehaus, and Sukhtankar 2016). In addition, we are one of the first papers that provide direct evidence that firms' tax evasion incentives affect their location choices and have important capital allocation implications.

This paper also contributes to the empirical literature on the effects of state capacity on economic development. Existent literature on the topic has been primarily at the cross-national level (e.g. Gennaioli and Rainer (2007); Baskaran and Bigsten (2013); Dincecco and Katz (2014)). Relative to these cross-country comparisons, Chinese counties are much more comparable with each other, which likely subjects our estimates to fewer interpretation and endogeneity problems.[2] In addition, our rich data at the county level also allows us to give deeper insight into the exact mechanisms through which state capacity affects economic development. In particular, we provide one of the first rigorous empirical tests on the relationship between a state's fiscal capacity and its market-supporting infrastructure investment. In contrast to the existent theoretical literature (Besley and Persson (2009)), which predicts complementarity between the two, we illustrate how capital mobility across states might undermine this complementarity relationship. This further allows us to

[2] The only other within-country study of the effects of local state capacity that we are aware of is Acemoglu, GarcÃ-a-Jimeno, and Robinson (2015), which studies the direct and spillover effects of local state capacity on economic prosperity.

show that the causal effect of state capacity on economic development is in fact heterogeneous and highly dependent on state characteristics, such as the extent of capital mobility across the state's boundary.

In addition, our paper relates to the literature on whether competition to attract mobile capital disciplines governments. A widespread view in both academic and policy circles is that, whether welfare-improving or not, competition for capital should shift government priorities away from corrupt use or nonproductive public spending toward business-friendly investment (e.g.Keen and Marchand (1997); Rom, Peterson, and Scheve (1998); Qian and Roland (1998)).[3] Our paper adds nuances to this conventional view, and demonstrates that whether competition for capital encourages a unit to invest more in business-friendly investment depends on the unit's characteristics and endowments. In particular, when units are heterogeneous in their tax enforcement costs, capital mobility, which erodes the complementarity between units' fiscal capacity and market-supporting investment, may in fact decrease market-supporting investment for units with lower tax enforcement costs. In other words, in our model, capital mobility tends to equalize outputs across units. Our argument stands in great contrast to Cai and Treisman (2005), which argues that capital mobility further polarizes output across units with heterogeneous initial productive endowments. Two main differences explain this contrast. First, in our model, units' heterogeneous endowments do not directly affect local firms' productivity. Second, we allow the effective tax rate to be units' endogenous choice and a key instrument units use to attract private capital. Therefore, high tax enforcement costs, which are purely an administrative disadvantage under capital immobility, can become an advantage in attracting private capital under capital mobility, as firms seek to evade taxes by relocating to high-cost units.

Furthermore, our paper makes contact with several other strands of literature. It supplements the literature on efficiencies in local public finances as suggested by the traditional tax competition literature (e.g. Wilson (1986); Zodrow and Mieszkowski (1986); Wildasin (1988)). Also related is the extensive literature that examines the effect of geography on economic development (e.g. Diamond (1999); Nunn and Qian (2011); Mayshar, Moav, Neeman, and De Pascalis (2015)). .

The remainder of the paper is organized as follows: Section 2 presents background information. Section 3 presents the conceptual framework. Section 4 describes the data. Section 5 discusses the empirical specification. Section 6 presents the estimation results. Section 7 concludes.

[3]Cai and Treisman (2005) has more detailed discussion of this conventional view in its footnote 1 and footnote 2.

2 Background

2.1 Value-added Tax Collection in the 1990s

In 1994, China abolished the cascading turnover tax and replaced it with a value-added tax (VAT) system.[4] Since then, VAT has been a key component of fiscal revenue for the Chinese government. For example, in 2013, the VAT revenue reached 2.88 trillion yuan, or 26.1 percent of China's total tax revenue.

A value-added tax (VAT) is a fee assessed against businesses at each step of their production and distribution process, usually whenever a product is sold or value is added to it. Firms pay VAT on the difference between total sales and total input costs. The VAT rate is fixed by the central government at a nationally uniform level: it is 17 percent for most manufacturing, retailing and wholesaling industries and 13 percent for a some necessities goods, including agricultural products, oils, gas, book, fertilizers, salt, and etc. Exports are fully or partially exempted from VAT, and the exemption rates vary by product and year based on an adjustment scale determined by the State Council. The central government takes 75 percent of VAT collected from each taxpayer and sub-national governments receive the remaining 25 percent.

The Chinese government collects VAT based on invoices submitted by firms. For any transaction, both the buying firm and the selling firm will keep two separate invoice copies of the same transaction. While the buyer gets "tax credit" (input costs) from the invoice, the seller submits a form that lists all the invoices to declare "tax debit" (sales). VAT therefore supposedly has a built-in "self-enforcing" mechanism: because the buyer firm and the seller firm of a transaction have opposite incentives in mis-reporting the transaction amount, the invoices submitted by the two firms can be used to cross-check each other.

In the 1990s, most tax invoices in China were hand-written (see a sample invoice in Figure 1). Whenever a transaction happened, the seller firm would hand-write all the transaction information, including the taxpayer identification numbers that uniquely identify both the seller and the buyer, and the date, the value and the product names of the transaction, on one of the empty invoices it had collected from the local tax agency. Each invoice contained several sheets of special carbon papers coated with a layer of dry ink at the back. Therefore, when the seller wrote the transaction information on the top sheet, each carbon sheet below would, supposedly, copy the same information. The buyer would then collect two sheets of the invoice from the seller: one for claiming tax credit and one for its own record keeping.

The invoice sheets had simple anti-counterfeit features against forgery. However, throughout

[4] Value-added tax was first implemented in France in 1954 and, after over half a century, it has become a crucial component of government revenue for more than 160 countries. One reason for the widespread adoption of the VAT is that it imposes compliance cost without raising administrative costs (Slemrod and Yitzhaki, 2002).

the 1990s, tax fraud was prevalent. Firms could evade VAT tax in three major ways. First, tax invoices could be forged: the anti-counterfeit techniques were not effective at deterring fraud, and it was possible for firms to fabricate or use fake invoices without being detected. Second, authentic tax invoices were traded on the black market. Firms in industries where customers had no demand for invoices sold invoices on the market. A firm could buy these invoices in the market and receive tax credits without actually purchasing inputs. Thirdly, firms can modify the information on tax invoices, or could simply write different information on different sheets. Without an effective way to cross-check invoices between sellers and buyers, it is difficult to detect tax evasion.

2.2 Tax Enforcement Costs and Geography

The main traditional methods to battle VAT evasion in China are through *ex ante* onsite inspections and *ex post* audits.[5] Both require physical visits to taxpayers.

An *ex ante* onsite inspection is also called a regular tax check and covers all firms in each county. It is implemented by tax inspectors from the department of tax collection at the county representative office of the State Administration of Taxation. There are usually several offices within each county, each of which oversees tax collection for a few townships or neighborhoods. Typically, each inspector is in charge of a few hundred firms. The main purpose of these regular checks is to verify firms' production and inventories, inspect firms' accounting books, check invoices, and confirm the value of deductible intermediate inputs.

An *ex post* audit is also called a tax investigation. It is implemented by tax auditors from the department of tax inspection (*jichaju*) at the county representative office of the State Administration of Taxation, which is a different department from the tax-collection department. It targets firms that are found suspicious of tax fraud or have overdue taxes.[6] A firm is found suspicious typically because of irregular tax payments or because tax fraud is reported by whistle-blowers. The main purpose of these investigations is to recover tax revenue loss and punish unlawful tax evasion activities. Auditors bring with them government warrants to collect evidence, such as firm accounting books, for further investigation. Additionally, the auditors can also contact tax agencies in counties where firms' suppliers or customers are located, and solicit tax invoices from them.[7] However, because such solicitation usually requires the cooperation of upper governments or agencies outside the county, it is relatively less frequently used.

[5] See the Detailed Rules for the Implementation of the Law of the People's Republic of China on the Administration of Tax Collection (State Council Order, No. 362, 2002).

[6] *Jichaju* often has limited capacity to audit all suspicious firms. For example, the *jichaju* in Shenzhou county, Hebei province, has in total 11 inspectors and 5 of them are seniors that do not actually participate in tax auditing. As a result, *jichaju* has to be selective when it comes to auditing firms.

[7] Tax agencies that are above the county level are in charge of drafting laws and regulations, coordinating with other government agencies in tax-related criminal cases, and initiating national or regional tax inspection campaign, and other formalities. The county-level departments are responsible for the actual implementation.

Since both *ex ante* onsite tax inspections and *ex post* tax audits require physical visits to firms, counties' tax enforcement costs varied with their geographic characteristics. For a county with a rugged terrain, the tax enforcement costs could be quite high. The following article, published on the website of the State Administration of Taxation in Tianjin Nankai on December 1, 2015, exemplifies the high tax enforcement costs caused by geography:

> "Deqin county in Yunan Province has more than 300 taxpayers, located in 8 townships over an area of 7000 square kilometers. In Deqin, there are snow mountains and river valleys. The mining firms and the power plants are the main taxpayers in the county. The mining firms are located in the mountains over 4000 meters above sea-level, and the power plants are located in the river valleys with temperature typically above 40 degree Celsius in the summer. It is difficult to enforce tax rules and collect overdue taxes here...When the young man, Sina Pinchu, started to work as a tax collector in 1978 in the county, he used to walk over the mountains to collect the overdue taxes, sometimes without a single person in sight for the whole day. Often, he went across the rough river through the rope because there was no bridge and it was nerve-wracking every time... In 2008, Sina Pinchu, already the director of the county tax agency, led a team to visit the mining firms. On the road, their SUV had flat tires every 20 to 30 kilometers..."

Although various methods were employed to battle tax evasion, value-added tax fraud was still prevalent in the 1990s, especially in geographically more rugged areas, partly because of the high costs to enforce tax payments and detect tax evasion.

2.3 The Golden Tax Project

The Golden Tax Project is a major endeavor by the Chinese government to deter VAT fraud and enforce its payments in China. Phase I of the project was launched in August 1994 to establish a computerized invoice cross-checking system in 50 major cities. To make the project cost-effective, the cross-checking system was built upon the existing clearing-house network of the People's Bank of China. The main technology service providers include the China Great Wall Computer Group Corporation and the Aisino Corporation, an information security company founded by 12 enterprises in the Chinese aerospace industry. However, Phase I required enormous manual data entry to digitize information from each invoice, which subjects the system to high administrative costs and an excessive error rate. Phase I was terminated by the end of 1996.

China re-launched the Golden Tax Project Phase II in 2001, after a new technology was developed to solve the main technical problems encountered in phase I. There are two major components of the Phase II reform. First, the reform introduced a software that could encrypt all transaction information on each invoice into a unique 84-digit code. After the Phase II reform, all firms are required to print their invoices directly from their computers using this software. Figure 2 shows a sample of the invoices after the Golden Tax reform. On the top right corner, the invoice displays the unique code that encrypts six pieces of information: the invoice number, the taxpayer identification number of the buyer and the seller, the transaction date, the transaction value, and the tax value. To file taxes, firms simply need to submit the code-encrypted invoices, either directly through an online system or by physically bringing the information to the local tax agency. Second, the Phase II Project also introduced a system of inter-connected computer terminals that can easily read and cross-check invoices received across all regions in China. With all the transaction information digitized, the system can easily detect tax fraud and issue alert, if any unique transaction code does not appear twice: once from the seller and once from the buyer.

This reform successfully solves the invoice forgery problem, as the complex encryption system makes it almost impossible to fabricate invoice: to fabricate any invoice that is readable by the system, one will have to first decipher the encryption method. In addition, mismatch in transaction values on the seller's output tax invoice and the buyer's input tax invoice is no longer possible: the unique invoice code contains the information on the transaction value, so any mismatch will be easily detected by the system.

The anti-counterfeit system and the cross-check system for Phase II of the Golden Tax Project were first connected nationwide in 2001. However, the central government did not abolish hand-written value-added tax invoices for transactions with value greater than 10,000 yuan until 2002. For smaller-value transactions, firms were allowed to claim tax credit from their hand-written invoices until Jan 1, 2003. In our empirical section, we take 2002 as the year that the Golden Tax Project starts taking effect. To address the concern that the reform may really have its major impact anytime between 2001 and 2003, and we also conducted robustness checks on our results by excluding the years of 2001 and 2002 in our empirical analysis. Our results look very similar.

Based on the description above, the Golden Tax Project obviates the need for local tax agencies to detect invoice forgery and mismatch in transaction values through onsite inspections and audits. Although other loopholes for tax evasion may still exist,[8] the reform should have significantly reduced local tax enforcement costs, primarily in VAT but also in all other types of firm taxers that rely on invoices for verifying transactions (e.g. the corporate income tax). In other words, the Golden Tax Project in 2002 should have exerted a positive fiscal capacity shock on all Chinese counties, and counties with more rugged terrain, where the costs of onsite inspections and audits

[8]There have been reports of downstream firms, which make transactions directly with end consumers who usually have no need for invoices, selling authentic invoices at discounted prices to buyers who use them to deduct VAT. In addition, four types of input costs invoices, which can be used to deduct VAT liability, have not been fully covered by the Golden Tax Project II yet. These include customs duty paid proofs, transportation cost invoices, old and waste material purchase invoices, and agricultural products procurement receipts.

used to impose a bigger constraint on their pre-reform tax enforcement, should have experienced an even bigger boost in fiscal capacity than other counties.

3 Conceptual Framework

The Golden Tax Project exogenously exerted a county-specific shock to county governments' tax enforcement costs. To conceptualize how this county-specific shock may affect county government's policy choices and local economic outcomes, we build a simple model, in which units with heterogeneous tax enforcement costs before the reform simultaneously choose their effective tax rate and market-supporting infrastructure investment to compete for capital.

Consider an economy divided into N units (counties) indexed by i, each of which has a government, G_i. Investors own a total amount of capital, K, which they invest in different units. Let k_i be the amount invested in unit i . Before the introduction of a computerized cross-check system, units differ in two respects, one exogenous and one endogenous. First, they differ in their exogenous fiscal capacity, δ_i, which denotes local governments' marginal per-unit-output cost to increase the region's effective tax rate from 0 to t, the nominal tax rate fixed at the national level. The exogenous fiscal capacity reflects units' different geographic features, which significantly influence local government's cost in cross-checking invoices and auditing taxable revenues and expenditures of firms. A unit with a higher δ_i faces higher enforcement costs, and therefore has lower exogenous fiscal capacity.

Second, the units differ in the policies that their governments enact during a game. In particular, governments choose two policies. First, G_i chooses π_i, the amount of enforcement costs it pays to collect taxes, knowing that some firms will evade taxes by manipulating the numbers on the invoices and therefore decrease the effective tax rate if it does not put enough effort in auditing. For simplicity, we assume that effective tax rate, t_i, will be such that

$$\begin{cases} t_i = \frac{\pi_i}{\delta_i F_i} & when \ \ \pi_i \leqslant \delta_i F_i t \\ t_i = t & when \ \ \pi_i > \delta_i F_i t \end{cases} \tag{1}$$

where F_i denotes region i's total output. This is equivalent to a case in which G_i chooses an effective tax rate, $t_i \leq t$, knowing that it will pay an enforcement cost of $\pi_i = \delta_i F_i t_i$. Second, G_i chooses a level of investment in market-supporting infrastructure, I_i. Infrastructure investment should be interpreted broadly as any costly actions governments take to increase productivity of capital in their unit. It could include physical infrastructure (transportation, telecommunications, electricity etc.), education, public health, financial support and a system of well-enforced property rights and legal protections.

Suppose the aggregate production function of unit i is

$$F_i = A k_i^{\alpha} I_i^{\beta}, \tag{2}$$

where $\alpha > 0$, $\beta > 0$, and $\alpha + \beta < 1$ and $A > 0$. The assumption that $\alpha + \beta < 1$ captures the notion that there is another fixed factor such as land or labor.

Following Cai and Treisman (2005), we assume local governments are partially self-interested, and their payoff function is

$$U_i = (1 - t_i)F_i + \lambda v(c_i) \tag{3}$$

where c_i is government spending, $v(\cdot)$ is an increasing and concave function, and $\lambda \geq 0$ measures the government's preference for public spending relative to private consumption. Here, c_i includes any government spending that is not productivity-enhancing. It can include spending related to re-distributive programs or public goods demanded by citizens, or corrupt officials' own consumption of budget funds. Equation (3) thus encompasses governments anywhere along the spectrum between pure benevolence (in which case c_i stands for public good provision and (3) is equivalent to payoff for a representative citizen) and pure predation (in which case c_i represents government consumption and λ approaches infinity). Each government is endowed with initial fiscal revenue $S \geq 0$. The budget constraint of government G_i is

$$\pi_i + I_i + c_i = S + t_i F_i. \tag{4}$$

We study a game in which all governments simultaneously decide how much to invest in tax enforcement and infrastructure. After that, investors will invest their capital. To examine how capital mobility may change some of the model predictions, we compare two polar cases: (a) capital is completely immobile and the allocation is fixed at some historically determined level, and (b) capital is perfectly mobile and can cross borders costlessly. Of course, reality lies somewhere in between, but the comparison suggests what is likely to happen as capital becomes more mobile.

3.1 Capital Immobility

In the case of capital immobility, the level of private capital in each unit is fixed. Let $\overline{k_i} > 0$ be the fixed capital allocation in unit i. Each government G_i chooses $(t_i, c_i, I_i\ )$ to maximize $U_i = (1 - t_i)F_i + \lambda v(c_i)$ subject to its budget constraint $c_i = S + t_i F_i (1 - \delta_i) - I_i$. Substituting the budget constraint into the objective function, we get two first-order conditions with respect to I_i and t_i respectively:

$$\frac{\partial F_i}{\partial I_i} = \frac{\lambda v'}{1 + (\lambda v'(1-\delta_i) - 1)t_i}, \tag{5}$$

$$\lambda v' = \frac{1}{1-\delta_i}. \tag{6}$$

The second-order derivatives of U_i with respect to t_i and I_i are both negative when F_i and v are concave, implying that (I_i, t_i) which satisfies the two first-order conditions should locally maximize U_i. Equation 6 further implies that equilibrium public consumption c_i chosen by G_i depend only δ_i, λ, and the curvature of v, but not i's initial capital endowment $\bar{k}_i$. In particular, applying the implicit function theorem on equation (6), we get

$$\frac{\partial c_i}{\partial \delta_i} = \frac{(1-\delta_i)^{-2}}{\lambda v''} < 0. \tag{7}$$

Higher tax enforcement costs decrease government's spending in public goods provision or corrupt use in equilibrium.

In addition, substituting (6) into (5), we get

$$\frac{\partial F_i}{\partial I_i} = \frac{\beta F_i}{I_i} = \frac{1}{1-\delta_i}. \tag{8}$$

Substituting (8) into (6) and using the implicit function theorem,

$$\frac{\partial t_i}{\partial \delta_i} = \frac{\lambda v'' \frac{(t_i-\beta)F_i}{(1-\beta)} + (1-\delta_i)^{-2}}{\lambda v''(1-\delta_i)F_i} = \frac{\lambda\,(1-\delta_i)^{-1}\,[v'(c_i) + v''(c_i)\cdot(\frac{c_i-S}{1-\beta})]}{\frac{v''}{v'}F_i}. \tag{9}$$

To fix ideas, we assume

$$\begin{aligned} &either S \geq v'^{-1}(\frac{1}{\lambda}) \\ &or v'(x) > -\frac{v''(x)(1-\alpha)(x-S)}{(1-\alpha-\beta)} \forall x \in (S, v'^{-1}(\frac{1}{\lambda})) \end{aligned}. \tag{10}$$

Intuitively, this assumption requires that either the government has enough residual funding or v's concavity is small so that government's need for public consumption will not drive them to compensate lower fiscal capacity with higher tax rate. Under this assumption, we can derive that $\frac{\partial t_i}{\partial \delta_i} < 0$.[9]

In addition, substituting $F_i = A\bar{k}_i^{\alpha} I_i^{\beta}$ into (8), we also get

[9] Later in the empirical section, we will show that the Golden Tax Project indeed increases effective value-added tax rate for counties with higher terrain ruggedness to a greater extent, verifying that the either or condition listed in equation (10) is indeed satisfied.

$$I_i(\overline{k_i}, \delta_i) = [(1-\delta_i)\beta A \overline{k_i}^{\alpha}]^{\frac{1}{(1-\beta)}}, \tag{11}$$

$$F_i(\overline{k_i}, \delta_i) = [(1-\delta_i)^{\beta} \beta^{\beta} A \overline{k_i}^{\alpha}]^{\frac{1}{(1-\beta)}}. \tag{12}$$

By (11), G_i's optimal infrastructure investment under capital immobility is increasing in $\overline{k_i}$ and decreasing in δ_i. In other words,

$$\frac{\partial I_i}{\partial \delta_i} = -\frac{I_i}{(1-\beta)(1-\delta_i)} < 0. \tag{13}$$

Therefore, similar to the results in Besley and Persson (2009), our model shows that, when capital is completely immobile, infrastructure investment and fiscal capacity are complements to each other: higher tax enforcement costs (lower fiscal capacity) decrease governments' investment in productivity-enhancing infrastructure. There are two separate effects that lead to such complementarity. First, there is a revenue effect: higher tax enforcement costs tend to decrease the amount of revenue governments can allocate to different expenditures, including their infrastructure investment. Second, because governments get returns of their infrastructure investment partly through collecting taxes on firms' outputs, higher tax enforcement costs also tend to decrease the marginal benefit governments can reap from their infrastructure investment. Both effects of higher δ_i, therefore, tend lower G_i 's incentive to invest in market-supporting infrastructure.

Given that $G_i's$ infrastructure investment under capital immobility is increasing in $\bar{k}_i$ but decreases with δ_i, it is not surprising that we derive in (12) that F_i also increases with $\bar{k}_i$ but decreases with δ_i.

$$\frac{\partial F_i}{\partial \delta_i} = -\frac{\beta F_i}{(1-\beta)(1-\delta_i)} < 0. \tag{14}$$

Therefore, by (13) and (14), we show that when capital is immobile, poor fiscal capacity decreases a unit's market-supporting infrastructure investment, and has a detrimental effect on a unit's total economic output. The Golden Tax Project, which decreases δ_i for all units, should unambiguously increase units' market-supporting infrastructure investment and total outputs, with its positive investment and output effects to be both higher in geographically more rugged counties (counties with higher pre-reform δ_i).

3.2 Capital Mobility

Next, suppose that capital is perfectly mobile across units. In an interior equilibrium in which all units have positive capital, the rates in all units must be equalized. Let r be the economy-wide net return to capital. We suppose for now that N is large, so that each region takes r as given and ignores potential effects of its decisions on r.

Solving this model, we derive two sets of first-order conditions, one for the governments and the other for investors:

$$\frac{\partial F_i}{\partial I_i}+\frac{\partial F_i}{\partial k_i}\frac{\partial k_i}{\partial I_i}=\frac{\lambda v'}{1+(\lambda v'(1-\delta_i)-1)t_i} \tag{15}$$

$$\lambda v'=\frac{(1-t_i)}{(1-\delta_i)(1-\alpha-t_i)} \tag{16}$$

$$(1-t_i)\frac{\partial F_i}{\partial k_i}=r \Longleftrightarrow k_i(r,t_i,I_i)=[\frac{\alpha A I_i^{\beta}(1-t_i)}{r}]^{\frac{1}{1-\alpha}} \tag{17}$$

Substituting (16) and (17) into (15), we get

$$\beta\frac{F_i}{I_i}=\frac{1}{(1-\delta_i)} \tag{18}$$

In addition, the three first-order conditions allow us to express I_i, F_i and k_i respectively as a function of r, $t_i$and δ_i. More specifically, let $H=\beta A^{\frac{1}{1-\alpha}}(\frac{\alpha}{r})^{\frac{\alpha}{1-\alpha}}$, then

$$I_i(r,t_i,\delta_i)=H^{\frac{1-\alpha}{1-\alpha-\beta}}(1-t_i)^{\frac{\alpha}{1-\alpha-\beta}}(1-\delta_i)^{\frac{1-\alpha}{1-\alpha-\beta}} \tag{19}$$

$$F_i(r,t_i,\delta_i)=\frac{1}{\beta}H^{\frac{1-\alpha}{1-\alpha-\beta}}(1-t_i)^{\frac{\alpha}{1-\alpha-\beta}}(1-\delta_i)^{\frac{\beta}{1-\alpha-\beta}} \tag{20}$$

$$k_i(r,t_i,\delta_i)=\frac{\alpha}{\beta r}H^{\frac{1-\alpha}{1-\alpha-\beta}}(1-t_i)^{\frac{1-\beta}{1-\alpha-\beta}}(1-\delta_i)^{\frac{\beta}{1-\alpha-\beta}} \tag{21}$$

Substituting (19),(20) and (21) into (16), we get

$$\lambda v'[\frac{(t_i-\beta)}{\beta}H^{\frac{1-\alpha}{1-\alpha-\beta}}(1-t_i)^{\frac{\alpha}{1-\alpha-\beta}}(1-\delta_i)^{\frac{1-\alpha}{1-\alpha-\beta}}+S]=\frac{(1-t_i)}{(1-\delta_i)(1-\alpha-t_i)}$$

Applying the Implicit Function Theorem on the above equation, we get

$$\frac{\partial t_i}{\partial\delta_i}=\frac{\lambda(1-\delta_i)^{-1}[v'(c_i)+v"(c_i)\cdot\frac{(c_i-S)(1-\alpha)}{1-\alpha-\beta}]}{\beta F_i\frac{(1-\beta)}{(1-\beta-\alpha)}\frac{v"}{v'}-(1-\delta_i)^{-1}\alpha(1-\alpha-t_i)^{-2}}. \tag{22}$$

With the assumption laid out in (10), $\frac{\partial t_i}{\partial\delta_i}<0$.

In addition, from equation (19), we get

$$\frac{\partial I_i}{\partial \delta_i} = -\frac{(1-\alpha)I_i}{(1-\alpha-\beta)(1-\delta_i)} - \frac{\alpha I_i}{(1-\alpha-\beta)(1-t_i)}\frac{\partial t_i}{\partial \delta_i}. \tag{23}$$

The first component of $\frac{\partial I_i}{\partial \delta_i}$ in 23, which is negative, reflects the same negative effects δ_i has on I_i as discussed in the capital immobility case (section (3.1)): a higher δ_i tends to decrease not only G_i's total revenue but also its ability to reap returns from its infrastructure investment and therefore reduces I_i in equilibrium. Notice that $\frac{1-\alpha}{1-\alpha-\beta} > \frac{1}{1-\beta}$. This implies that the first component of $\frac{\partial I_i}{\partial \delta_i}$ in this mobile case is of a greater magnitude than $\frac{\partial I_i}{\partial \delta_i}$ in the immobile case (see equation (13)). The greater magnitude of this negative component reflects the augmenting effect of capital mobility: as governments decrease their infrastructure investment, private capital will respond by moving away, further decreasing the marginal benefit of infrastructure investment and governments' incentive to invest in infrastructure. Therefore, this direct negative effect of δ_i on I_i will in fact be even larger under capital mobility than if governments have effective capital control.

Different from the immobility case, $\frac{\partial I_i}{\partial \delta_i}$ under capital mobility also has an additional second component, whose sign depends on the sign of $\frac{\partial t_i}{\partial \delta_i}$. This second component consists of an indirect effect of δ_i on I_i through its effect on t_i. It exists under capital mobility, because the effective tax rate chosen by governments can now influence firms' decision in capital location and therefore indirectly affect governments' marginal return in infrastructure investment. When $\frac{\partial t_i}{\partial \delta_i} < 0$, this second component is positive. Intuitively, when a government chooses a lower effective tax rate because of higher enforcement costs, more capital is attracted to the unit, increasing the marginal benefit of infrastructure investment and the government's incentive to make more infrastructure investment.

Therefore, under capital mobility, $\frac{\partial I_i}{\partial \delta_i}$ will in fact consist of two components of opposite signs, and the overall effect will be ambiguous. The existence of the second positive component suggests that capital mobility may have an eroding effect on the complementarity before fiscal capacity and market-supporting infrastructure investment.

From equation (19) and (16) , we also get

$$\frac{\partial F_i}{\partial \delta_i} = -\frac{\beta F_i}{(1-\alpha-\beta)(1-\delta_i)} - \frac{\alpha F_i}{(1-\alpha-\beta)(1-t_i)}\frac{\partial t_i}{\partial \delta_i}. \tag{24}$$

$$\frac{\partial c_i}{\partial \delta_i} = \frac{(1-\delta_i)^{-2}\frac{(1-t_i)}{(1-t_i-\alpha)} + (1-\delta_i)^{-1}\frac{\alpha}{(1-t_i-\alpha)^2}\frac{\partial t_i}{\partial \delta_i}}{\lambda v\text{''}} \tag{25}$$

Similar to $\frac{\partial I_i}{\partial \delta_i}$, $\frac{\partial F_i}{\partial \delta_i}$ under capital mobility (equation (24)) contains two components of opposite signs. The first component, which is negative, consists of the effect of δ_i on F_i through δ_i's direct effect on I_i (the first component of $\frac{\partial I_i}{\partial \delta_i}$ in (23)). The component corresponds to the same effect δ_i has on F_i in the immobility case (see equation(7)), but has a greater magnitude. There are two reasons why the magnitude of this first component is greater than that of its counterpart in the immobility case. First, as explained above, where we discuss the effect of δ_i on I_i, the magnitude of the direct effect of δ_i on I_i itself is larger under capital mobility. Second, with mobile capital, any exogenous change in I_i will change k_i, which also positively affects F_i, in the same direction, further amplifying the negative effect of δ_i on F_i through I_i . The second component of $\frac{\partial F_i}{\partial \delta_i}$ in equation (24) is positive when $\frac{\partial t_i}{\partial \delta_i} < 0$. It consists of an indirect effect δ_i on F_i through δ_i 's effect on t_i. Intuitively, when an increase in δ_i leads to a lower t_i, k_i will increase as firms, attracted by the lower tax rate, move into unit i. This increase in k_i not only directly contributes to a higher F_i but also tends to increase I_i (the second component of $\frac{\partial I_i}{\partial \delta_i}$ in (23)) which further increases F_i. Therefore, the second component is positive and opposite in sign compared to the first component . With two countervailing components, the overall effect of fiscal capacity on output under capital mobility is ambiguous.

δ_i affects c_i mainly through δ_i's effect on G_i's revenue, which depends on F_i. Therefore, it is not surprising that when δ_i has two countervailing effects on F_i under capital mobility, c_i also consists of two components of opposite signs. As seen in equation (25), the overall sign of $\frac{\partial c_i}{\partial \delta_i}$ is also ambiguous.

3.3 Efficiency

Notice that in both cases of mobile and immobile capital, we have derived that $\beta(1-\delta_i)F_i = I_i$ in equilibrium (equations 8 and 18). This implies that

$$\begin{aligned} F_i &= Ak_i^{\alpha}[\beta(1-\delta_i)F_i]^{\beta} \\ &= [A\beta^{\beta}]^{\frac{1}{1-\beta}}(1-\delta_i)^{\frac{\beta}{1-\beta}}k_i^{\frac{\alpha}{1-\beta}}. \end{aligned} \tag{26}$$

Therefore, in either case, the most efficient allocation of capital $\{k_i^*\}_{i=1}$ across units, i.e. the allocation that generates the highest amount of total output, is such that

$$\frac{(1-\delta_i)^{\frac{\beta}{1-\alpha-\beta}}}{k_i^*} = \frac{\sum_{i=1}^{N}(1-\delta_i)^{\frac{\beta}{1-\alpha-\beta}}}{K}\forall i. \tag{27}$$

In the previous subsection, we have derived that in the case of mobile capital,

$$k_i(r,t_i,\delta_i) = \frac{\alpha}{\beta r}H^{\frac{1-\alpha}{1-\alpha-\beta}}(1-t_i)^{\frac{1-\beta}{1-\alpha-\beta}}(1-\delta_i)^{\frac{\beta}{1-\alpha-\beta}}, \tag{28}$$

which is the efficient allocation of capital if and only if t_i is the same across all regions. However, as shown in the previous subsection, when δ_i is heterogeneous across regions, t_i also varies. This implies that during the pre-reform period when δ_i is heterogeneous, capital will NOT be allocated efficiently across counties even when capital can move freely without any friction. Therefore, before the Golden Tax Project, depending on the initial capital distribution across counties, policies aimed at reducing regional barriers and encouraging capital mobility do not necessarily improve capital allocation efficiency.

However, after the Golden Tax Project, which effectively brings down δ_i to zero for all regions, all regions will choose the same effective tax rate in equilibrium. Then, the equilibrium capital allocation across regions under mobile capital will be equivalent to the optimal efficient capital allocation. This implies that any effort aimed at removing capital frictions across regions will unambiguously improve capital allocation efficiency.

3.4 Summary of Predictions

In summary, under the assumption of immobile capital, we have shown that counties with lower fiscal capacity (higher enforcement costs) tend to adopt lower effective tax rate, invest less in market-supporting infrastructure, has less resource to allocate to public consumption and suffers from a lower economic output. Similar to Besley and Persson (2009), our model predicts that fiscal capacity and market-supporting infrastructure are complements to each other when capital is relatively immobile. The complementarity between fiscal capacity and market-supporting infrastructure explains one channel through which fiscal capacity can positively affect local economic development.

Based on a comparison between two cases with immobile and mobile capital, we have also shown that capital mobility has two interesting effects on units' policies and economic outcomes. On the one hand, similar to Cai and Treisman (2005), we find that capital mobility in general tend to amplify the effects that lead heterogeneous units to different outcomes under capital immobility, and may therefore encourage further polarization of both policies and economic outcomes.

On the other hand, different from Cai and Treisman (2005), we also find a counter-effect of capital mobility. More specifically, because capital is attracted by not only good market-supporting infrastructure but also lower tax rates, counties with lower fiscal capacity, which tend to enforce a lower effective tax rate in equilibrium, have some innate advantage in attracting capital for their economic development under mobile capital. This implies that capital mobility also has a separate equalizing effects on units' policies and economic outcomes.

Because of this counter-effect of capital mobility, the effects of fiscal capital on units' market-supporting infrastructure investment, public consumption, and economic outputs all become ambiguous once we allow capital to be fully mobile.

4 Data

We use four sources of data to compute the proxy for county tax enforcement costs. The first one is the GTOPO30, a global digital elevation model (DEM) produced by the United States Geological Survey in 1996. This dataset contains earth ground elevation information on 30-arcsecond grids. At the equator, 30-arcsecond equals 1 kilometer. Second, we use the DMSP-OLS Nighttime Light (2001) data, which is also available on 30-arcsecond grids, to assign weights to the grids. These light data are based on cloud-free images collected by the United States Air Force Weather Agency. Third, we use the Get-point tool from Baidu Map API to find the geographic coordinates for all county representative offices of the State Administration of Taxation. Last, we merge the county tax agency coordinates, elevation data, light data, and a Chinese county shapefile into one data set on ArcGIS to construct the proxy for each county's specific pre-reform tax enforcement costs. In Figure 3a, we visually present the geographical locations of county offices of the State Administration of Taxation. In Figure 3b and Figure 3c, we show the night lights and elevation for each grid in Pingshan county in 2001. In the same figure, the red triangle is where the tax office is located.

We use firm-level data from the *Annual Survey of Manufacturers* (1998-2007) to compute the firm-level VAT rate. These data cover all state firms and non-state firms with annual sales above 5 million yuan in the mining, manufacturing, and power sectors in China, which contributes the majority of China's value-added taxes. For instance, in 2001, value-added taxes paid by the firms covered by the *Survey* summed up to 74 percent of the national total. The county-level VAT revenue data are from the *Public Finance Yearbooks for Chinese Counties and Prefectures* (1996-2006). These data contain information on the total amount of value-added tax, business tax, corporate income tax, and personal income tax collected by each county government in each year. These *Yearbooks* also cover all types of public expenditure at the county level. We use the public expenditure data to proxy for the market-supporting infrastructure spending. At last, we use the county GDP statistics from the *Chinese Economic and Social Development Statistical Database* (1996-2006) to measure yearly county output. These GDP data are consistent with those in the annual county government reports.

5 Empirical Specification

5.1 Tax Enforcement Costs

For each county, we compute terrain ruggedness as a proxy for tax enforcement costs before the Golden Tax Reform. We use a measure similar to the one used by Nunn and Puga (2012):

$$r_i = \sqrt{\frac{\sum_{j=1}^{N_i}(e_{j,i}-e_{0,i})^2 L_{j,i}}{\sum_{j=1}^{N_i} L_{j,i}}}, \tag{29}$$

where $L_{j,i}$ is the light measure of grid j in county i before reform; $e_{j,i}$ is the elevation (in meters) for the grid j in county i and $e_{0,i}$ is the elevation (in meters) at the location of the tax office in county i. In other words, r_i measures the average weighted elevation difference tax officials travel to conduct onsite inspections and auditing within each county. We assign a greater weight to a grid with higher light intensity to account for the fact that areas with higher light intensity are where more firms are located, and consequently where more onsite inspections and auditing are needed. Based on our data, our terrain ruggedness measure is highly correlated with the simple standard deviation of county grid elevations as well as the measure used by Nunn and Puga (2012).

Because counties' geographic expansion also affects tax officials' traveling costs, we compute the average weighted horizontal distance tax officials travel to conduct onsite inspections and auditing as an alternative proxy of pre-reform tax enforcement costs:

$$d_i = \frac{\sum_{j=1}^{N_i} d_{j,i} L_{j,i}}{\sum_{j=1}^{N_i} L_{j,i}}. \tag{30}$$

$d_{j,i}$ is the geodesic distance between each grid j in county i to the tax office in county i.

5.2 Capital Mobility

We use two different measures to estimate the extent of capital mobility in a county. Both measures act as proxies for the relocation costs that firms within a county face in order to relocate to a different county.

Our first measure of capital mobility, $Mobility1_i$, follows Ederington, Levinson, and Minier (2005) and assumes that firms which have a higher share of assets as fixed assets (e.g. buildings and machinery) will be less mobile. This is because, relative to non-fixed assets (e.g. account receivables and intangible assets), fixed assets usually incur much greater costs of either replacement or transportation. We therefore calculate $Mobility1_i$ as the pre-reform average value of the median share of non-fixed assets in total assets for all firms in each county. To solve the problem that firms may endogenously choose the composition of their assets in response to their county's policies, we use the national median in a firm's industry to measure each firm's share of non-fixed assets in total assets. In other words, we only allow the component of a firm's non-fixed assets share related to the characteristics of the firm's industry to enter our measure of capital mobility. $Mobility1_i$, therefore, depends only on county i's pre-reform industrial composition, which may reflect the county's natural advantages in certain industries. Given that a county's tax enforcement should affect firms in all industries homogeneously, counties' pre-reform industrial composition, and therefore our measure of $Mobility1_i$, are not endogenous to a county's tax enforcement power in any obvious way.

The second measure calculates the weighted average inverse distance that firms in a county needs to travel to reach a different county:

$$Mobility2_i = \sum_{j \neq i}^{J} \frac{1}{d_{j,i}} GDPshare_j, \quad (31)$$

where J includes all counties in China; $d_{j,i}$ is the geodesic distance from the centroid of county j to the centroid of county i, and $GDPshare_j$ is the share of county j's GDP in China's national GDP (in 2000). We weight the counties by their GDP share, which acts as a proxy for the probability a relocated firm may choose to relocate to a county. Based on this measure, counties which are in more central locations of China or closer to areas with higher GDP share will have lower firm relocation costs and therefore higher capital mobility. A major advantage of this capital mobility measure is that, because the measure is determined purely by the relative location of the county within China, it is not endogenous to the policy choices made by county governments.

5.3 Market-Supporting Infrastructure Investment and Income

We use three variables to measure county market-supporting infrastructure investment. The first measure is the county government spending on capital construction, which includes the expenditure in the building or maintenance of physical public infrastructures, such as road, airports, water or power supply systems, or telecommunication networks. All these physical public infrastructures are essential for local firms to operate productively. The second measure is the county government spending on public security, procuratorate, courts, and judicial affairs. This part of expenditure helps to protect property rights, enforce regulations and contracts, and therefore preserve market incentives and creates business-friendly environment for firms. It is a proxy for market-supporting social infrastructure investment in the sense of Hall and Jones (1999). The third measure adds up all types of county public expenditure that could influence local firms' production decisions and potentially increase their productivity, including expenditures directly related to providing infrastructure support, subsidies or services to local firms. The types of expenditures we include in this measure include local public spending on capital construction, renovation, agricultural production, administration, legal support and price subsidy. For simplicity, we call this third measure "county production-related spending."

We use two different variables to measure county income. The first one is county GDP, which is calculated as the total value-added of all firms in the county. Because one effect of the Golden Tax Project is to make it much harder for firms to under-report their value-added, one may be concerned that the estimated effect using this firm-reported measure may not accurately account for the actual effect on output, but simply reflect better reporting. To address this concern, we use the logarithm of the average night light in a county as an alternative measure of GDP.[10] Given that the night light data based on satellite images cannot be easily manipulated by governments or firms, this alternative measure is much less prone to measurement errors due to systematic misreporting.

5.4 Identification Strategy

We run the following regression to test the effect of a county's fiscal capacity on its effective tax rate:

$$VATRate_{i,j,t} = \alpha + \beta Ruggedness_i \times Post_t + \sigma_{ij} + \lambda_t + \varepsilon_{i,j,t}, \tag{32}$$

where $VATRate_{i,j,t}$ is the effective value-added tax rate for firm j in county i in year t, measured as the firm's remitted value-added tax divided by its total sales. $Ruggedness_i$ is the terrain ruggedness of county i, and $Post_t$ is a dummy that equals 0 before year 2002 and 1 otherwise. σ_{ij} and λ_t represent firm and year fixed effects respectively. The standard errors in this equation, as in all other equations in this section, are clustered at the county level. The main parameter of interest, β, measures how the post-reform effective value-added tax rate imposed on a firm, relative to its pre-reform value, differs across counties with different geographic ruggedness. Based on the prediction of the model, because the Golden Tax Reform increased the fiscal capacity of counties with higher ruggedness to a greater extent, we should expect β to be positive.

We employ a similar difference-in-differences strategy to study the effect of the reform on county public spending in market-supporting infrastructures, total county GDP, and county effective VAT rate calculated as the ratio between a county's VAT revenue and its GDP :

$$y_{i,t} = \alpha + \beta Ruggedness_i \times Post_t + \gamma_i + \lambda_t + \varepsilon_{i,t}. \tag{33}$$

In this regression, $y_{i,t}$ is county i's outcome in year t. γ_i and λ_t are county and year fixed effects. Similar to equation (32), the main parameter of interest in equation (33) is β, which measures how the change in $y_{i,t}$ due to the reform differs across counties with different geographic ruggedness. Because the Golden Tax Project essentially exerted a shock on counties' fiscal capacity that increases with geographic ruggedness, β measures the causal effects of a county's fiscal capacity on its outcomes. Based on our model, the predicted sign of β will be positive if y_{it} is the county effective VAT rate. However, if y_{it} is county market-supporting investment or GDP, the sign of β will depend on the extent of capital mobility across counties in China.

To investigate how the effects of fiscal capacity vary with the extent of capital mobility, we

[10] The night light measure has been used a many authors to measure economic activity (e.g. Henderson, Storeygard, and Weil (2012)).

adopt a triple difference strategy, and examine the heterogeneous effects of fiscal capacity across counties with different capital mobility:

$$\begin{aligned} y_{i,t} = \quad & \alpha + \beta_1 Mobility_i \times Ruggedness_i \times Post_t + \beta_2 Ruggedness_i \times Post_t \\ & + \beta_3 Mobility_i \times Post_t + \gamma_i + \lambda_t + \varepsilon_{i,t}, \end{aligned} \tag{34}$$

where $y_{i,t}$ is the county's market-supporting investment or county GDP, and $Mobility_i$ is the capital mobility of county i, measured by the two proxies introduced in Section 5.2.[11] In this regression, β_1 measures how the causal effects of fiscal capacity on $y_{i,t}$ change as capital becomes more mobile.

Our estimation strategy helps to address several endogeneity problems in estimating the causal effects of fiscal capacity. First, restricting the estimates to the change in counties' outcomes due to an exogenous shock from the Golden Tax Project ensures that the estimated effects are not biased by reverse causality. Second, the difference- in-difference strategy also helps mitigate omitted variable bias: the county fixed-effect should eliminate any omitted variable bias caused by time-invariant county characteristics.

One concern with the identification strategy in equations (33) is that the estimated effects may reflect other over-time changes that are correlated with our independent variables of interest. For instance, our estimates may be biased by the effects of other reforms happening around the same time, which perhaps targeted county characteristics that are correlated with counties' geographic features. To eliminate such bias, the paper controls for the interactions between the post dummy and counties' pre-reform characteristics, such as their export intensity, population density and the logarithm of GDP per capita. The three characteristics of the county are measured by their respective value in the year 2000. In some specifications, we further control for province-year and industry-year fixed effects to reduce endogeneity due to industry-year or province-year specific shocks. In addition, in Section 6.6.1 and Section 6.6.2, we conduct robustness checks to address the specific concerns of reforms that happened in close chronological proximity to the Golden Tax Project, such as China's accession to WTO in 2001 and the 2002 Chinese Income Tax Reform. We argue that our estimates are unlikely to be biased by these potentially confounding changes.

[11] One thing to note is that while our model predicts that capital mobility tends to decrease the positive effect of fiscal capacity on market-supporting investment and GDP, we do not know the exact functional form of these relationships. In equation 34, we have assumed a linear functional form for simplicity. However, it is possible that the effect of capital mobility is highly non-linear, such that once a certain level of capital mobility is achieved, marginal mobility no longer has any additional impact. What we estimate in that case will therefore be the weighted average marginal effect at various levels of capital mobility of all Chinese counties.

6 Results

6.1 Summary Statistics

Table 1 presents summary statistics for our sample in 2000. In this table, we separate counties into two groups by their terrain ruggedness and compare how the pre-reform county characteristics differ across the two groups. As observed from the table, counties with more rugged terrain tend to have lower population density, GDP per capita and export intensity. In addition, the two groups also have different mean capital mobility and average tariff rates, which imply that they may have different pre-reform industrial compositions. Given that we control for county fixed effects in our regressions, these differences in county characteristics should only bias our estimates if they somehow send counties along different over-time trajectories. We address the differential time trends concern mainly in two ways. First, we estimate the yearly effects of terrain ruggedness, and show that our estimates are unlikely driven by differential time trends across counties. Second, in all our regressions, we check the robustness of our estimates by adding the interaction between the post dummy and these pre-reform county characteristics as additional controls. This should eliminate any bias caused by differential time trends due to difference in these pre-reform characteristics across the comparison groups .

Table 1 already gives us some preliminary evidence in support of weaker pre-reform VAT enforcement in high-ruggedness counties. As mentioned before, the nominal VAT rate, fixed by the central government, is uniform across all counties in China. Therefore, if the extent of tax evasion is uniform across counties, we should expect counties with higher export intensity, and therefore a higher percentage value-added/GDP exempted from VAT, to collect less VAT as a percentage of their GDP. However, based on the statistics in Table 1, although high-ruggedness counties, on average, had lower export intensity in 2000, the VAT collected from these counties as a percentage of their GDP was lower. This is consistent with weaker VAT enforcement in high-ruggedness counties during the pre-reform period.

6.2 The Impact on Effective VAT Tax Rate

Table 2 presents our estimated effect of the Golden Tax Project on the effective VAT rate based on equation (32). In this table, the outcome variable is the effective VAT rate that firms face, calculated as each firm's total VAT payment divided by the firm's total sales. In all columns, we control for firm fixed effects and year fixed effects, standardize county terrain ruggedness to have a mean of zero and a standard deviation of one, and cluster the standard errors at the county level. Column (1) corresponds to the baseline regression in (32). Column (2) uses the geographic expansion of a county as an additional proxy for pre-reform tax enforcement costs. Column (3) adds a set of pre-reform county characteristics, including population density and per capita GDP, interacted with a post-reform dummy as additional controls. In column (4), we further control for industry-year fixed effects to remove the potential confounding effects caused by different industrial compositions in different counties. [12]

In all columns, our estimates of β are positive and significant, implying that counties with more rugged terrain indeed experienced a higher VAT rate increase after the reform. The inclusion of additional controls does not significantly alter the magnitude of our estimate. Based on our results, a one standard deviation increase in county terrain ruggedness leads to an around 0.1 percentage points increase in the post-reform effective VAT rate (relative to its pre-reform value). Note that the median pre-reform ratio between a firm's VAT payment and its total sales is 3.3 percentage points in our sample. Thus, a one standard deviation increase in terrain ruggedness raises a county's post-reform effective VAT rate by 3 percent. These results are consistent with Chinese firms engaging in VAT evasion during the pre-reform period, and the Golden Tax reform exerting heterogeneous fiscal capacity shocks on counties with different terrain ruggedness.

As all difference-in-difference estimators, a key underlying assumption of our identification strategy is that the outcomes in different comparison groups would have followed parallel time trends in the absence of the treatment. In other words, my estimates of β may be biased if either terrain ruggedness itself, or some omitted variables correlated with it, cause the outcomes of interest to follow different growth trajectories.

We did two things to address this omitted variable bias concern. First, in columns (5) and (6) of Table 2, we rerun equation (32) but replace $Ruggedness_i$ with $Distance_{ij}$, a firm-specific measure of tax agents' traveling costs calculated as the simple geodesic distance between firm j and its local county tax agency weighted by the standard deviation of the terrain elevation for all grids in the county.[13] This enable us to control for county-year fixed effects in our regression. Our results show that, even within the same county, traveling costs associated with visiting a firm positively predict the effective VAT rate increase that the firm experiences after the Golden Tax Project. Our results are therefore not purely driven by differences at the county level.

Second, we estimate the yearly effects of a county's terrain ruggedness on firms' effective VAT rate using the following specification:

$$VATRate_{i,j,t} = \alpha + \sum_{\tau \neq base\ year} \beta_\tau \cdot Ruggedness_i + \gamma_{ij} + \lambda_t + \varepsilon_{i,j,t}, \quad (35)$$

[12]The industries are defined at the 2-digit industry level.

[13]Ideally, we can estimate the cost associated with the least-cost path computed in ArcGIS, based only on the geographic features (e.g., slopes) of the terrain. Computing this proxy for all sampled firms, however, is inhibitingly time-consuming. Based on a sample of randomly chosen 166 firms, we find that our concurrent measure of weighted distance is very closely correlated with the actual travel cost.

where the omitted base year in the regression is 1998, the year that the *Annual Survey of Manufacturers* become available. β_τ therefore measures the effect of geographic ruggedness on county effective VAT rate in year τ relative to 1998. We plot our estimated β_τs against τ in Figure 4. Consistent with what our model predicts, the estimated β_τs are fairly constant at zero throughout the pre-reform period, but experienced a sharp increase after the Golden Tax Project took effect. The evidence supports the parallel trend assumption, and makes it unlikely that our estimates be driven by bias due to differential time trends across counties.

A caveat for interpreting our estimates in Table 2 is that these estimates based on within-firm change in VAT rate can only be calculated for firms that are surveyed both before and after reform. This inevitably subjects the estimates to possible sample selection bias, especially given that the effective tax rate faced by firms may directly affect either their growth in scale or their entry and exit decisions.

Given this caveat, we also compute an alternative measure of county effective VAT rate using the government administrative data at the county level. In this second measure, we compute the effective VAT rate enforced by a county as the ratio between the county's total VAT revenue and its total GDP. Table 3 presents our estimates when we run regression (33) on this measure of effective VAT rate. Again, our estimates are positive and significant, and highly robust when we control for confounding time trends. Based on the results in the Table 3, a one standard deviation increase in terrain ruggedness increases the post-reform county VAT revenue over GDP by about 0.03 percentage points, which is 7% of the median VAT over GDP ratio before the reform. Given that counties only keep less than 25% of the total VAT remitted by firms, the estimates imply that a one standard deviation increase in terrain ruggedness increases the post-reform effective firm VAT rate by about 0.12 percentage points, which is slightly bigger than our within-firm estimates in Table 2.

Figure 5 replicates Figure 4 by plotting the estimated β_τs of the following regression:

$$y_{i,t} = \alpha + \sum_{\tau \neq base\ year} \beta_\tau \cdot Ruggedness_i + \gamma_i + \lambda_t + \varepsilon_{i,t}, \tag{36}$$

where $y_{i,t}$ is the ratio between a county's total VAT revenue divided by its total GDP. 1996 is the base year in this figure. Again, consistent with what our model predicts, β_τs in equation 36 are fairly constant at zero throughout the pre-reform periods, but experienced a sharp increase in 2002 and 2003 (the years in which the Golden Tax Project took effect). The evidence supports the parallel trend assumption and makes it unlikely that our estimates are driven by bias due to differential time trends across counties with different terrain ruggedness.

Our results in Table 4 and Table 3 suggest that terrain ruggedness is a stronger and much more consistent predictor of counties' effective VAT rate than horizontal expansion. This is consistent with the fact that the difference in vertical altitudes is usually a much greater hindrance for travel than the horizontal distance. For all our other regressions, we are going to use terrain ruggedness as our main measure of counties' pre-reform tax enforcement costs.

6.3 The Impact on Firms' Capital Allocation

Next, we examine whether and how the heterogeneous fiscal capacity shocks experienced by the counties cause firms to reallocate their capital after the Golden Tax Reform. Such an examination will allow us to directly test whether firms make their location or capital allocation choices based on tax evasion incentives, which is a key result that leads to the erosion of complementarity between fiscal capacity and market-supporting investment under capital mobility in our model. In addition, we can also provide some validity tests for our measures of capital mobility: if our measures of capital mobility accurately capture firms' capital relocation costs across counties, we should expect capital reallocation to be more severe among firms with higher measured capital mobility.

We use three variables to measure capital stock: the number of firms, firms' aggregate value of fixed assets, and firms' aggregate value of total assets. To better make use of the richer firm-level data, we aggregate our capital stock measures at the industry-county-year level instead of the county-year level. This enables us to directly control for industry-county fixed effects in our specifications, which helps to mitigate any potential bias caused by differential industrial compositions across counties with different terrain ruggedness in our estimates.[14]

Table 4 shows our regression results when we use the logarithm of the number of firms in each county-industry in each year as the outcome variable. Columns (1) and (2) correspond to the difference-in-difference regression to estimate the main effect of fiscal capacity on local capital stock, while columns (3) and (4) run the triple difference regression to examine how the effect may be heterogeneous across firms facing different capital mobility constraints. We use the pre-reform national median firm share of assets in non-fixed assets in the firm's industry to measure firms' capital mobility. This industry-specific measure uses the same definition of capital mobility as our county-level measure, $Mobility1$.[15] Based on our estimates, terrain ruggedness has a significant

[14] In other words, we run the following regressions to estimate the effects of fiscal capacity on local capital stock:

$$y_{i,j,t} = \alpha + \beta Ruggedness_i \times Post_t + +\eta_{ij} + \lambda_t + \varepsilon_{i,j,t}, \tag{37}$$

$$y_{i,j,t} = \alpha + \sum_{\tau \neq 1998} \beta_\tau \cdot Ruggedness_i + \gamma_i + \lambda_t + \varepsilon_{i,t}, \tag{38}$$

$$\begin{aligned} y_{i,j,t} = \quad & \alpha + \beta_1 Mobility_j \times Ruggedness_i \times Post_t + \beta_2 Ruggedness_i \times Post_t \\ & + \beta_3 Mobility_j \times Post_t + \eta_{ij} + \lambda_t + \varepsilon_{i,j,t}, \end{aligned} \tag{39}$$

where $y_{i,j,t}$ is the capital stock in county i in industry j at year t, and η_{ij} and λ_t represent county-industry and year fixed effects respectively.

[15] See Section (5.2) for a discussion of why $Mobility1$ measures capital mobility across a county's borders.

negative effect on the number of post-reform firms in a county. This suggests that firms have indeed relocated out of high-ruggedness counties and into low-ruggedness counties in response to the heterogeneous fiscal capacity shocks counties receive from the Golden Tax Project. In addition, the negative effect of terrain ruggedness is significantly more negative in county-industries with higher measured capital mobility, confirming that our measure of capital mobility indeed captures firms' ability or willingness to move across county boundaries.

Table 5 repeats the regressions in Table 4 with the logarithm of the aggregate value of firms' fixed assets and total assets respectively as the outcome variable. Our estimates based on these alternative measures of capital stock present a similar pattern of cross-county capital reallocation after the reform: terrain ruggedness negatively affects a county's post-reform aggregate firm fixed assets and total assets. In addition, based on our estimates, a one standard deviation increase in capital mobility reduces this effect of terrain ruggedness on post-reform capital stock by about 2% per standard deviation (of terrain ruggedness). This again validates $Mobility1$ as a measure of capital mobility across a county's borders. The greater extent of capital reallocation among counties with higher measured capital mobility also implies that the complementarity between fiscal capacity and market-supporting investment is more likely to be eroded in these counties.

Figure 6 also replicates Figure 4 and plots how the estimated effects of terrain ruggedness on capital stock vary over time. [16] With all three measures of capital stock, we do not observe a discernible negative time trend in the estimated yearly effects of terrain ruggedness during the pre-reform period, suggesting that it is unlikely that our estimated effects be driven by pre-existing differential time trends across counties with different terrain ruggedness. Instead, in all three sub-figures, we observe a sharp break in trend in the estimated effects in 2002. The fact that the negative effect of terrain ruggedness on capital stock only emerged after the reform gives us reassurance that our estimates reflect only changes in outcomes related to the reform.

6.4 The Impact on Market-Supporting Investment

In this section, we examine the effect of the Golden Tax Project on counties' market-supporting infrastructure investment. We use three variables to measure counties' market-supporting infrastructure investment: the respective logarithm of counties' public spending in capital construction; spending in public security, people's procuratorate, court, and judicial affairs; and total production-related spending. We discuss in detail in Section 5.3 why we believe these three measures can act as proxies for counties' market-supporting investment.

Table 6 examines the effect of the Golden Tax Reform on county capital construction spending.

[16] In each sub-figure, we regress a measure of capital stock against the interaction terms between terrain ruggedness and all the year dummies while controlling for county-industry and year fixed effects, and plot the estimated coefficients.

In all columns, the dependent variable is the logarithm of county public spending on capital construction. Column (1) corresponds to the baseline difference-in-differences regression in equation (33). Columns (2) and (4) run the triple difference regression in equation (34) using $Mobility1$ and $Mobility2$ respectively as a proxy for capital mobility. Compared to columns (2) and (4) respectively, columns (3) and (5) further control for the interaction between the post dummy and county pre-reform characteristics that are correlated with counties' terrain ruggedness, including counties' population density and the logarithm of counties' GDP per capita in 2000. In all our regressions, standard errors are clustered at the county level, and both the county terrain ruggedness and capital mobility measures are respectively standardized to have a mean of zero and a standard deviation of one.

Column (1) shows that the estimated β based on equation (33) is small but significantly negative, implying that counties with higher terrain ruggedness, and therefore higher increase in fiscal capacity due to the reform, actually experienced decrease in public expenditure in capital construction on average relative to counties with low ruggedness. The estimated negative effect of fiscal capacity on counties' market-supporting investment contradicts with the model of capital immobility, in which counties' fiscal capacity positively affects their market-supporting investment. Therefore, the result implies that capital is relatively mobile across counties in China.

In columns (2) to (5), our estimates of β_1 in equation (33) are highly robust across different measures of capital mobility and when we add additional time trends controls in our regression. In all columns, the estimated β_1 is negative and highly significant, implying that the effect of fiscal capacity on counties' public expenditure in physical infrastructure construction is significantly more negative for counties where capital is more mobile. These results are consistent with our model of capital mobility, and show that capital mobility tends to erode the complementarity between counties' fiscal capacity and market-supporting investment.

Table 7 and Table 8 re-run the same regressions in Table 6, but replace the dependent variable with the logarithm of county spending in legal support and county production-related public spending respectively. The results are similar to the results Table 6. With all three measures of market-supporting investment, we find that the effect of fiscal capacity on county market-supporting investment is significantly more negative for counties where capital is more mobile. The results suggest that capital mobility tends to erode the complementarity between fiscal capacity and county market-supporting investment.

6.5 The Impact on County Output

Finally, we examine the impact of the project on county output, measured by two separate measures mentioned in 5.3. In Table 9 and Table 10, we replicate all regressions in Table 6 but replace the dependent variable with the logarithm of counties' reported GDP and average night light intensity respectively. According to our estimates in Table 9, the overall effect of fiscal capacity on counties' reported GDP is positive: a one standard deviation increase in terrain ruggedness predicts a 2 percent increase in a county's post-reform GDP. However, our estimates of β_1 in columns (2) to (5) also show that this positive effect of fiscal capacity on output is significantly lower in counties whose capital is more mobile: a one standard deviation increase in capital mobility reduces the effect of terrain ruggedness on county-industry GDP in the post-reform period by about 3% per standard deviation (of terrain ruggedness). In fact, for counties with the highest capital mobility, the causal effect of fiscal capacity on county GDP is negative. Table 10 shows very similar results, except that the magnitude of the estimated positive effect of fiscal capacity on GDP becomes smaller. This suggests that the Golden Tax Reform might indeed have heterogeneously affected the reporting of GDP across counties with different pre-reform fiscal capacity. However, our estimated of β_1 in columns (2) to (5) of Table 10 remains negative and significant, confirming that capital mobility indeed tends to erode the positive effect of fiscal capacity on GDP.

These results are consistent with what the model predicts. When capital is relatively immobile, improved fiscal capacity in counties of higher terrain ruggedness after the Golden Tax Reform potentially increased these counties' expenditure in market-supporting investment, and therefore positively affected their GDP. However, because capital mobility tends to erode the complementarity between fiscal capacity and market-supporting investment and because an increase in fiscal capacity may have a direct negative effect on counties' capital stock, this positive effect of fiscal capacity is significantly weakened under capital mobility.

6.6 Robustness Checks

6.6.1 China's Accession to the WTO

One concern with our identification strategy is that our estimated effects may be confounded by other over-time changes that happened around the same time. For instance, two other major reforms that happened in close proximity to the Golden Tax Reform are China's accession to the WTO in 2001 and the Chinese Income Tax Reform in 2002. One may worry that the two confounding reforms could bias our results, if they happen to also affect our outcomes of interest and their effect is somewhat correlated with county terrain ruggedness.

China's WTO accession mainly has two effects on domestic economy. First, it significantly reduced the tariff rate China imposes on its trading partners, exposing its domestic firms to a greater extent of foreign competition. The decline in the tariff rate on imports after WTO varies significantly across industries. Industries that originally imposed a higher tariff rate before WTO usually experienced a greater decline in tariff rate after WTO.[17] To show that the differential tariff rate decline across different counties with different industrial composition does not bias our estimates, we add the interaction between county average import tariff rate in 2000 and the post dummy as an additional control in our regressions.

Second, China's accession to the WTO also reduces the tariff rate Chinese firms face in exporting their products to foreign countries and therefore significantly increased demand for Chinese products in foreign markets. Counties with higher export intensity, which are likely counties whose industrial composition reflects China's comparative advantage in trade, should experience a larger shock in foreign demand after WTO. To show that the change in foreign demand after WTO also does not significantly bias our results, we add the interaction between county export intensity in 2000 and the post dummy as a second additional control in our regressions. In addition, for the firm-level outcomes, we also conduct robustness checks on our estimates by restricting our sample only to non-exporting firms.

Columns (1) to (4) in Table 11 conduct robustness checks on our estimates for regression (32) with firms' effective VAT rate as the dependent variable. Column (1) runs the baseline regression for all firms. Compared to column (1), Column (2) adds the interaction between $Post_t$ and counties' pre-reform characteristics, including their average tariff rate and export intensity in 2000, as additional controls. Columns (3) and (4) repeat the regression in column (2) but restrict the sample to non-exporting firms and domestic non-exporting firms respectively. In each column, our estimate of β, which reflects the causal effect of fiscal capacity on firms' effective VAT rate, remains positive and significant. In fact, the magnitude of the estimated effect becomes bigger when we add additional controls or restrict our sample to non-exporting firms.

Columns (5) and (6) of Table 11 and Table 12 test the robustness of our estimates of regression 33 and regression (34) against the additional controls of the interaction between $Post_t$ and counties' average tariff rate and export intensity in 2000. [18] The results show that, for all the outcome variables, our estimates are highly robust against these additional controls, suggesting that our estimated effects are unlikely driven by confounding effects due to China's accession to WTO in 2001.

6.6.2 The Chinese Income Tax Reform

Next, we examine whether the 2002 Chinese Income Tax Reform, which changed the way tax revenue is allocated across different levels of government in China, biases our results. Before 2002,

[17] A plot of Chinese industries' pre-reform tariff rate and change in tariff rate before and after the WTO indeed shows a highly linear relationship.

[18] For length consideration, the robustness checks conducted in Table 12, Table 13, and Table 14 only use $Mobility1$, counties' pre-reform industrial composition weighted by industrial fixed assets share, as our measure of capital mobility. The results look very similar when we use $mobility2$ as the proxy for capital mobility.

each level of government separately extracted corporate income taxes from their respective tax base. A firm that registered with the central government would not enter the tax base of the local government it resided in, but instead remitted corporate income taxes directly to the central government. On the flip side, local governments could keep all the income taxes they extracted from other local firms. However, starting from 2002, the central government relinquished their rights to charge income taxes on central firms back to the local governments that the firms reside in, but required that all local governments remit part of their total income tax revenue to the central government. In 2002, income tax revenues were shared half and half between the central government and the local governments. Starting from 2003, the tax sharing rule was changed to 60 percent for the central government and 40 percent for other levels of government.

Because locally registered firms were more profitable and way larger in number, the Income Tax Reform effectively reduced income tax revenue for all local governments. In general, counties that had a higher share of their revenue from income taxes or a lower proportion of firms (in terms of income tax payments) which were registered as central firms suffered from a higher percentage decline in their total revenue after 2002. To test whether the such differential change in county revenue after the Income Tax Reform might bias our results, we rerun our regressions, adding the interaction between the post dummy and counties' pre-reform values in these two variables as additional controls.

On the other hand, the increase in tax revenue directed to the central government after the Income Tax Reform could mean that the central government has more resources to influence distribution of revenue across counties through inter-governmental transfers. Therefore, the Income Tax Reform could further confound our estimates, if it led to changes in inter-government transfers and these changes happened to be systematically correlated with counties' terrain ruggedness or capital mobility. To address this concern, we also add the amount of net transfers each county receives from upper governments in each year as an additional control in our regressions.

Table 13 displays the results of these robustness checks. Based on our results, none of our estimates change significantly after adding these three additional controls. The robustness of our estimates against these additional controls imply that it is unlikely that the confounding effects of the Income Tax Reform have significantly biased our estimates.

6.6.3 Functional Form Assumptions

Based on our summary statistics in Table 1, the extent of capital mobility in a county is highly correlated with terrain ruggedness. Therefore, one may be concerned that our estimated differential effects of terrain ruggedness on public expenditure across counties with different capital mobility simply reflect effects of higher-order terms of terrain ruggedness. To address this concern, we add higher-order terms of county terrain ruggedness up to the power of five as additional controls for each of our triple-difference regressions. As seen from the results displayed Table 14, all our our estimates remain robust after the addition of this polynomial.

To address the concern that our estimated triple-interaction effects may capture a spurious correlation between capital mobility and the variation in the effect of the reform across counties with different geographic features, we also rerun regression (34) but replaces the continuous variable $Mobility_i$ with six mobility interval dummy variables. Counties are grouped into these six mobility intervals based on their measured capital mobility, with each interval containing one sixth of the sampled counties. We define a higher mobility category number to indicate higher measured capital mobility. In results not shown, we plot the estimated coefficients of the six triple-interaction terms against the six mobility categories, and find that, for almost all our outcome variables, the estimated effects to fiscal capacity have been monotonically decreasing in counties' mobility category number. This makes it unlikely that our results be driven by spurious correlations, and supports the model prediction that capital mobility erodes the complementarity between fiscal capacity and market-supporting investment, and decreases the positive effect of fiscal capacity on GDP.

7 Conclusion

Overall, our results show that capital mobility has an eroding effect on the complementarity between fiscal capacity and market-supporting investment. This implies that the causal effect of fiscal capacity on a local state's market-supporting investment and overall economic prosperity is in fact ambiguous and heterogeneous: both the sign and the magnitude of this effect depend heavily on the extent to which local firms can relocate their capital out of the states. Based on our estimates, although the Golden Tax Reform significantly increased counties' fiscal capacity, Chinese counties that have higher capital mobility experienced a significantly lower increase in market-supporting investment and overall economic growth from this fiscal capacity increase. In fact, the causal effect of fiscal capacity on market-supporting investment and overall economic growth is negative for some of the counties where capital is most mobile.

The reason why capital mobility erodes the positive effect of fiscal capacity on market-supporting investment and GDP is that, under capital mobility, firms that seek to evade taxes have incentives to relocate out of counties that experience a relatively higher fiscal capacity shock. Our estimated effects of the Golden Tax Reform indeed confirm such a pattern of capital reallocation. Based on our estimates, after the Golden Tax reform, counties that experienced a higher fiscal capacity increase, i.e. counties with higher terrain ruggedness, experienced significant reduction in their capital stock relative to other counties. This implies that, at least during the pre-reform period, the feasibility of tax evasion was a serious consideration for firms in determining where to locate and how much capital to invest. In other words, some firms may have strategically located capital in counties with high terrain ruggedness just to increase their chances of evading taxes. From the central government's prospective, such strategic behaviors of firms not only decrease the effectiveness of governments' fiscal policies, but also create distortions in capital allocation across China, which inevitably have a detrimental effect on China's overall economic performance.

Therefore, although counties that experienced the highest boost in fiscal capacity did not necessarily benefit the most from the reform; by equalizing fiscal capacity across counties and thereby eliminating tax evasion as a determinant of firms' location, the Golden Tax Reform may have an additional benefit for the overall economy by improving capital allocation efficiency across China. Testing whether this is indeed the case is beyond the scope of this paper, but is an interesting avenue for future research.

Our results also have some interesting and important implications on how we should evaluate policies aimed at improving capital mobility across counties. They suggest that lower fiscal capacity, which is purely an administrative disadvantage for counties under capital immobility, can become a county's advantage in attracting private capital that seeks to evade taxes once capital becomes mobile. Therefore, by possibly shifting private capital towards counties with lower geographic endowments (higher ruggedness), policies that facilitated capital mobility before the Golden Tax Reform would have had an equalizing effect on counties' economic performance. However, on the other hand, given that firms were choosing their locations based on tax evasion incentives, this equalizing effect comes at a cost of distortions on how capital is allocated across counties in China. In fact, based on our model, depending on the initial capital distribution across counties, policies that aimed to reduce regional capital barriers before the Golden Tax Reform could very well have decreased overall capital allocation efficiency in China. However, after the Golden Tax reform, assuming that fiscal capacity is no longer heterogeneous across counties, any effort aimed at removing capital frictions across regions will unambiguously improve capital allocation efficiency.

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Notes: The photo above shows a VAT invoice used in the 1990s, when most invoices were hand written. The invoice specifies the firm names, addresses, taxpayer identification numbers, bank accounts for both the buyer and the seller. It also includes the transaction date, product name, units, quantity, price, value, applied VAT rate, and total amount of VAT in the transaction. Although the invoice has simple anti-counterfeit technical features, it is relative easy for firms to forge invoices or modify transaction information on real invoices without being detected.

Figure 1: A Hand-Written Invoice in the 1990s

1300053140

河北增值税专用发票

№ 02995606

开票日期: 2005年12月19日

纳税人识别号: 142701602922440

>9+90>63676/+819*1386
*+344<>>*76<941>/6/-0
-4>1/>6<>+1*8**8051>2
-1/85>0>>23<>//*8>>8*

1300053140
02995606

货物或应税劳务名称	规格型号	单位	数量	单价	金额	税率	税额
	810x1100		3.5	2442.0023932	8547.01	17%	1452.99
合计					¥8547.01		¥1452.99

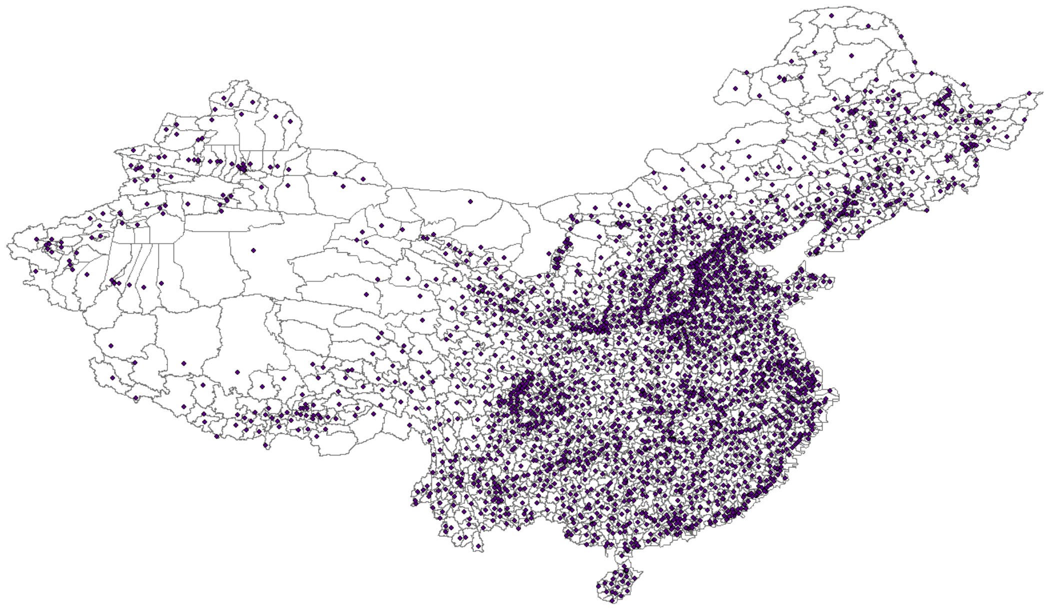
价税合计（大写） （小写） ¥10000.00

纳税人识别号: 131102723355122

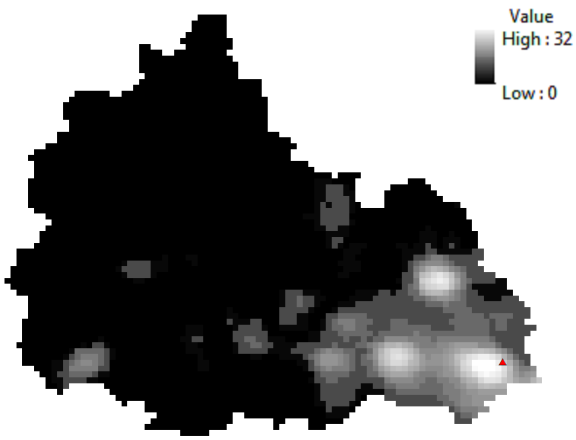
收款人: 复核: 开票人:

Notes: The photo above shows a VAT invoice used after the Golden Project. The invoice specifies the same information as the old invoice. However, there are two new features. First, the invoice is printed rather than hand-written. The information is also recorded in an IC card and difficult to modify. Second, the encrypted code in the upper-right corner uniquely specifies the transaction information on the invoice. The encryption method is difficult to decipher and therefore makes it impossible to forge invoices.

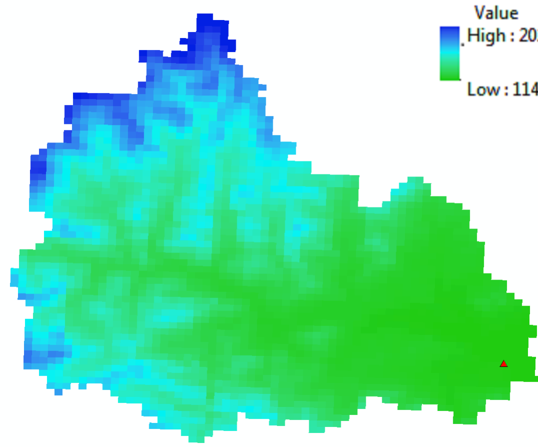
Figure 2: A Computer-Printed Invoice in 2005



(a) Locations of County Tax Offices



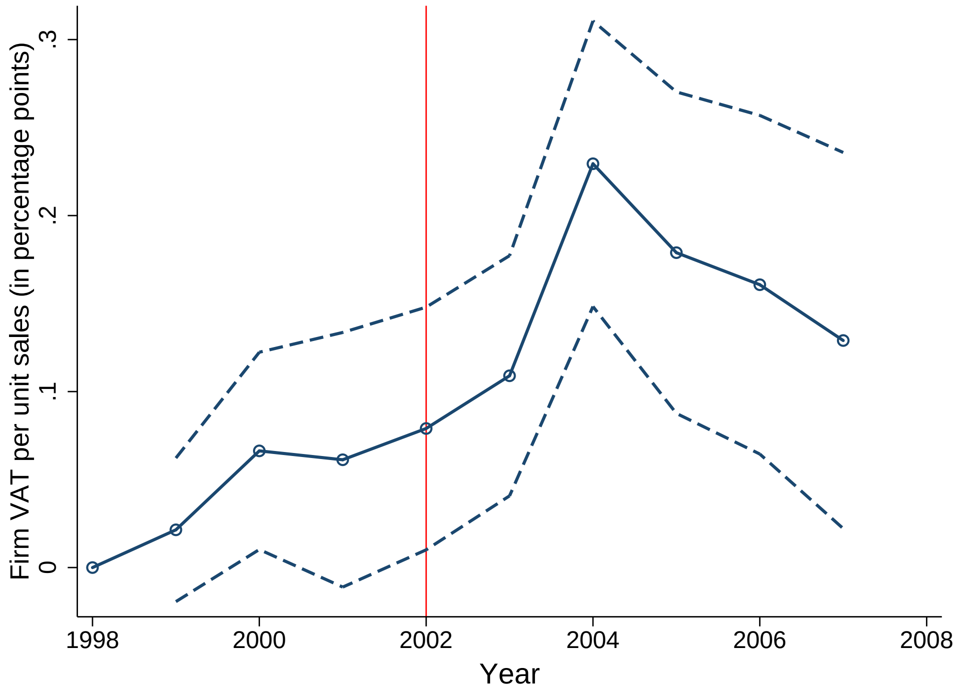
(b) Night Light of Pingshan County



(c) Elevation of Pingshan County

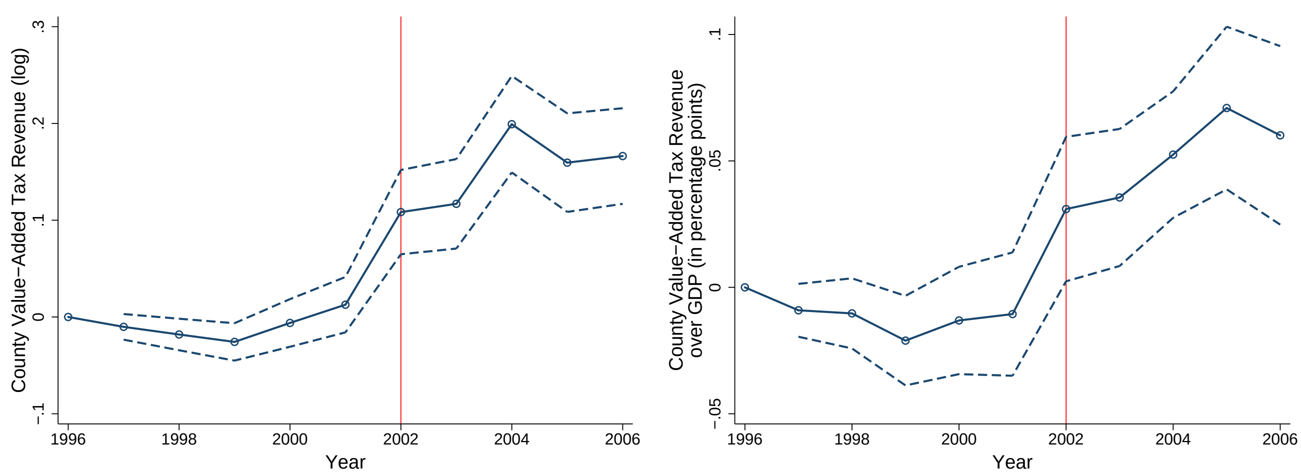
Notes: The purple dots in Figure (a) are where county tax agencies are located. These agencies collect and enforce the value-added taxes. The red triangles in Figure (b) and (c) are where the tax agency of Pingshan county is located. Although there might be township branches for this office, most of the tax inspectors are located in the county seat. Figure (b) shows the night light for each grid (about 1km by 1 km) of the county; Figure (c) shows the elevation for each grid in Pingshan County.

Figure 3: Tax Enforcement Costs



Notes: This figure presents how the estimated yearly effects of terrain ruggedness on effective VAT rate vary over time. We calculate a firm's effective VAT rate as the firm's reported amount of VAT payment over its total sales. The solid line connects all the estimated $\beta_\tau s$ in equation (35), while the dashed line describe their 95% confidence intervals.

Figure 4: Yearly Effects of Terrain Ruggedness on Firm VAT Rate

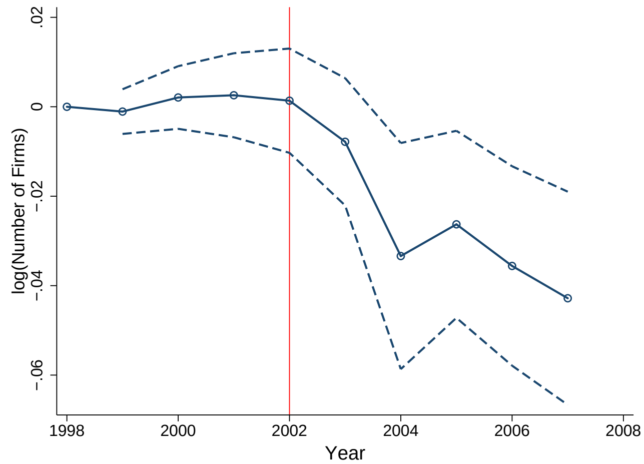


(a) Log VAT Revenue

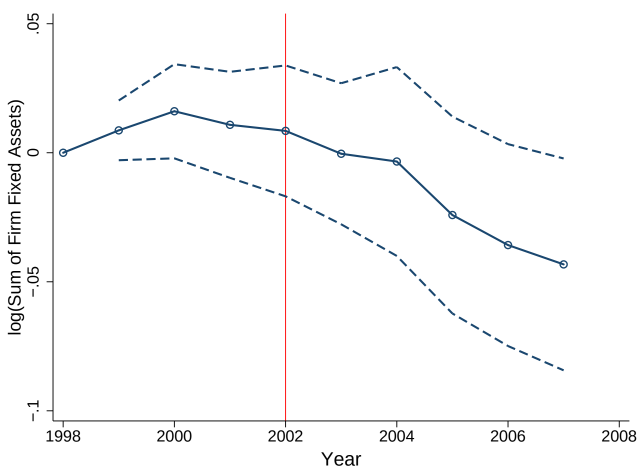
(b) VAT over GDP

Notes: This figure presents how the estimated yearly effects of terrain ruggedness on county VAT revenue and county effective VAT rate vary over time. We calculate the effective VAT rate enforced by a county in each year as the county's total VAT revenue over its GDP. The solid line connects all the estimated $\beta_\tau s$ in equation 36, while the dashed line describe their 95% confidence intervals.

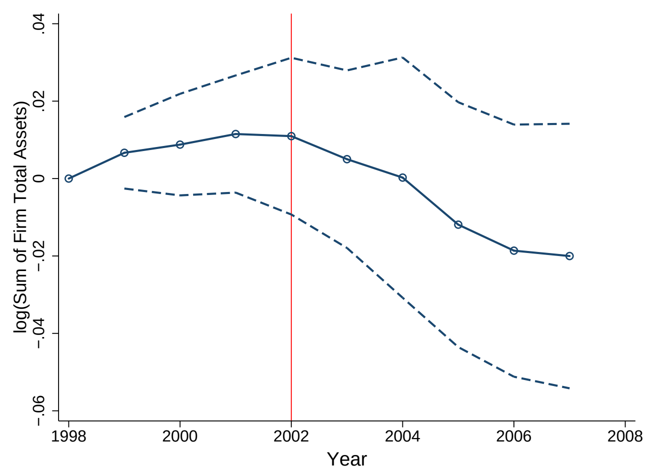
Figure 5: Yearly Effects of Terrain Ruggedness on County VAT



(a) log(No. of Firms)



(b) log(Aggregate Firm Fixed Assets)



(c) log(Aggregate Firm Total Assets)

Notes: This figure presents how the estimated yearly effects of terrain ruggedness on county capital stock vary over time. We use the number of firms, the sum of fixed assets held by the firms, and the sum of total assets held by the firms respectively to calculate capital stock within a county-industry. The solid line connects all the estimated $\beta_\tau s$ in equation 38, while the dashed line describe their 95% confidence intervals.

Figure 6: Yearly Effects of Terrain Ruggedness on Capital Stock

Table 1: Summary Statistics

Counties grouped by terrain ruggedness			
Year=2000	Low	High	$\|t-stat\|$
Observations	709	708	-
Terrain ruggedness (log)	2.81	5.05	45.46
Geographic expansion (log)	2.40	2.42	0.53
Mobility 1 (Footloose-ness)	0.58	0.53	16.71
Mobility 2 (Connected-ness)	0.15	0.12	12.31
Population density (persons per sq kms)	411.60	218.22	14.53
GDP per capita (log)	8.44	8.32	3.08
Average tariff rate (%)	23.73	18.91	8.29
Export intensity (%)	8.30	6.72	2.40
VAT over all taxes (%)	18.30	19.76	2.86
VAT over GDP (%)	1.57	0.64	1.22

Table 2: The Impact of the Reform on Effective Firm VAT Rate (VAT/Sales)

	Dep. var.: Firm VAT/Sales (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Ruggedness × post	0.082***	0.080***	0.088***	0.067**		
	(0.028)	(0.028)	(0.029)	(0.029)		
Expansion × post		0.038	0.041	0.028		0.477
		(0.040)	(0.040)	(0.040)		(1.080)
Distance× post					0.085***	0.052***
					(0.013)	(0.013)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	No
Post × $X_{i,2000}$	No	No	Yes	Yes	No	Yes
Industry-year FE	No	No	No	Yes	No	Yes
County-year FE	No	No	No	No	Yes	Yes
Obs.	947415	947415	947415	947415	947415	947415
Clusters	2078	2078	2078	2078	2078	2078
R-sq.	0.72	0.72	0.72	0.72	0.75	0.75

Notes: An observation is a firm and a year. The outcome variable is calculated as the ratio between firm remitted VAT and sales.County terrain ruggedness, expansion, and firm distance are each normalized to have mean zero and standard deviation one. $X_{i,2000}$ includes population density in 2000 and log county GDP per capita in 2000. All regressions control for firm and year fixed effects. Standard errors in parentheses are clustered at the county level. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 3: The Effect of the Reform on County VAT Rate (VAT/GDP)

	Dep. var.: County VAT/GDP (%)		
	(1)	(2)	(3)
Ruggedness × Post	0.034***	0.034***	0.041***
	(0.007)	(0.007)	(0.008)
Expansion × Post		0.032***	0.026***
		(0.007)	(0.008)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Province-year FE	No	No	Yes
Post × $X_{i,2000}$	No	No	Yes
Obs.	16822	16822	16822
Clusters	2080	2080	2080
R-sq.	0.78	0.78	0.82

Notes: An observation is a county and a year. The outcome variable is calculated as the ratio between county VAT revenue and county GDP. County terrain ruggedness and expansion are each normalized to have mean zero and standard deviation one. $X_{i,2000}$ includes population density in 2000 and log county GDP per capita in 2000. All regressions control for county and year fixed effects. Standard errors in parentheses are clustered at the county level. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 4: The Effect of Fiscal Capacity on the Number of Firms

	log(Number of Firms)			
	(1)	(2)	(3)	(4)
Ruggedness × Mobility × Post			-0.005*	-0.006*
			(0.003)	(0.003)
Ruggedness × Post	-0.022***	-0.014**	-0.015*	-0.011
	(0.007)	(0.006)	(0.008)	(0.008)
Mobility × Post			0.051***	0.040***
			(0.003)	(0.003)
County-Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	Yes	No	Yes
Obs.	528538	528538	528538	528538
Clusters	2101	2101	2101	2101
R-sq.	0.79	0.79	0.79	0.79

Notes: An observation is a county-industry and a year. "Mobility" is measured by the average pre-reform non-fixed asset share in each industry. Terrain ruggedness and mobility are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county-industry and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 5: The Effect of Fiscal Capacity on Capital Stock

	log(Fixed Assets)				log(Total Assets)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ruggedness × Mobility × Post			-0.022***	-0.023***			-0.013**	-0.014***
			(0.006)	(0.006)			(0.005)	(0.005)
Ruggedness × Post	-0.023**	-0.018*	-0.032**	-0.030**	-0.011	-0.003	-0.013	-0.009
	(0.012)	(0.011)	(0.014)	(0.013)	(0.011)	(0.009)	(0.012)	(0.011)
Mobility × Post			0.017***	0.007			0.028***	0.014***
			(0.006)	(0.006)			(0.005)	(0.004)
County-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	500828	500828	500828	500828	500828	500828	500828	500828
Clusters	2102	2102	2102	2102	2102	2102	2102	2102
R-sq.	0.81	0.81	0.81	0.81	0.85	0.85	0.85	0.85

Notes: An observation is a county-industry and a year. "Mobility" is measured by the average pre-reform non-fixed asset share in each industry. Terrain ruggedness and mobility are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county-industry and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 6: The Effect of Fiscal Capacity on County Physical Infrastructure Investment

	Dep. Var.: log(Capital Construction Spending)				
	(1)	(2)	(3)	(4)	(5)
Ruggedness × Mobility 1 × Post		-0.128***	-0.138***		
		(0.049)	(0.052)		
Ruggedness × Mobility 2 × Post				-0.244***	-0.217***
				(0.048)	(0.049)
Ruggedness × Post	-0.147***	-0.166***	-0.179***	-0.119**	-0.138**
	(0.046)	(0.053)	(0.054)	(0.056)	(0.056)
Mobility 1 × Post		-0.055	0.021		
		(0.061)	(0.067)		
Mobility 2 × Post				-0.129**	-0.065
				(0.060)	(0.065)
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	No	Yes	No	Yes
Obs.	16740	16740	16740	16740	16740
Clusters	1781	1781	1781	1781	1781
R-sq.	0.775	0.775	0.776	0.776	0.777

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share; "Mobility 2" is measured by the weighted sum of inverse distance between the county to all other counties in China. Terrain ruggedness and the two mobility measures are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 7: The Effect of Fiscal Capacity on County Legal Support Spending

	Dep. Var: log(Legal Support Spending)				
	(1)	(2)	(3)	(4)	(5)
Ruggedness × Mobility 1 × Post		-0.020***	-0.017**		
		(0.008)	(0.007)		
Ruggedness × Mobility 2 × Post				-0.015*	-0.017**
				(0.008)	(0.008)
Ruggedness × Post	0.011	0.026***	0.027***	0.040***	0.043***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Mobility 1 × Post		0.039***	0.025**		
		(0.010)	(0.010)		
Mobility 2 × Post				0.054***	0.043***
				(0.011)	(0.010)
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	No	Yes	No	Yes
Obs.	17096	17096	17096	17096	17096
Clusters	1781	1781	1781	1781	1781
R-sq.	0.949	0.949	0.949	0.949	0.950

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share; "Mobility 2" is measured by the weighted sum of inverse distance between the county to all other counties in China. Terrain ruggedness and the two mobility measures are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 8: The Effect of Fiscal Capacity on All Production-Related Public Spending

	Dep. Var.: log(All Production Related Spending)				
	(1)	(2)	(3)	(4)	(5)
Ruggedness × Mobility 1 × Post		-0.039***	-0.041***		
		(0.008)	(0.007)		
Ruggedness × Mobility 2 × Post				-0.034***	-0.040***
				(0.008)	(0.008)
Ruggedness × Post	0.026***	0.029***	0.033***	0.045***	0.049***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Mobility 1 × Post		0.007	0.007		
		(0.009)	(0.009)		
Mobility 2 × Post				0.017*	0.013
				(0.009)	(0.009)
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	No	Yes	No	Yes
Obs.	17022	17022	17022	17022	17022
Clusters	1781	1781	1781	1781	1781
R-sq.	0.944	0.945	0.946	0.945	0.946

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share; "Mobility 2" is measured by the weighted sum of inverse distance between the county to all other counties in China. Terrain ruggedness and the two mobility measures are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 9: The Effect of Fiscal Capacity on County GDP

	Dep. var.: log (County GDP)				
	(1)	(2)	(3)	(4)	(5)
Ruggedness × Mobility 1 × Post		-0.033***	-0.030***		
		(0.008)	(0.008)		
Ruggedness × Mobility 2 × Post				-0.023***	-0.024***
				(0.006)	(0.006)
Ruggedness × Post	0.014**	0.024***	0.025***	0.040***	0.041***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Mobility 1 × Post		0.028***	0.013		
		(0.009)	(0.011)		
Mobility 2 × Post				0.041***	0.032***
				(0.007)	(0.008)
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	No	Yes	No	Yes
Obs.	17043	17043	17043	17043	17043
Clusters	1783	1783	1783	1783	1783
R-sq.	0.974	0.974	0.974	0.974	0.974

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share; "Mobility 2" is measured by the weighted sum of inverse distance between the county to all other counties in China. Terrain ruggedness and the two mobility measures are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 10: The Effect of Fiscal Capacity on County Night Light

	Dep. var.: log(County Night Light)				
	(1)	(2)	(3)	(4)	(5)
Ruggedness × Mobility 1 × Post		-0.003**	-0.003***		
		(0.001)	(0.001)		
Ruggedness × Mobility 2 × Post				-0.004***	-0.005***
				(0.001)	(0.001)
Ruggedness × Post	0.002**	0.001	0.001	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Mobility 1 × Post		-0.003	-0.002		
		(0.002)	(0.003)		
Mobility 2 × Post				0.004***	0.005***
				(0.001)	(0.001)
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	No	Yes	No	Yes
Obs.	16990	16990	16990	16990	16990
Clusters	1783	1783	1783	1783	1783
R-sq.	0.993	0.993	0.993	0.993	0.993

Notes: An observation is a county and a year. “Mobility 1” is measured by counties’ pre-reform industrial composition weighted by industrial non-fixed asset share; “Mobility 2” is measured by the weighted sum of inverse distance between the county to all other counties in China. Terrain ruggedness and the two mobility measures are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. All regressions control for county and year fixed effects. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 11: Robustness: China's Accession to the WTO on Effective VAT Tax Rate

	Firm VAT/Sales (%)				County VAT/GDP (%)	
	All Firms		Non-Exporter	Domestic Non-Exporter	All Counties	
	(1)	(2)	(3)	(4)	(5)	(6)
Ruggedness × Post	0.083***	0.095***	0.095***	0.096***	0.035***	0.023***
	(0.028)	(0.030)	(0.031)	(0.033)	(0.007)	(0.008)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	No	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No
Post × $X_{i,2000}$	No	Yes	Yes	Yes	No	Yes
Post × County Tariff (2000)	No	Yes	Yes	Yes	No	Yes
Post × Export Intensity (2000)	No	Yes	Yes	Yes	No	Yes
Obs.	729651	729651	560925	517797	14910	14910
Clusters	1744	1744	1744	1744	1739	1739
R-sq.	0.726	0.726	0.751	0.753	0.773	0.778

Notes: This table checks whether China's accession to WTO bias our estimated effects. Columns (1) and (2) compare the effects of terrain ruggedness on county effective VAT rate with and without controls for impacts from international trade. Columns (3) restricts the sample to non-exporting firms; column (4) further restricts the sample to domestic non-exporters. Terrain ruggedness and expansion are each standardized to have mean zero and standard deviation one. $X_{i,2000}$ includes population density and log county GDP per capita in 2000. Standard errors in parentheses are clustered at the county level. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 12: Robustness: China's Accession to the WTO on County Spending and GDP

(All in log)	Capital construction		Legal support		All productive spending		GDP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ruggedness × Mobility 1 × Post	-0.102*	-0.104*	-0.018**	-0.018**	-0.027***	-0.029***	-0.033***	-0.026***
	(0.057)	(0.062)	(0.009)	(0.009)	(0.009)	(0.008)	(0.007)	(0.007)
Ruggedness × Post	-0.211***	-0.204***	0.025***	0.024***	0.021***	0.022***	0.023***	0.020***
	(0.056)	(0.058)	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.007)
Mobility 1 × Post	-0.132**	0.056	0.042***	0.021*	0.002	0.014	0.032***	0.014
	(0.064)	(0.075)	(0.011)	(0.011)	(0.009)	(0.010)	(0.009)	(0.011)
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	Yes	No	Yes	No	Yes	No	Yes
Post × County Tariff (2000)	No	Yes	No	Yes	No	Yes	No	Yes
Post × Export Intensity (2000)	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	16487	16487	16844	16844	16769	16769	16149	16149
Clusters	1749	1749	1749	1749	1749	1749	1735	1735
R-sq.	0.769	0.772	0.947	0.948	0.940	0.941	0.979	0.979

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share. Terrain ruggedness and mobility are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log GDP per capita in 2000. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 13: Robustness: The Effects of the 2002 Chinese Income Tax Reform

(All in log)	Capital construction		Legal support		All productive spending		GDP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ruggedness × Mobility1 × Post	-0.103*	-0.128**	-0.015*	-0.011	-0.034***	-0.035***	-0.025***	-0.017**
	(0.056)	(0.058)	(0.008)	(0.008)	(0.009)	(0.008)	(0.008)	(0.007)
Ruggedness × Post	-0.214***	-0.161***	0.028***	0.029***	0.026***	0.037***	0.017**	0.011*
	(0.058)	(0.056)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Mobility 1 × Post	-0.136**	0.019	0.040***	0.027**	0.003	0.008	0.027***	0.006
	(0.066)	(0.073)	(0.011)	(0.011)	(0.009)	(0.009)	(0.010)	(0.011)
Log(Net Transfers)		1.262***		0.041***		0.240***		-0.055***
		(0.129)		(0.015)		(0.019)		(0.014)
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	No	Yes	No	Yes	No	Yes	No	Yes
Post × % Revenue in Income Tax (2001)	No	Yes	No	Yes	No	Yes	No	Yes
Post × % Central Firms (2000)	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	15404	15231	15737	15573	15663	15507	12919	12700
Clusters	1584	1584	1584	1584	1584	1584	1555	1555
R-sq.	0.769	0.780	0.945	0.945	0.938	0.943	0.978	0.979

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share. Terrain ruggedness and mobility are respectively standardized to have mean zero and standard deviation 1. $X_{i,2000}$ includes population density and log GDP per capita in 2000. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.

Table 14: Robustness: Controlling for Ruggedness Polynomials

(All in log)	Capital construction		Legal support		All productive spending		GDP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ruggedness × Mobility 1 × Post	-0.202***	-0.245***	-0.016*	-0.015	-0.037***	-0.029***	-0.029***	-0.025***
	(0.050)	(0.062)	(0.008)	(0.012)	(0.008)	(0.011)	(0.008)	(0.008)
Ruggedness × Post	-0.158***	-0.388***	0.041***	0.023	0.045***	-0.004	0.022***	0.020
	(0.057)	(0.147)	(0.008)	(0.019)	(0.008)	(0.019)	(0.006)	(0.017)
Mobility 1 × Post	-0.036	-0.023	0.045***	0.046***	0.020**	0.023**	0.011	0.010
	(0.066)	(0.067)	(0.010)	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)
Ruggedness Polynomial × Post	No	Yes	No	Yes	No	Yes	No	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post × $X_{i,2000}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	16796	16796	17153	17153	17079	17079	15655	15655
Clusters	1781	1781	1781	1781	1781	1781	1761	1761
R-sq.	0.771	0.772	0.949	0.949	0.941	0.941	0.980	0.980

Notes: An observation is a county and a year. "Mobility 1" is measured by counties' pre-reform industrial composition weighted by industrial non-fixed asset share. Terrain ruggedness and mobility are respectively standardized to have mean zero and standard deviation 1. The ruggedness polynomial includes higher-order terms of terrain ruggedness up to the power of five. $X_{i,2000}$ includes population density and log GDP per capita in 2000. Coefficients are reported with standard errors clustered at the county level in parentheses. *, **, *** respectively denotes significance at 10%, 5%, and 1% level.