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POLICY ANALYSIS ON LOCAL GOVERNMENT FISCAL SQUEEZE, POLITICAL CONNECTIONS, AND SIMULATION ON RELIGIOUS FUNDAMENTALISM

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Abstract

Policy Analysis on Local Government Fiscal Squeeze, Political Connections, and Simulation on Religious Fundamentalism

Jijian Fan

A rich literature examining the effects of intergovernmental grants has documented evidence of the "flypaper effect" in terms of overall and categorical expenditures. Chapter 1 considers this phenomenon in the context of a budget shortfall generated by a targeted tax reduction. Specifically, we examine whether local government increases tax revenue from other sources to offset the shortfall, reduces expenditures that benefit the targeted group, and consider the net impact of these local responses on income and economic productivity. Comparing nearly identical counties in adjacent provinces reveals that large differences in revenue shortfall are not offset by increased taxes on other subgroups, consistent with a strong flypaper effect. However, local government expenditure on agriculture is disproportionately reduced, attenuating the benefits to the targeted group.

There is a great deal of variation in how countries regulate the relationships between politicians and private sector firms, but little evidence about how such policies affect firm performance. In 2013, China passed a regulation that banned politicians from serving on the boards of directors of companies. Using a novel data set that links board members,

government officials, and forced resignations, in Chapter 2, I estimate the effect of the policy on the composition of corporate boards and subsequent changes in firm performance and stock returns. I find that the loss of a high-level politician significantly reduces a firm's cumulative stock return and future profits.

Chapter 3 reports agent-based simulations of religiosity dynamics in a spatially dispersed population. Agents' religiosity responds to neighbors via direct interactions and club goods effects. A simulation run is deemed fundamentalist if the final distribution contains a cohesive group of very high religiosity. We investigate whether such distributions are more prevalent when model parameters are shifted to reflect the transition from traditional societies to the modern world. The simulations suggest that the rise of fundamentalism in the modern world is aided by weaker attachment to the peer group, greater real income, and less substitutability between religious and secular goods, and arguably also by higher relative prices for secular goods and lower tolerance.

Local Government Response to Fiscal Squeeze: Evidence from a Targeted Tax Reduction

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June 13, 2019

Abstract

A rich literature examining the effects of intergovernmental grants to local governments has documented evidence of the "flypaper effect" in terms of overall and categorical expenditures. This paper considers this phenomena in the context of a budget shortfall generated by a targeted tax reduction that benefits a subset of the population. Specifically, we examine whether local government increases tax revenue from other sources to offset the shortfall, reduces expenditures that benefit the targeted group, and consider the net impact of these local responses on income and economic productivity. Identification comes from a ban on all agricultural taxes in China combined with differential revenue replacement levels determined by a national formula at the province level. Comparing nearly identical counties in adjacent provinces reveals that large differences in revenue shortfall are not offset by increased taxes on other subgroups, consistent with a strong flypaper effect. However, local government expenditure on agriculture is disproportionately reduced, attenuating the benefits to the targeted group. Further analysis reveals that farmers in counties that experienced larger revenue shortfalls suffered a loss of net income.

Keywords: flypaper effect; fiscal squeeze; local government; agricultural tax.

JEL classification: H71, H72, Q18.

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1 Introduction

The flypaper effect suggests that government responds differently to local income and intergovernmental subsidies, and is one of the most widely-documented anomalies in public finance (Henderson, 1968; Courant et al., 1978). Counter to traditional economic models which predict an equivalent response to local income and intergovernmental transfers, subsidies tend to generate a greater increase in government expenditure (Courant et al., 1978; Hines and Thaler, 1995). While a large literature has studied the effects of grant and income shocks from various sources, there is less research on the effects of shortfalls stemming from a targeted tax reduction, and little consensus about the magnitude and mechanisms of the flypaper effect and consequent economic impacts. This study considers these questions by examining the impact of an agricultural tax reduction on county-level government revenue, expenditure, and agricultural production and income. Specifically, we estimate how counties with fiscal shortfall adjust other sources of revenue, alter spending across categories, and examine how these responses impact agricultural output and farmers' net income. Understanding how local governments respond to fiscal shortfalls and alter expenditures will shed light the optimal budget policy.

The flypaper effect, originally noted by Henderson (1968) and Courant et al. (1978), describes the differential reaction of local government to income from citizens relative to an intergovernmental subsidy. Government expenditure may exhibit a high correlation with the source of revenue, even if local government could allocate it elsewhere. Early studies investigated the overall expenditure change and found a crowd-in effect for intergovernmental subsidies, that is, local governments increase spending rather than reducing taxes. While a number of studies find evidence of a strong flypaper effect (Dahlberg et al., 2008; Allers and Geertsema, 2016; Suárez Serrato and Wingender, 2016; Kakamu et al., 2014), others find weak or mixed evidence (Becker, 1996; Knight, 2002; Darby et al., 2005; Brunner and Schwegman, 2017). Recent studies refine money stickiness to examine whether subsidies for specific budget categories generate disproportionate spending increases in those areas, and find evidence that revenues earmarked for health (Levaggi and Zanola, 2003), road work (Leduc and Wilson, 2017), and administration (Berg and Rattsø, 2007) tend to boost corresponding expenditure. However, Knight (2002) and Gordon (2004) find crowd-out effects on local infrastructure and education spending, respectively. The anomaly of the flypaper effect may be explained by collective decisions (Roemer and Silvestre,

2002), fiscal illusion (Turnbull, 1992), behavioral responses (Hines and Thaler, 1995), risk aversion and insurance (Vegh and Vuletin, 2015), or unobserved political preferences (Knight, 2002, 2004; Inman, 2008). Few studies have focused on the social and economic impact of the flypaper effect (Leduc and Wilson, 2017). In this study, we examine the overall and categorical flypaper effects driven by a policy-induced fiscal shortfall from a targeted agricultural tax break, and evaluate the consequent economic impact on agricultural production and farmer income.

There are a number of challenges in identifying the effect of an intergovernmental subsidy on local spending and economic outcomes. First, it is difficult to find truly exogenous shocks to local revenue, as the amount of intergovernmental subsidy is usually not randomly determined, and is likely to correlate with unobservables at the local level (Knight, 2002; Inman, 2008). Previous studies address this issue by using various identification strategies such as regression discontinuity based on a grant formula (Dahlberg et al., 2008), political power of congressional delegations as an instrumental variable (Knight, 2002), and census calibration changes (Gordon, 2004; Suárez Serrato and Wingender, 2016). Second, local governments are inherently heterogeneous in terms of their population characteristics, natural endowments, and socioeconomic conditions, hence it is difficult to find similar local governments to use as a counterfactual. In order to generate an unbiased estimate of the impact of a specific policy, we need an observable, exogenous shock that is imposed on otherwise similar local governments.

This paper examines the effect of fiscal squeeze caused by a targeted tax reduction. In 2004, the central government of China passed a law to abolish all agricultural taxes in order to benefit the country's 900 million farmers and promote agricultural production. This tax reduction prohibits county governments from collecting agricultural taxes as one of their sources of income. As compensation, county governments were subsidized by a designated transfer from the central government, and the amount of the subsidy was determined at the province level: depending on whether a province is coastal and a major-grain producer, they receive either 0%, 50%, 80% or 100% replacement of pre-policy agricultural tax revenue. Thus, we are able to compare very similar counties that are adjacent to each other geographically but received substantially different replacement subsidies. We consider local government response in terms of revenue, expenditure, and agricultural outcomes using a difference-in-differences design.

To allow for heterogeneous effects, we differentiate by per-capita gross product, agricultural dependence, and the political experience of county governors. To conduct the analysis, we create a merged data set from The County Public Finance Statistics Yearbook of China, China Regional Economic Statistics Yearbook, China County Social and Economic Statistical Yearbook, and a manually collected county politician profile data set that includes county governors' age, tenure, and level of education.

We find that counties on both sides of the province border follow a similar government budget trajectory prior to the agricultural tax cancellation in 2004. However, after policy implementation, when counties can no longer collect agricultural taxes, those receiving incomplete subsidies experienced a significant reduction of 45 yuan per capita, which is an 81 percent reduction in agricultural revenue, or a 10 percent reduction in overall local government revenue. In the years following policy implementation, we find that tax revenues from other sources (such as sales tax and value-added tax) and intergovernmental subsidies remain unchanged in shortfall counties relative to their neighbors. This finding is consistent with Dye and McGuire (1997), Darby et al. (2005), Bradbury and Case (2001), and Jonas (2012), each of whom find that local government does not alter taxes when there is a fiscal surplus or shortfall. Given the balanced budget requirement, the significant reduction confirms a clear first stage on revenue shortfall, and exhibits a nearly perfect overall flypaper effect.

The consequent change in government expenditure may reflect the flypaper effect in terms of categorical stickiness. Specifically, we find that the per-capita agricultural spending of counties without full revenue replacement is reduced by 18 yuan, or 36 percent, which is much larger than the reductions in other categories (6 percent on average). This is not consistent with the predictions of traditional models, which suggest for proportional reductions. (Henderson, 1968; Hines and Thaler, 1995). This large reduction on local agricultural expenditure shows that, at the category level, local governments reduce the extent to which the benefits of the tax reduction accrue to the targeted group. However, the fact that agricultural expenditure reduction is less than revenue reduction still implies partial stickiness of the targeted money, which is consistent with Leduc and Wilson (2017) and Levaggi and Zanola (2003). In addition to examining the effect on agriculture, this natural experiment allows us to consider which other

categories of spending are most affected by a shortfall. Apart from the agricultural spending reduction, we find significant reductions in social security spending (11.4 percent), short-run liquidity reserves (12.5 percent), and a catch-all category comprised of non-profitable public sector subsidies including designated pension and relief fees.

We examine the consequent effects of agricultural expenditure reduction on agricultural production and farmers' income. While government spending on agriculture is mostly used for fixed investment and technology promotion, the reduction on spending may also have a negative impact on agricultural production, but examining the relative changes in agricultural factor inputs (cultivated land area, agricultural labor force, and its share among population) and agricultural outputs (output of grain crops, oiling crops, and meat product) reveals no significant changes in agricultural production when counties receive incomplete subsidies. However, we find that farmers' net income in less-subsidized counties is significantly less than that of fully subsidized counties after the agricultural tax cancellation. Net income refers to revenue from agricultural production less the costs of production minus taxes and fees. Given similar levels of agricultural tax relief, similar levels of agricultural output, and no de facto tax increase from other sources, the explanation for the income decline may be that individual agricultural producers face increased costs of production. Thus, the effect of reduced government agricultural expenditure reduction may result in higher costs of production and lower net income.

This paper contributes to the literature in several ways. First, we address the effect of a fiscal shortfall driven by a policy change instead of changes in local income or wealth (Darby et al., 2005; Dye and McGuire, 1997; Jonas, 2012). Second, as the fiscal shock is due to a targeted tax break in agriculture, we can investigate the categorical flypaper effect for the agricultural sector, enriching the existing literature by considering the extent to which local government redistributes away from the intended beneficiaries (Levaggi and Zanola, 2003; Leduc and Wilson, 2017; Berg and Rattsø, 2007). Finally, by examining the impacts on agricultural outcomes and farmers' net income, we are able to estimate the impact of local government responses on the targeted group.

The paper is organized as follows. Section 2 presents background information about the revenue and expenditure system in China, the agricultural tax, and its cancellation. Section 3

describes the construction of the data set on local revenue, expenditure, agricultural outcomes, and other local economic variables. Section 4 presents the empirical strategy and methods of testing its validity. Section 5 and 6 present the results of local government revenue and expenditure changes, showing the overall and categorical flypaper effects. Section 7 shows the consequent effects on the inputs and outputs in agricultural production, and farmer net income. Section 8 shows the heterogeneous effects, and Section 9 concludes.

2 Background

2.1 Revenue and Expenditure System

China, one of the largest countries in the world, has 34 provinces, 333 prefectures, and 2,862 counties.[1] County government is the lowest level of government that has independent authority, above which there are prefecture, provincial, and central governments.[2]

Tax revenue and other government income are shared between central and local (including county, prefecture, and provincial) governments by methods detailed in the Tax Sharing System (TSS). This system classifies three types of taxes: central taxes, local taxes, and shared taxes. Examples of each type of tax can be found in Table 1.[3] While part of central government tax revenue is distributed as subsidies for local governments, all revenue from local personal income, land use, property, and agricultural taxes, goes directly to the local budget. In 2000, local revenue accounted for half of the local budget, while the rest came from central subsidies.[4] In less developed areas, central subsidies account for an even higher fraction of revenue. For example, in our sample, which does not include wealthy coastal cities, intergovernmental transfers finance about two-thirds of local budgets.

In conjunction with revenue sharing between central and local governments, public expenditure in China is also shared. Local governments have high levels of expenditure responsibility that exceed those in most countries. In most countries, it is the central government's responsi-

[1] Data comes from the China government website in 2014. The numbers include equivalent administrative divisions, for example, the number of provinces includes number of autonomous regions and municipalities.

[2] There are also 44,741 township-level governments below the counties, however, due to their dependency on county government, few fiscal studies had focused on township government behavior.

[3] The detailed tax sharing is listed in Appendix Table A1.

[4] Including the local share from shared tax revenue.

bility to provide social security and welfare, while education and health are often shared between state/provincial and central governments. In China, county and township governments provide the majority of public services, including 70 percent of budgetary expenditures for education, and 60 percent of those for health (Bank, 2002). As of 2006, China did not have national social security legislation. At that time, most social security revenue (pensions and medical insurance, etc.) was also administrated at the county level.[5] Appendix Table A2 shows the assignments of expenditure responsibilities between central and local governments from 2003 to 2006. It shows that local governments have primary responsibility for most public services, including agriculture, education, and public health.

2.2 Agricultural Tax

China has long been an agricultural nation, and agricultural taxes have existed for over 2,600 years. All individuals and organizations who receive revenue from certain agricultural products are required to pay the tax. The agricultural tax is a proportional tax on perennial production under normal climate, soil, and cultivating conditions. Therefore, by definition, it is a lump-sum tax based on past production levels instead of current revenue (Wang and Shen, 2014). Counties are the smallest administrative division in China that has authority to determine the agricultural tax rate and collect agricultural taxes. The statutory highest agricultural tax rate by the central government is 15.5% , but the average tax rate in practice is 8.4%.[6] As all agricultural taxes go to county governments, in this paper, we study the policy effects on county-level governments.

In the 1950s, when the People's Republic of China was newly founded, agricultural taxes accounted for more than 40% of total government revenue. While the importance of agricultural tax revenue has been decreasing during recent decades, it still accounts for 30% of local revenue for counties and 10% of total revenue. Nevertheless, the implementation of agricultural taxes has potentially harmful implications. First, agricultural taxes may discourage agricultural

[5]The central government, for instance, the Ministry of Labor and Social Security, may provide general guidance and ensure that local regulations follow central government guidelines. Provincial or city/county social insurance agencies administrate their respective social security pools and individual accounts. Provincial labor and social security authorities are responsible for regulatory funds to which locally pooled funds in the jurisdiction must pay a percentage of their revenue. Notably, all revenues and expenditures of social security are managed under a specific account called "Social Security Fund", and the fund has an independent budget which is separately prepared from the general budget. Moreover, governments always subsidize the funds with general public budget to make ends meet.

[6]The statutory tax rate is based on the historical production level, while the practical rate is calculated on the actual production level.

production. Second, the burden of the agricultural producer may be high: in some provinces, aggregate tax burdens on farmers are as high as 30 percent, which is higher than for the nation's highest earners (Chen, 2003). Third, agricultural taxes collected in less-developed areas will aggravate spatial inequality, which is a critical issue in China, and accelerate conflicts between farmers and local governments (Bernstein and Lü, 2000; Lin et al., 2007).

In 2004, in order to encourage agricultural production, reduce farmers' economic burdens, and narrow spatial development gaps, China's central government decided to abolish agricultural taxes.[7] The nationwide agricultural taxes were immediately reduced.[8] In 2006, all local governments had fully stopped collecting agricultural taxes. This policy affected 900 million Chinese farmers, exempting them from over 100 billion yuan in agricultural taxes. Previous studies on the abolishment of China's agricultural taxes focus on agricultural productivity and the economic outcomes for farmers (Xu and Wang, 2009; Wang and Shen, 2014), but find little effects.

As agricultural tax was one of the major sources of local government revenue in China, and all revenue from it went to local governments, the abolishment could lead to large local deficits, especially for agriculture-dependent counties. In order to offset this deficit, China's central government offered a permanent, annual lump-sum grant called "Subsidy for Agricultural Tax Cancellation" to local governments. This grant is differentiated by province so that counties in some provinces got full offset while others did not. The amount of central government subsidy is determined by each county's 2002 agricultural tax revenue, but varies in compensation rate. The subsidy rate from the central government was set as: a) 100% for major-grain producing (MGP) provinces in central and western regions, b) 80% for non-MGPs in central and western regions, c) 50% for MGPs in eastern (coastal) regions, and d) 0% for non-MGPs in eastern (coastal) regions.[9] We acquire the level of total offsetting subsidies from both central and provincial

[7]The agricultural taxes being canceled included three types of taxes: *Agricultural Tax*, *Agricultural Specialty Tax* and *Livestock Tax*. Other relevant taxes, including *Land Occupation Tax*, *Tobacco Product Tax* and *Deed Tax*, even if accounted under the category of "Agricultural Taxes", are still in effect. Therefore, the value of revenue categorized as "agricultural tax" does not fall to zero after the abolishment.

[8]In the beginning of 2004, the agricultural specialty tax was immediately canceled, and the tax rate of agricultural tax was reduced by three percentage points for MGP provinces and one percentage point for non-MGP provinces.

[9]However, provincial governments may also provide subsidies to county-level governments. This happens in areas with incomplete subsidies, and thus reduces the policy differences induced by central policy. When we define less-subsidized counties, we focus on the 50% and 0% cases since there are no de facto first stage differences between 100% and 80% provinces.

governments, and categorize provinces by whether this total subsidy is equal to or less than the baseline level. Figure 1 shows the geographical distribution of provinces with balanced revenue and with net revenue loss due to the abolishment.[10] As the figure shows, there is a clear border, meandering from the Southwest to East Coastal Area, that separates areas that got full compensations and those that did not.

3 Data

The data used in this study comes from multiple sources. The primary data is converted from The County Public Finance Statistics Yearbook of China. Two more data sets, the China Regional Economic Statistics Yearbook and the China County Social and Economic Statistical Yearbook, provide county-level economic variables. In addition, we manually collect a data set of the background and careers of counties' local governors.

The primary data set used for analysis is The County Public Finance Statistics Yearbook of China, for the years 2001 to 2006. This yearbook includes government revenues and expenditures at the county level. The data set is available in the form of print books through Department of Budget, Ministry of Finance of China. We manually digitized the yearbooks from 2001 to 2006 by scanning each page and then using Optical Character Recognition (OCR) software to convert scanned images to spreadsheets. We exploit the balancedness of the budget to manually check for and correct errors that occurred during data conversion.[11]

The resulting data reveal revenue sources: agricultural revenue (including agricultural tax revenue and the subsidy for agricultural tax cancellation after 2004), other non-agricultural revenue (including revenue from value-added taxes, sales taxes, city maintenance taxes, local personal income taxes, firm taxes, and other non-tax local revenue such as fees), and subsidies (including all intergovernmental subsidies, except for the agricultural subsidy mentioned above). Importantly, the yearbooks also include expenditures, including: agriculture (forestry, livestock

[10] Precisely speaking, given the increasing trend in agriculture tax revenue, counties getting full subsidies of 2002 agricultural tax revenue will still expect relative fiscal losses after 2004. We focus on the loss of insufficient baseline subsidy, i.e., the missing part in 2002 baseline subsidy, assuming that counties in different provinces had same trajectories of agricultural tax revenue if the agricultural taxes were not canceled.

[11] A technical notes regarding error fixing in OCR can be found in Appendix Section A. There are other studies, such as Yin and Zhu (2012), using the same data set with a shorter year span from The County Public Finance Statistics Yearbook, however, the quality of data is limited and thus is not adopted by our study.

and fishing are included), infrastructure, education, governmental administration, social security, public safety, miscellaneous, and changes in reserves. A detailed description of expenditures can be found in Section 6.

To study the effects of the cancellation of agricultural tax on outcomes such as agricultural production and farmers' income, we also use data from the China Regional Economic Statistics Yearbook. This book is available in electronic form, and we extract variables that capture agricultural inputs and outputs, such as agricultural labor force, area of cultivated land, farmers' income, and the amount of agricultural production (grain crops, oil crops, and meat product). The third data set used in this study is the China County Social and Economic Statistical Yearbook. This data set is also in electronic form, and provides information on both the production and welfare sectors, such as by-sector gross regional product for each county.

Furthermore, to study how local governors may impact the revenue and expenditure changes when the agricultural taxes are canceled, we manually collect information for county-level officials. We focus on the top local governor (County Party Secretary, i.e., Xian Wei Shu Ji) for counties located on province borders in 2004, and collect their age, education level, the time when they started to serve as County Party Secretary, and whether they were promoted afterwards.[12] This information was collected from the Baidu Encyclopedia, which is a commonly used website that contains profiles for noteworthy individuals. For officials not included in the Baidu Encyclopedia, we searched county newspapers, and made phone calls to county governments. Our data is new, as there are no existing data sets on county-level governors. Existing data sets, such as Jiang (2018), are focused on profiles of prefecture or higher level governors.[13]

We capture per-capita values by dividing each county's revenue and expenditure by its population in the corresponding year. The variable "Other Income" is the summation of per-capita local revenues except for revenue from agricultural taxes. We also keep track of its sub item, value added tax and sales tax, in order to compare with previous studies that find income substitution from sales and value-added taxes (Burge et al., 2012; Zhao and Hou, 2008; Chen,

[12]The border counties will be discussed in Section 4.

[13]In China, officials in prefecture or higher level are counted as high-level officials. Their profiles are managed and supervised by the central government, so access to these profiles is readily available. However, county-level officials are counted as low-level officials, and their profiles are not uniformly managed.

2017). The variable "Other Intergovernmental Subsidy" is the summation of per-capita subsidies. We do not provide the sub-items, as their categories are changing over time during the sample period.

4 Empirical Framework

In this section, we detail the empirical strategy used to estimate the effect of the targeted agricultural tax cancellation and incomplete subsidy on county fiscal outcomes on revenue and expenditure. We introduce a baseline difference-in-difference design first, discuss the shortcomings of this approach, and then develop a border design and present evidence of its validity.

4.1 Baseline Difference-in-Difference Design

The endogeneity of grant levels is a common issue in the literature, and it is resolved in different ways, such as using power of congressional delegations or census calibration changes as instruments (Knight, 2002; Gordon, 2004; Suárez Serrato and Wingender, 2016), or exploiting discontinuities in grant determination (Dahlberg et al., 2008). This paper exploits an exogenous policy difference in compensation rates across provinces. A baseline version of the specification can be written as follows:

$$Outcome_{i,t} = \beta_0 + \beta_1 Post04_t + \beta_2 Incomplete_i + \beta_3 Post04_t \times Incomplete_i + \vec{\eta}\vec{X}_{i,t} + \varepsilon_{i,t} \quad (1)$$

where the subscript i and t denote county and year respectively. The $Outcome$ represents a county's revenue from agricultural tax and subsidy, revenue from other local sources, intergovernmental subsidies, and expenditure on agriculture, infrastructure, education, social security, administration, public safety, and change in financial resources from special government funds. $Post04$ is a dummy variable that takes value 1 if the year is equal to or after 2004 when the policy shock occurred, and $Incomplete$ equals to 1 if the county is in treatment group, i.e., in those provinces that are expected to have insufficient subsidy due to the policy. We also add other county-level control variables $\vec{X}$, including county population, and the per-capita regional domestic product in each sector. The coefficient β_1 captures the changes in the outcome between the pre period (2001–2003) and the post period (2004–2006). β_2 captures the initial

difference between county governments on each side of the treatment border. Our interest is in the coefficient β_3, which reveals the effect of an incomplete subsidy.

However, simply using a difference-in-difference design that includes all counties in all provinces of China may generate biased estimates. As shown in Figure 1, provinces that receive insufficient subsidies are, by design, located in coastal areas, with high levels of regional development. Wealthier counties may have fundamentally different trends in revenue, expenditure, farmer's income, and other, unobserved factors over time than the poorer, more agricultural counties. To generate more credible estimates, we implement a border design.

4.2 Border Design

China has more than 2,000 counties with diverse geographic and socioeconomic conditions. We strengthen our design by restricting the sample to adjacent counties on either side of provincial borders. The border design has been implemented in various studies, such as Card and Krueger (2000); Dube and Reich (2010); Duranton et al. (2011); Thompson and Rohlin (2012); Turner and Blagg (2017). Counties on the border of adjacent provinces are likely to be similar in terms of natural and socioeconomic conditions, such as population density, geographical endowment, road system, economic development, etc. They may also experience similar shocks to weather and economic conditions. The identification strategy is valid under the assumption that the pre-post change on each side of the border would be similar in the absence of the change in tax law. This assumption would be violated if any other policy changes are implemented at the same time and introduce asymmetric effects across the border, or if there exists different trends in outcome variables for treated and control counties. This results in a sample of 1,002 observations from 168 counties over 6 year.

As an alternative design, we extend the definition of "border counties" to include counties that are contiguous to border counties. This extended sample includes 1,855 observations from 311 counties. Using the extended sample helps control for geographic trend. Further discussion about this extended sample and matching results can be found in Section 5.3.

We estimate the following equation using restricted border contiguous sample and extended border sample, respectively:

$$Outcome_{i,t} = \delta_i + \gamma_t BorderSegment_i + \beta_3 Post04_t \times Incomplete_i + \vec{\eta}\vec{X}_{i,t} + \varepsilon_{i,t} \quad (2)$$

Pre-existing county differences are absorbed by county fixed effects. We include year-by-segment fixed effect as suggested in Dube and Reich (2010). As the province border extend across all of Southern China Mainland, the differences between the east and west counties can be large. Having year-by-segment fixed effects allow for locally varied year effects, reducing the potential for bias, and generating greater precision in estimation. A segment is defined as a section of border that separates two distinct provinces. There are 15 segments along the border. Counties are clustered into segments exclusively. At the junction area of multiple provinces, if a county is contiguous to more than one province, it is clustered to whichever is closer to the county administrative center. The standard errors are clustered on province level, assuming error independence across provinces. (Cameron and Miller, 2015).

We further estimate the year-by-year specification using restricted border contiguous sample:

$$Outcome_{i,t} = \delta_i + \gamma_t BorderSegment_i + \sum_{k=2004}^{2006} \beta_k \mathbf{1}(Year = k) Post04_t \times Incomplete_i + \vec{\eta}\vec{X}_{i,t} + \varepsilon_{i,t} \quad (3)$$

This alternative specification may show the partial implementation of the policy, and capture any effects faded or increased over time.

4.3 Design Validity

We define counties as treated if they are located in provinces that, by national law, are set to receive less than a full offsetting subsidy, and counties as part of the control group if they are in provinces that re provided with full compensation. Identification is based on contiguous counties that are on opposite sides of the provincial borders, as shown in Figure 1.[14] This results in a

[14]The distribution of counties inn the extended sample is shown in Figure 2. In China, county-level administration unit includes *district*, *county-level city*, and *county*. A *district* is part of a city which is most developed, and a *county-level city* is smaller and less industrialized than a city, but larger and developed than a typical county. We exclude these two and only study *counties*.

sample with 86 counties in 8 provinces as the control group and 82 counties in 7 provinces as the treatment group. Table 2 shows that counties on either side of the border are quite similar in terms of population and gross regional product in each sector before the agricultural tax abolishment (2001—2003).[15] The overall fiscal structures for treated and control counties are also similar: while the majority revenue (70 percent of total revenue) comes from intergovernmental subsidies, agricultural tax income accounts for about 7 percent of total revenue. The shares of other income and expenditure are similar as well.[16] Appendix Figure A1 and A2 show the distribution of key variables. These figures show that counties in the border sample are more similar than those in full sample.

To confirm that contiguous counties on opposite sides of the border follow the same trajectories prior to the policy, we implement a series of timing placebo tests by estimating Equation 3 using observations in pre- and post-treatment periods, but a false treatment time dummy one year before and two years after the actual year of agricultural tax abolishment. Likewise, we implement a geographical placebo test using the true timing of the policy, but false borders within provinces with and without full subsidy replacement. These placebo tests help to rule out the cases that the effect comes from a time or geographical trend.

5 The Effect of a Subsidy Shortfall on Local Revenue

The agricultural tax cancellation along with different fiscal subsidy creates an exogenous shock to county government budget. In this section, we first discuss how agricultural revenue is changed due to the agricultural tax cancellation, then show the effect on net revenue change, and provide robustness tests in the end.

5.1 Agricultural Revenue

We first investigate the effect of the cancellation of the agricultural tax and incomplete replacement subsidies on local government revenue. Figure 3 shows the population-weighted trends of agricultural revenues per-capita: counties on both sides of the border have similar trends in

[15] For comparison, in Appendix Table A3 we present the summary statistics for all sample.

[16] The share of intergovernmental subsidy is large in our sample, mainly as a consequence of the fact that most of border counties are relatively poor and less developed.

agricultural tax income prior to the policy change. After the abolishment of agricultural taxes, counties in provinces with incomplete replacement experience significant revenue losses compared with counties in the control group. Specifically, in 2001, 2002 and 2003, counties on each side of the border have nearly identical per-capita agricultural tax revenue. In 2004, revenue in treated counties drops to about 10 yuan per capita, while control counties remain closer to 40 yuan. This gap grows even larger in 2005 and 2006.

To examine whether these differences are driven by trends around the border, we examine how the effects vary with distance from the border. Figure 4 plots the average differences in agriculture revenue against the distance from the the province border.[17] Counties on the treated side are assigned positive distances, while control group counties are assigned negative distances. This reveals a strong first stage in agricultural revenue income difference across the border.[18] The graph shows that there is no noticable geographical trend, so the results appear to stem from the policy shock.

Table 3 presents the estimates of the policy effects on local government revenue. Column (1) shows that treated counties get an agricultural tax subsidy of 32.47 yuan per capita less than control counties on average due to the policy.[19] Consequently, in column (2) we find that net agricultural revenue for local governments is reduced by 34.79 yuan per capita.[20] Taking into account that the agricultural revenue has been cut by more than 80 percent, and that the aggregate effect is a reduction of about 17 million yuan per county (which is equivalent to 2.5 million USD), the first-stage effect is strong in both economic magnitude and statistical significance.

While the first two columns in Table 3 show average changes in agricultural tax revenue before and after policy implementation, columns (1) and (2) in Table 4 examine how these subsidy gaps vary by year. The agricultural subsidy for treatment counties is partially reduced in 2004 (21.72

[17]The distance is measured from the county administrative center, which is defined by the location of the county government building, to the nearest province border.

[18]Note that, this is exhibition similar to, but not a regression discontinuity design, in that we do not regard distance from the border as a running variable to explain the differences in fiscal outcome.

[19]Based on the fact that both treated and control counties get no agricultural tax subsidy prior to the agricultural tax cancellation.

[20]The agricultural revenue for local governments is defined by adding agricultural subsidy to agricultural tax revenue. Despite that most agricultural taxes are canceled, there are some taxes in effect post to the policy, such as land use tax and tobacco tax. This explains why the difference in agricultural revenue is slightly different from that of agricultural subsidy.

yuan per capita, a 47.2 percent change), which is consistent with the fact that the policy of agricultural tax cancellation was partially implemented in that year. In 2005 and 2006, treated counties experienced a full reduction in agricultural revenue, totaling 40.58 and 42.43 yuan per capita, respectively, or a roughly 100 percent change, indicating full policy compliance.

5.2 Net Local Revenue

Given the fiscal shortfall caused by the loss of agricultural revenue, and the balanced budget requirement, local government must either increase revenue from other sources, reduce expenditures, or use reserve funds.[21] The overall flypaper effect would suggest that the expenditure will decrease. While most studies investigate the income and expenditure effects of increased fiscal income and find positive net revenue effects (Sjoquist et al., 2005; Allers and Geertsema, 2016; Dahlberg et al., 2008; Brunner and Schwegman, 2017), there is little consensus about the revenue response when government faces a fiscal squeeze. Jonas (2012) shows that local governments in the U.S. simultaneously increased their income from other sources and decreased local government expenditure after the 2008 economic recession. Other studies find that local governments tend to maintain their levels of expenditure by raising money from other sources Lago-Penas (2008); Melo (2002); Gamkhar and Oates (1996). The practice of revenue raising differs by the institutional context. In countries where local governments have the authority to determine tax rates, they can simply increase the tax rate, while in countries where local governments do not have the authority to change tax rates freely, this tax revenue increase can be done by strengthening tax enforcement.[22] In China, local governments have limited authority to change tax rates, but they have the freedom to change the extent of tax enforcement.[23]

In Table 3, column (3), we find no evidence that local governments facing fiscal squeeze increase revenue from other sources, which exhibits perfect overall money stickiness. Lost the other potential sources, column (4) shows no difference in other intergovernmental subsidies, which rules out the case that treatment counties get insufficient agricultural subsidies but are

[21] Yu suan fa [Budget Law] (promulgated by the National People's Congress, Aug. 31, 2014) art. 12, 28 (P.R.C.) The reserve funds come from the general local reserve, and the surplus in special government funds.

[22] In developing countries, the tax enforcement level is usually low, leaving enough room for revenue raising Khan et al. (2016).

[23] Chen (2017) finds that local governments increased income from value-added and sales taxes by imposing higher de facto tax rates. Notably, Chen (2017) exploits the same shock but uses a difference-in-differences design to compare counties within the same prefecture.

compensated through other intergovernmental transfers. Therefore, as shown in column (5), the aggregate effect on net revenue change is about -44.87 yuan per capita, corresponding to an average reduction of about 9.6 percentage in total local revenue.

Column (3) to (5) in Table 4 shows the net revenue effects by year. As shown in column (3), the percentage changes of other sources of local revenue are insignificant and negligible, while the changes, if anything, are negligible in 2005 and 2006. Column (4) shows that in neither post-treated year local governments with incomplete replacement got abnormal subsidies from other sources. The aggregated changes in government revenue are shown in column (5), revealing that the per-capita revenue reduction in 2004 is half as large as in the following two years.[24]

5.3 Robustness Tests

In this section we present the results of various robustness tests, including using the extended sample, and using a sample matched on county characteristics.

The goal of the border design is to find the counterfactual that is the most similar to treated counties. However, in the border design, the sample size is limited, so we use an enlarged sample as a robustness test. Besides border-contiguous counties, we also include counties that are adjacent to border-contiguous counties, i.e., the closest off-border counties. Therefore, the sample size is roughly doubled. Another advantage of using the extended border sample is that it allows us to control for geographical trends that may otherwise contaminate the estimates.

By including additional county observations, we replicate our primary estimates on agricultural revenue and net revenue change. Table 5 shows the effects on local revenues for the extended sample. Compared with the main results on local revenue (Table 3), we find that the effects are slightly smaller, and the precision is slightly greater, but there is no statistical difference between the results using the extended sample and those using the border county-only sample. This suggests that the results are robust to the selection of counterfactual counties and that the border design is likely to be valid.

[24]The fact that local governments did not raise revenue from other sources may be explained by the institutional context in China. Local government officials are often appointed by higher levels government, so there is no voting pressure for local government to maintain expenditure level.

While the border design assumes that contiguous counties along the border are similar, we cannot rule out the possibility that non-adjacent counties may be a better counterfactual. Specifically, using matched, non-adjancent counties eliminates concerns about potential spillover effects. Therefore, as an alternative approach, we implement propensity score matching (PSM) as a method of choosing counterfactual counties that are most likely to experience similar outcomes. Propensity score matching is used to estimate an ex-ante probability of being treated, i.e., the propensity score, and to use counties with a similar propensity score as the counterfactual.(Rosenbaum and Rubin, 1983; Imbens, 2000; Gelman and Imbens, 2014) This strategy is commonly used to select a control group when a subset of individuals are affected by an exogenous shock in a panel data context. Counties in fully and less subsidized provinces are matched by population, the share of revenue from intergovernmental subsidies (a proxy for the dependence on central government), and the share of agricultural tax income in local revenue (a proxy for agricultural dependence).[25] These two variables are crucial in determining how a county will be affected by the policy. Appendix Figure A3 shows the density of propensity scores, revealing that the propensity scores in provinces with and without full compensation are distributed differently. We use propensity score matching to compare the sample from the common support of distributions using caliper matching, as there are often multiple potential control counties with similar propensity scores.

Table A4 presents the changes in revenue estimated with the propensity score matched sample. Compared with main result in Table 3 and the extended sample in Table 5, we find the net effect on agricultural revenue reduction (-19.96 yuan per capita, 38.8 percent) is smaller and imprecisely measured, while the effects on outcomes in natural logs are larger. Overall, the similarity in magnitude and percentage change shows that the treatment effects are robust to the selection of counterfactual, and also indicates that the cross-border spill-over effect of public spending is not a major concern that might dampen the estimate.

5.4 Placebo Tests

One may argue that the estimated treatment effect may come from not the policy but predetermined differences between opposite sides of the province border, or geographical or time-

[25] We use fiscal data from County-level Public Finance Statistics Yearbook of 2002.

related confounding treatments. In order to rule out these cases, we conduct a series of placebo tests in both time and space. Four different tests are implemented, in which we a) let the year 2003, one year prior to the actual cancellation of agricultural tax be the treatment time, and only use observation from 2002 to 2003, i.e., use 2002 observations as pre-treat and 2003 observations as post-treated; b) let year 2006, i.e., two years after the agricultural tax cancellation, be the treatment time, and only use observation from 2005 to 2006; c) fabricate a border by using the original treated counties as the control group, while using border contiguous counties also on the treated side as the treatment group, i.e., move the whole policy border to the south by one county so that we are comparing within provinces with insufficient subsidy; d) fabricate a border by using the original control group counties as the treatment group, while using border contiguous counties as the new control group, i.e., move the border to the north by one county, and thus compare within provinces with full revenue replacement.[26]

Table A5 shows the revenue effects for each of these placebo tests. The results of the tests are shown in Panel A to D, respectively. We find no significant changes in any sources of local government revenues in any test, which strongly suggests that pre-existing differences and post-treatment trends and confounders are not driving the results.

6 The Effect of a Subsidy Shortfall on Expenditure

Given the significant reduction in agricultural revenue and the lack of increased revenue from other sources, the agricultural tax cancellation provides an opportunity to examine how local governments adjust their expenditure. Specifically, we examine how agricultural expenditure and other categories of expenditure are affected by the fiscal shortfall.

6.1 Agricultural Expenditure

For the expenditure effects, first and foremost, we are interested in the consequent change in agricultural spending. The literature examining how an increase in governmental subsidy changes local spending reveals mixed evidence. Levaggi and Zanola (2003), Berg and Rattsø

[26] In test b), the reason for not using one year post to actual treatment time is that year of 2004 is partially treated. If we use the faked treatment time which is one year after the true time, it will capture the partial implementation of policy.

(2007) and Leduc and Wilson (2017) find that intergovernmental subsidies targeted to a specific sector boosts the spending in that sector. However, crowd-out effects are found in Knight (2002) and Gordon (2004), that is, federal funds for a specific category of expenditure will reduce the spending of local government on that category. In our case, agriculture is the targeted benefited sector. If the reduction of local government spending on agriculture is proportional to overall revenue reduction, it implies perfect categorical money stickiness. On the contrary, if the reduction of local government spending on agriculture is as much as overall revenue reduction, it implies that local governments fully offset the targeted policy intended by the central government.

Table 6 shows the policy effects on local government expenditure on agriculture. Column (1) shows that the per-capita agricultural expenditure is reduced by 17.61 yuan, which is 35.6 percent of agricultural spending. Recall that in Table 3 we find an 81 percent reduction in agricultural revenue, this implies an elasticity of 0.44, implying a partial categorical flypaper effect. When the negative income shock stems from the agricultural sector, the expenditure on agriculture is significantly reduced, yet the multiplier effect is limited compared to other studies, indicating that local governments partly reduce the extent to which the benefits of the tax reduction accrue to the targeted group.

In column (1) of Table 7 we present the expenditure effects over time. The pattern of changes is interesting. Unlike the revenue effect, that is, partial reduction in 2004 and full effect in 2005 and thereafter, agricultural spending in counties with incomplete subsidy is reduced immediately in 2004, the first year of the policy change. Per-capita agricultural spending is reduced by 22.75 yuan, which is a 44.6 percent decline. The reductions in 2005 and 2006 are 27.1 and 32.9 percent, respectively.

6.2 Other Expenditures

In addition to expenditure on agriculture, we are interested in how expenditure in other categories responds to fiscal squeeze. Previous theoretical studies claim that a neutral government may adjust its expenditure proportionally (Barro, 1990; Yin and Zhu, 2012).[27] Mahdavi (2004)

[27]While previous studies do not differentiate the sources of money and merely focus on revenue from local taxation, in Appendix Section B we present a simplified model, which particularly shows how productive spending

compares the elasticity of expenditure in different categories and finds that spending on luxury goods (such as park and recreation) is more volatile than that on necessity goods (such as public safety).

Table 6 shows the effect of each category of expenditure. In general, different categories of spending are not proportionally changed. Specifically, column (7) shows that one of the most significantly reduced categories of spending is for a broad, catch-all category consisting of hospitals and libraries, designated pensions and relief fees for veterans, science and technology expenditure, public health and medic expenditure, general government fund expenditure, cultural and sports undertakings, militia and military reserve expenditure, lottery and community fund operation cost, and government donation and humanitarian assistance.[28] Treated counties have experienced a per-capita reduction of 21.23 yuan in miscellaneous spending, which is a 12.5 percent reduction. Local governments also reduce payments into liquid reserves.[29] Column (3) shows that Social security spending is also reduced by 2.96 yuan per capita. Despite the fact that the magnitude is relatively small compared with agricultural spending, this reduction accounts for 11 percent of social security spending. Other categories of expenditure, such as infrastructure, education and public policy, do not respond significantly to the reduction in revenue.[30]

The pattern of changes in expenditure indicates that reduction in agricultural expenditure accounts for about half of the revenue change in magnitude. Apart from that, the miscellaneous spending and social security expenditure are vulnerable to fiscal deficit. However, spending on infrastructure, education and public safety are less elastic, perhaps because they are more likely to be guided and supervised by the higher-level governments.

and welfare-related expenditure are proportionally adjusted in response to change in intergovernmental subsidy.

[28] Each of the sector accounts for a small share in the category of miscellaneous spending, however, we are unable to decompose and estimate sector-by-sector changes from the data.

[29] In China, there are general government budget and special government funds. The former can be freely allocated by the local government, but the latter is for specific use, and is controlled or guided by central government. When there is a surplus in government funds, it is allowed to use them to fill the deficit gap of general spending, but it is not allowed to move the money in the opposite direction. Therefore, apart from the general liquidity reserve fund (which is included in miscellaneous spending), the government funds serve as another source of local government reserve.

[30] The administration expenditure is rather increased by 4.08 yuan per capita in counties that got insufficient subsidies. However, considering that the base level of administrative spending is large, this increase accounts for a negligible percentage change.

Table 7 shows the effect over time. Contrary to agricultural spending, which shows a stable reduction, treated counties are more inclined to decrease their miscellaneous expenditure and reserves from special government funds in 2005 and 2006: the reduction in miscellaneous spending and special government funds reserves are around 30 and 20 yuan per capita, respectively, much larger than the effects in 2004 (7.95 and 12.71 yuan per capita). The shift in expenditure reduction from agricultural spending to miscellaneous spending and special government funds reserve indicates that the expenditure pattern changes are different in short- and long-run: most of the short-run effect comes from the agricultural sector, which means local governments partially offset the targeted policy by the central government. However, as time goes by, the long-run effect is more likely to be determined by expenditure elasticity, as miscellaneous expenditure seems to be the most elastic among all expenditure categories. We also observe a persistent reduction in social security spending.

6.3 Robustness Tests

Similar to Section 5.3, we examine the robustness of estimates to using an extended border sample and a propensity score matched sample. Table 8 shows the expenditure effects estimated with the extended sample. Agricultural expenditure is decreased by 18.08 yuan per capita (38.0 percent) for less-subsidized counties. Miscellaneous spending and social security spending are reduced by 7.0 and 12.0 percent, respectively. Apart from a 5.7 percent reduction in public safety spending (though the magnitude effect is subtle), these results are similar to the primary estimates.

Table A6 presents the expenditure effects estimated with the propensity score matched sample. Column (1) shows that the agricultural expenditure is reduced by 16.61 yuan per capita, which is 37.2 percent of agricultural expenditure. In column (3) and (7), we find that the relative reduction of miscellaneous expenditure is about 10.9 percent, and the percentage reduction of social security spending is 15.9 percent. These results are similar to the main regression results, but are less precisely estimated.

7 Agricultural Production and Farmers' Income

Now that we have observed the categorical flypaper effect in agricultural spending, an important concern is that what will be the resulting impact of lost expenditure on agricultural production and farmer income. Previous literature has shown that government spending plays a crucial role in agricultural production Griliches (1964); Chavas (2001). In China, Zhou and Chen (2005) finds that farmers' income is significantly increased by benefiting policies, such as tax-for-fee reform. Wang and Shen (2014) studies how does agricultural tax cancellation affect farmers, but finds little effects on agricultural inputs, outputs, or farmer income. We re-examine these effect under a difference-in-differences framework on border counties.

For agricultural production, we measure factor inputs in three dimensions: the area of cultivated land, local agricultural labor force, and the share of agricultural workforce among total labor force.[31] Table 9 shows the policy effects on factor inputs in agricultural production. Column (1) to (3) shows the average treatment effect, while column (4) to (6) shows the effect by year. Despite the fact that the cultivated land size in counties with insufficient budget replacement tends to be lower, no significant results in terms of magnitude or percentage change are found in either dimension, indicating that there is no factor input difference between counties getting full subsidies or not. For agricultural output, as we have found no notable changes in agricultural inputs, we would expect no output change as well. Table 10 shows the changes in agricultural outputs, measured in the grain crops yield, oil crops yield, and meat production.[32] We find the grain crops yield and per-capita production are slightly reduced in 2005 and 2006, but other agricultural production outputs are unaffected.

Table 11 shows the effect of agricultural tax cancellation on farmer net income. The net income is defined as revenues minus costs minus government transfers, which, precisely speaking, is the summation of wages, productive income, and business income, minus expenditure and depreciation in family production and business, minus taxes and other fees. Column (1) in Panel A implies that farmers' average net income in counties with insufficient subsidy is 86.24

[31] Some provinces provide additional county-level data on agricultural production, such as electricity used in agricultural production and number of registered agricultural machinery. However, the sample size is too limited to draw any informative result.

[32] Grain crops include rice, wheat, cereal, corns, etc. Oil crops include beans, peanuts, sunflower seeds, rape seeds, etc. Meat product includes pork, beef, chicken, lamb, etc. Note that beans are usually accounted as oil crops in China, which is different from American and European practice.

yuan less than that in counties with full replacement. This accounts for 2.5 percent of farmer's total income, which is both economically and statistically significant, indicating that farmers are worse off when their local government receives incomplete subsidy replacement. Column (2) shows the decomposed income effects by year: in 2005 when the policy is fully implemented, farmers in counties with insufficient subsidy earn around 100 yuan less than those in control counties; while in 2004 when the policy is partially implemented, the income effect is also in proportion. Panel B shows the resulting income effect in natural logarithm: the income difference accounts for about three percentage in farmers' total income. This pattern is similar to the revenue change of local government.

The effects on farmers' net incomes are unexpected but interesting. After agricultural tax cancellation, no matter how the government subsidizes local governments, farmers are directly better off, and thus farmers' income is expected to rise. The significant results and consistent pattern in our estimation indicate that counties with deficit pass their fiscal shortfall to farmers, from whom they previously collected agricultural taxes. Recall that the net income is determined by revenues, costs, and transfers, and the revenue effect is supposed to be the same across the border since there are no significant differences in levels of agricultural outputs, and the agricultural product purchase price is set by the central government thus there is no price effect across the border. The taxes and fees should also be the same, in that agricultural taxes for farmers in treatment and control counties are equally exempted, and that in Table 3 we do not observe governments on either side exhibiting abnormal revenue increases, which rules out the case of transferring tax burden to farmers by collecting from other sources. Therefore, the only possible change must come from costs.

The treatment effects on farmer's net income and agricultural outcomes reveal that when local governments reduce their expenditure on agriculture, the actual agricultural production is not significantly affected. However, farmer's net income is reduced in counties with insufficient tax compensation, roughly equal to the agricultural revenue change. One explanation for this is a transferring effect: when local governments spend less on agricultural expenditure that may promote agricultural productivity, the responsibility falls to farmers and thus they, as individual producers, spend more on production materials (such as fertilizer, agricultural machine,

technology investment, etc.)

8 Heterogeneous Effects

In the previous sections, we have shown the pattern of local government revenue and expenditure in response to the loss of an agricultural subsidy. We further our study by examining the effects for different types of counties, as average effects may obscure interesting heterogeneity. Specifically, we examine how local government revenues and expenditures are affected by the tenure of the local governor, as well as by the level of of county agricultural dependence and wealth.

First, we are interested in how a county's local governor affects its fiscal behavior. On one hand, as discussed in Li and Zhou (2005), central government uses personnel control to induce desired local economic performance, thus local governors have an incentive to generate economic growth in order to get a promotion. On the other hand, extensive existing evidence about political connections (Faccio, 2006; Li et al., 2008; Fisman and Wang, 2015) indicates that local governors may build stronger connections if he or she stay in the office for longer time. Therefore, we are testing whether counties with newly-appointed governors and with experienced governors implement a similar response when facing fiscal deficit.

Table 12 presents the revenue effects. We categorize counties by whether their top local governor (County Party Secretary) was appointed within the last two years or not.[33] When counties have fiscal deficit due to insufficient revenue replacement, columns (1) and (2) show that treated counties are exposed to similar fiscal shocks, regardless of the tenure of of local governors. However, column (3) and (5) show a large (but less precisely estimated) difference, where new governors accept the revenue shortfall, while longer-tenured governors tend to collect revenue from other sources. The decomposed effects are fuzzy, but in aggregate, counties with new governors exhibit larger average deficits. This finding is consistent with previous literature,

[33]In China, each county has its own election period, however, the time is correlated, in that county-level election and governor appointment are usually right after the election of higher level government. In our sample, governors of nearly two thirds of counties are categorized as "newly-appointed", while the longer-tenured accounts for just 30 percent. Particularly, to make this variation exogenous, we exclude those who are on their second term, i.e., have served more than five years. Thus, all politicians in our sample are on their first term, and thus the variation of politician tenure is exogenous.

as politicians with longer tenure are more likely to increase revenue from other sources (Li and Zhou, 2005).

Table 13 presents the expenditure effects. We find that new governors tend to reduce local expenditure, especially reducing agricultural and miscellaneous spending. On the contrary, the expenditure reduction in counties with experienced governors is subtle: they even increase their administration and public safety spending. Instead, their major adjustments come from using reserves. These results, to some extent, indicate that experienced governors are more likely to use their fiscal sources when facing an unexpected deficit, including raising additional revenue and using government funds, while newly-appointed governors reduce local spending.

Additionally, we examine heterogeneous effects by the agricultural tax dependence of each county. Agricultural tax dependence is measured by the share of agricultural tax income among local government's total revenue prior to the cancellation of the agricultural tax. We separate counties into two groups based on the median level. In the high-dependency group, agricultural taxes accounted for 37.7 percent of local tax revenue on average, while in the low-dependence group, this number is 17.3 percent. When the agricultural tax is abolished, agriculture dependent counties will be affected more than counties that are less dependent on such tax revenue. Appendix Table A7 shows the revenue effects by agricultural tax dependence. In column (1), we see that agricultural tax-dependent counties lose relatively more subsidy from tax cancellation compared to those counties also receiving an incomplete subsidy but that are less dependent on agricultural taxes. However, in column (2), we find that high-dependence counties, apart from the loss due to the incomplete subsidy, lose even more in their revenue from land use taxes, tobacco taxes and deed taxes (which are categorized as "agricultural income" but not canceled by the policy). The percentage of agricultural revenue reduction for agriculture-dependent counties is about 100 percent, while this number for less agriculture-dependent counties is 24.1 percent. For the expenditure effects, Appendix Table A8 column (1) shows that, both agricultural dependent and independent counties experience similar reduction in agricultural spending in terms of magnitude and percentage change. Other expenditure effects are less precisely estimated.

We also study how the local government behavior varies by local wealth, i.e., gross regional product per capita. Similar to the heterogeneity tests for agricultural dependence, we split

based on the median level and separate counties into rich and poor counties. Rich counties have average per-capita gross product of 5,866.24 yuan, while poor counties have 2,828.67 yuan. Appendix Table A9 shows the heterogeneous effects in local revenue changes. Column (1) and (2) show that treated counties with lower per-capita GDP experience a bit more loss in agricultural revenue than treated but rich counties. The correlation to the previous result shown in Appendix Table A7 is intuitive, as rich counties usually have more development in industry and business sector, but poor counties are usually agricultural-based. The net revenue change in column (7) also reflects such differences. However, given the difference in net revenue shortfall, when we turn to the expenditure effects, Appendix Table A10 shows that rich and poor counties exhibit similar reduction in agricultural spending.

The heterogeneous effects by agricultural dependence and wealth indicate that, despite the flypaper effect, i.e., reduction in government agricultural spending, the magnitude and percentage change is not highly sensitive to how much it decreased the total revenue of the county. A potential explanation is that county governments perform revenue and expenditure accounting at the sector level, providing additional insight into the presence of a categorical flypaper effect.

9 Conclusion

In 2004, China's central government abolished agricultural taxes and provided annual subsidies to offset local budget losses. However, the amount of the subsidy varied by province, and otherwise similar counties on opposite sides of provincial borders experienced significantly different revenue shocks. Using a merged data set from the County Public Finance Statistics Yearbook of China, the China Regional Economic Statistics Yearbook, the China County Social and Economic Statistical Yearbook, and a manually collected county politician profile data set, a difference-in-difference design on border counties shows that agricultural tax revenue was reduced by 81 percent when counties received no subsidy replacement, accounting for a 10 percent reduction in total local revenue. We find no evidence that local governments offset the loss by increasing taxes on other sectors on the economy. Instead, we find that local agricultural spending is reduced by 36 percent. Social security and other expenditures were also reduced, while expenditures on infrastructure, administration, and education experienced little or no change.

We further find that agricultural factor inputs and production were not significantly affected, but the net income of farmers in less-subsidized counties decreased, suggesting that the cost pressure of public goods supply reduction is transferred to agriculture producers.

This study contribute to the literature in several ways. First, it addresses the effect of fiscal squeeze driven by a policy change and finds no crowd-in effect from other sources of local income, which exhibits the flypaper effect in terms of overall revenue. Second, it supplements the existing categorical flypaper effect literature by examining the consequent effects for the agricultural sector, revealing that local government reduces expenditures that benefit farmers. Specifically, we find that government spending is reduced for farmers, and farmers' net income declines in less-subsidized counties due to the increased cost. Our findings imply that local government is reluctant to shift the tax burden to other residents, and partially offsets the benefits intended for the group receiving the tax reduction through reduced expenditure. This highlights the potentially unintended consequences of a targeted tax reduction imposed by the central government when expenditures are determined at the local level.

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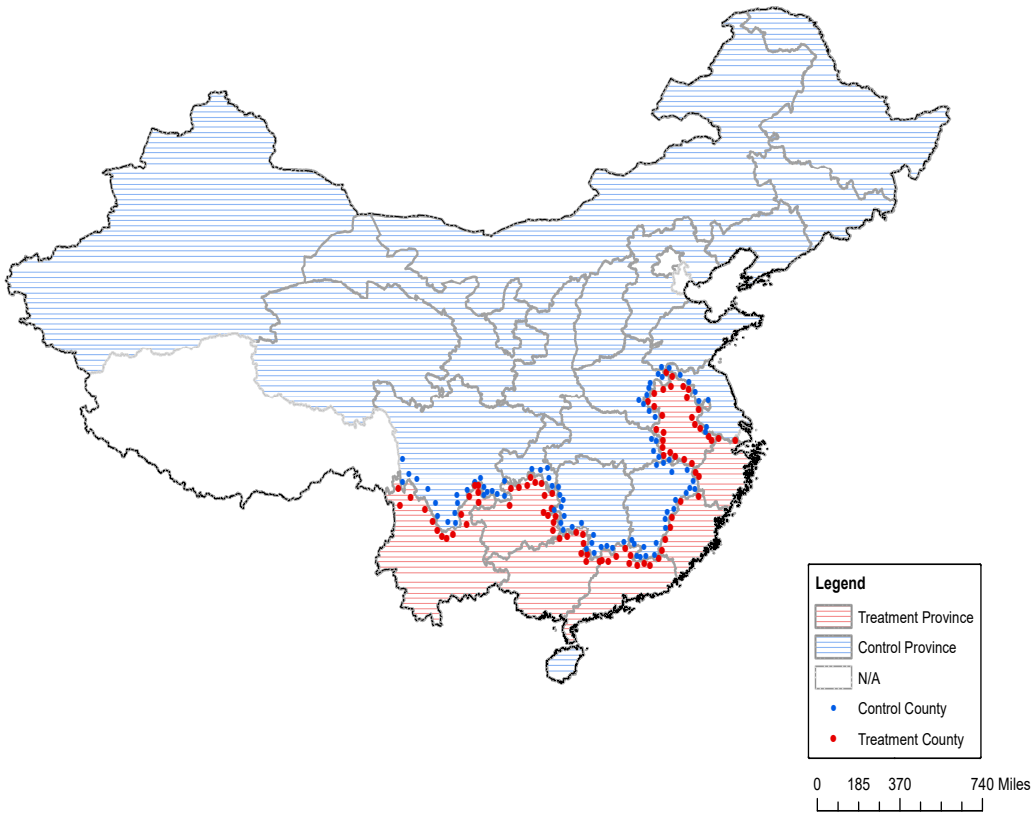
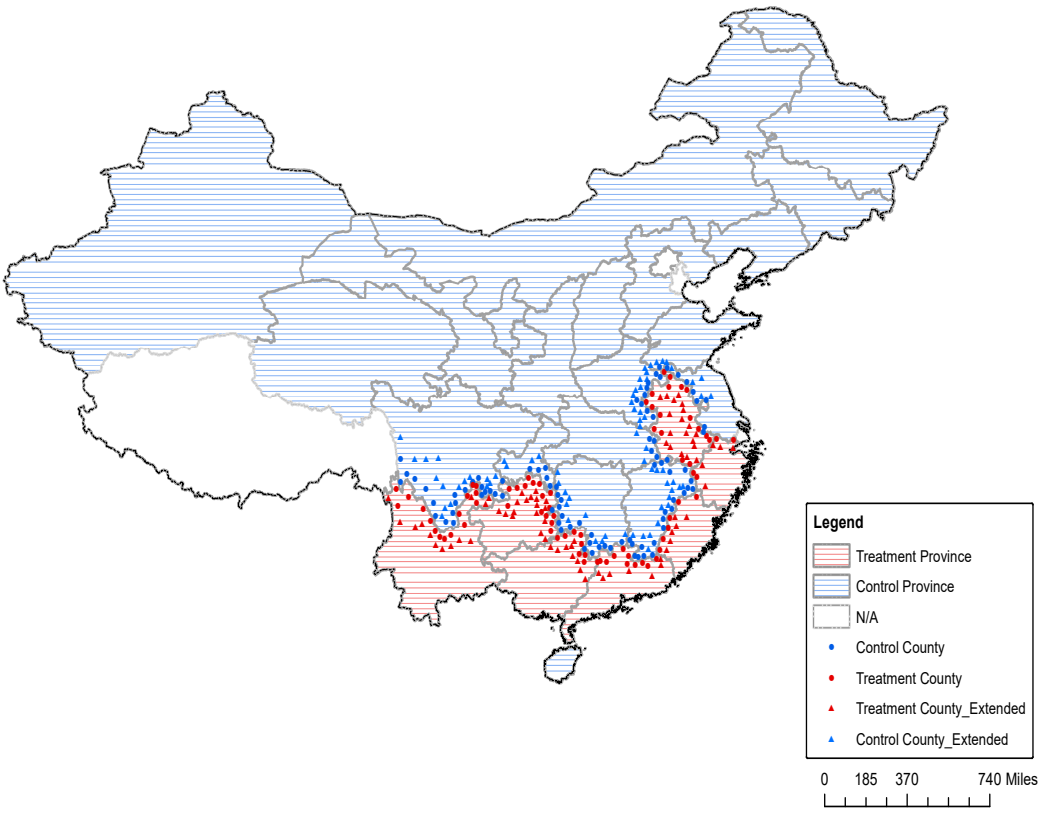
Figure 1: Geographical Distributions of Policy Effects: Border Sample



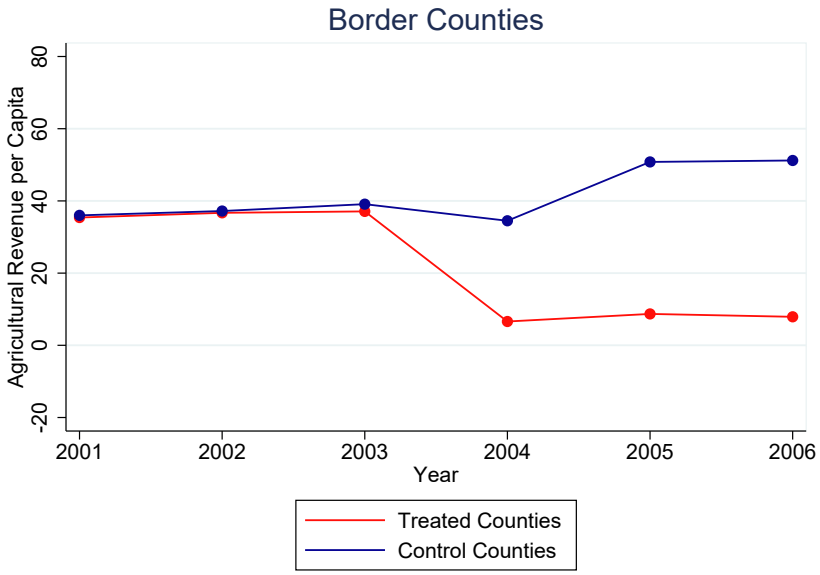
This figure shows geographical distribution of China Mainland provinces with different policy effects. Counties in blue-colored provinces (Sichuan, Chongqing, Hunan, Jiangxi, Hubei, Henan, Shandong, Jiangsu, and other northern provinces which are not included in the sample) get full amount of baseline subsidy, and counties in provinces in red (Yunnan, Guizhou, Guangxi, Guangdong, Fujian, Zhejiang and Anhui) get insufficient level compared to baseline. We exclude Municipal Cities (Beijing, Tianjin and Shanghai), Special Autonomous Regions (Hong Kong, Macau and Taiwan), and Tibet (where there is agricultural tax exemption since 1950). All the counties labeled on map are adjacent to the border. There are 90 counties in control group (blue) and 87 in treatment group (red).

Figure 2: Geographical Distributions of Policy Effects: Extended Sample



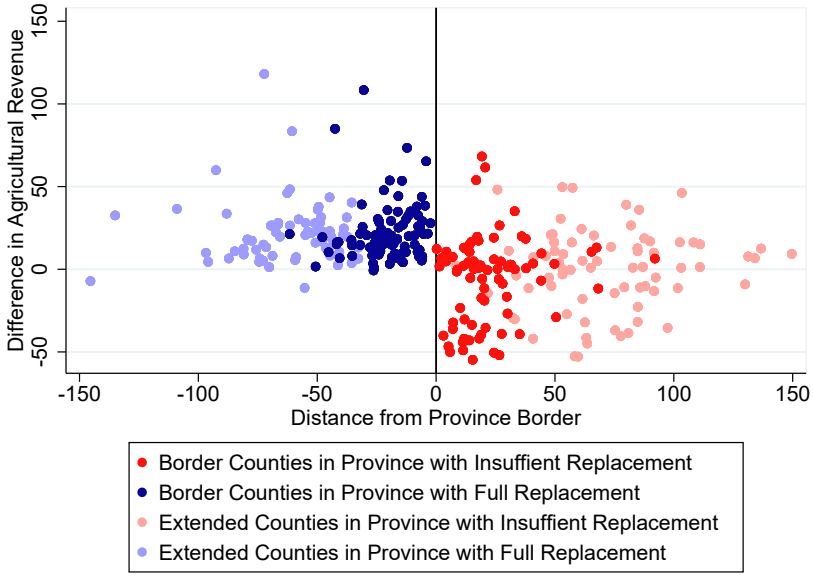
This figure shows geographical distribution of China Mainland provinces with different policy effects. Counties in blue-colored provinces (Sichuan, Chongqing, Hunan, Jiangxi, Hubei, Henan, Shandong, Jiangsu, and other northern provinces which are not included in the sample) get full amount of baseline subsidy, and counties in provinces in red (Yunnan, Guizhou, Guangxi, Guangdong, Fujian, Zhejiang and Anhui) get insufficient level compared to baseline. We exclude Municipal Cities (Beijing, Tianjin and Shanghai), Special Autonomous Regions (Hong Kong, Macau and Taiwan), and Tibet (where there is agricultural tax exemption since 1950). By including off-border counties to the original sample, the extended sample includes 1,978 observations in total, with 164 counties in control group (blue) and 166 in treatment group (red).

Figure 3: Policy Effects on Agriculture Revenues by Year



This figure shows the population-weighted trends of local government's agricultural revenue (tax+subsidy), adjusted for agricultural importance (using share of agricultural tax income) as covariates. Their pre-treatment trend looks matched after the adjustment. Agricultural revenue includes agricultural tax (Agricultural Tax, Agricultural Specialty Tax and Livestock Tax) income and specific subsidies from central government.

Figure 4: Policy Effects on Agriculture Revenues by Distance From Border



This scatter plot shows spatial distribution of changes in agriculture revenue after the agricultural tax abolishment. Distance is measured from county administrative center (i.e., the location of county government) to the nearest border and is in unit of kilometer. Positive distance represents counties in provinces with full subsidy, and negative distance represents counties in provinces with incomplete replacement.

Table 1: Revenue Sharing between the Central and Local Governments

I.Taxes exclusively assigned to the Central and Provincial Governments
1. Excise taxes
II. Taxes shared between the central and local governments
1. Value-added tax
2. Enterprise income tax
3. Natural resource tax
4. Construction tax
5. Industrial and commercial tax
III.Taxes exclusively assigned to local governments
1. Agricultural tax
2. Personal income tax
3. Land use tax
4. Property tax

Notes: For a detailed description of Revenue Sharing System, please refer to Appendix Table A1.

Table 2: Descriptive Statistics for the Border Sample

Unit: RMB per capita

	Control Group		Treatment Group	
	Mean	Std.dev.	Mean	Std.dev.
Total Revenue	532.99	215.51	661.09	387.93
Local Revenue	182.02	99.74	174.15	98.00
Agricultural Tax	44.42	22.58	41.37	21.74
Value Added Tax	19.59	19.44	26.09	31.13
Personal Income Tax	7.91	5.62	9.87	10.95
Sales Tax	32.17	26.88	32.63	27.44
Other Income	137.60	88.18	132.78	97.00
Intergovernmental Subsidy	350.97	189.21	486.95	351.78
Total Expenditure	501.48	192.45	615.99	370.53
Agriculture	46.94	33.69	73.78	76.56
Infrastructure	33.95	58.60	21.15	44.28
Education	120.99	36.82	159.45	65.09
Administration	72.91	38.15	90.00	54.81
Social Security	18.17	12.56	14.72	14.71
Public Safety	29.77	13.92	33.32	19.56
Miscellaneous	170.84	68.39	211.91	139.48
Gross Regional Product in				
Primary Sector	1,444.30	464.20	1,537.08	643.07
Secondary Sector	1,484.04	1,271.77	1,239.29	928.95
Tertiary Sector	1,630.06	4,405.61	1,378.58	816.82
Population	561,261	362,629	492,549	354,556
Number of Counties	86		82	
Number of Observations	257		244	

Notes: This table shows the pre-treatment descriptive statistics of counties in treatment group and control group, restricted to border sample. Revenue, expenditure and gross regional product are in unit of RMB per capita (2004 real price).

Table 3: Policy Effects on Local Government Revenue

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form, OLS estimate					
Post04×Incomplete	-32.468***	-34.788***	-8.934**	-1.151	-44.873***
	(4.948)	(8.293)	(4.049)	(16.469)	(9.774)
Mean Dep.Var.	12.365	46.870	135.390	406.007	588.267
Observations	1,002	1,002	1,002	1,002	1,002
R-squared	0.826	0.556	0.718	0.865	0.878
Number of Counties	168	168	168	168	168
Panel B: Natural-logs Reduced form, GLM estimate					
Post04×Incomplete		-0.810***	-0.023	-0.056	-0.096***
		(0.229)	(0.031)	(0.050)	(0.022)
Observations		1,002	1,002	1,002	1,002
Number of Counties		168	168	168	168

Agricultural revenues include agricultural tax revenues and agricultural subsidy revenues (which only exists after 2004).
All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-segment fixed effects, and covariates of population and per-capita GDP in each sector.
Standard errors in parentheses are clustered at province-border level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 4: Policy Effects on Local Government Revenue by Year

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form, OLS estimates					
Post04×Incomplete×Year=04	-21.939***	-21.722***	-1.938	-2.116	-25.776*
	(2.626)	(5.235)	(3.684)	(18.509)	(13.952)
Post04×Incomplete×Year=05	-38.455***	-40.580***	-11.988**	-0.927	-53.496***
	(6.385)	(9.863)	(4.127)	(18.569)	(12.617)
Post04×Incomplete×Year=06	-37.335***	-42.432***	-13.072*	-0.386	-55.891***
	(6.383)	(10.187)	(6.995)	(14.310)	(9.751)
Mean Dep.Var.	12.365	46.870	135.390	406.007	588.267
Observations	1,002	1,002	1,002	1,002	1,002
R-squared	0.848	0.591	0.719	0.865	0.879
Number of Counties	168	168	168	168	168
Panel B: Natural-logs Reduced form, GLM estimates					
Post04×Incomplete×Year=04		-0.472***	-0.024	-0.042	-0.072***
		(0.103)	(0.028)	(0.050)	(0.024)
Post04×Incomplete×Year=05		-0.986***	-0.027	-0.048	-0.102***
		(0.353)	(0.032)	(0.054)	(0.027)
Post04×Incomplete×Year=06		-1.042***	-0.019	-0.073	-0.110***
		(0.339)	(0.041)	(0.049)	(0.020)
Observations		1,002	1,002	1,002	1,002
Number of Counties		168	168	168	168

Agricultural revenues include agricultural tax revenues and agricultural subsidy revenues (which only exists after 2004).

All regressions are weighted by 2005 county-level population.

All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.

Standard errors in parentheses are clustered at province level.

*** p<0.01, ** p<0.05, * p<0.1.

Table 5: Policy Effects on Local Government Revenue: Extended Sample

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form, OLS estimates					
Post04×Incomplete	-31.291***	-32.150***	-4.734	0.231	-36.654***
	(5.412)	(7.744)	(3.754)	(19.568)	(11.026)
Mean Dep.Var.	12.553	47.651	139.239	398.354	585.244
Observations	1,855	1,855	1,855	1,855	1,855
R-squared	0.822	0.564	0.690	0.832	0.853
Number of Counties	311	311	311	311	311
Panel B: Natural-logs Reduced form, GLM estimates					
Post04×Incomplete		-0.760***	-0.021	-0.042	-0.084***
		(0.216)	(0.030)	(0.059)	(0.026)
Observations		1,855	1,855	1,855	1,855
Number of Counties		311	311	311	311

Agricultural revenues include agricultural tax revenues and agricultural subsidy revenues (which only exists after 2004).

All regressions are weighted by 2005 county-level population.

All regressions are controlled with county fixed effects,year fixed effects× border-segment fixed effects, and fraction of agriculture tax revenue in local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).

Those counties not on the province border is clustered into the same border segment as its closest neighbor county, where the distance is calculated using county seat-to-county seat straight distance.

Standard errors in parentheses are clustered at province level.

*** p<0.01, ** p<0.05, * p<0.1.

Table 6: Policy Effects on Local Government Expenditures

Unit: RMB per capita

Outcome Variable	(1) Agriculture	(2) Infrastructure	(3) Social Security	(4) Administration	(5) Education	(6) Public Safety	(7) Miscellaneous	(8) Total	(9) Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete	-17.608***	4.623	-2.963**	4.083***	3.839	-0.611	-21.231***	-25.836**	-19.037***
	(5.545)	(7.644)	(1.209)	(1.189)	(3.203)	(1.106)	(4.380)	(10.873)	(4.942)
Mean Dep.Var.	53.636	24.683	17.422	72.443	141.253	29.763	188.395	545.768	42.499
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
R-squared	0.913	0.680	0.807	0.950	0.932	0.924	0.939	0.963	0.815
Number of Counties	168	168	168	168	168	168	168	168	168
Panel B: Natural-logs Reduced Form, GLM estimate									
After×Treatment	-0.356***	-0.000	-0.114**	0.015	-0.016	-0.026	-0.125***	-0.064**	-0.216
	(0.062)	(0.432)	(0.057)	(0.026)	(0.013)	(0.018)	(0.019)	(0.027)	(0.133)
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
Number of Counties	168	168	168	168	168	168	168	168	168

All regressions are weighted by 2005 county-level population

All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.

Standard errors in parentheses are clustered at province level.

*** p<0.01, ** p<0.05, * p<0.1.

Table 7: Policy Effects on Local Government Expenditures by Year

Unit: RMB per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome Variable	Agriculture	Infrastructure	Social Security	Administration	Education	Public Safety	Miscellaneous	Total	Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete ×Year=04	-22.754**	3.309	-3.304**	2.896**	10.977***	0.083	-7.946**	-13.070	-12.706*
	(8.658)	(5.819)	(1.254)	(1.336)	(1.857)	(0.756)	(3.678)	(10.331)	(6.476)
Post04×Incomplete ×Year=05	-12.000***	3.649	-1.979	3.066**	0.879	-1.971*	-29.525***	-34.317**	-19.178***
	(3.550)	(7.829)	(1.126)	(1.405)	(4.530)	(1.094)	(4.536)	(12.301)	(4.763)
Post04×Incomplete ×Year=06	-17.861***	6.919	-3.581*	6.291***	-0.537	0.015	-26.646***	-30.537**	-25.354**
	(3.581)	(8.710)	(1.971)	(1.360)	(4.163)	(1.530)	(5.967)	(11.211)	(9.282)
Mean Dep.Var.	53.636	24.683	17.422	72.443	141.253	29.763	188.395	545.768	42.499
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
R-squared	0.634	0.217	0.454	0.727	0.810	0.689	0.809	0.879	0.431
Number of Counties	168	168	168	168	168	168	168	168	168
Panel B: Natural-logs Reduced form, GLS estimate									
Post04×Incomplete ×Year=04	-0.446***	-0.213	-0.139***	0.015	0.055***	-0.014	-0.068***	-0.042*	-0.244*
	(0.102)	(0.352)	(0.046)	(0.020)	(0.014)	(0.022)	(0.017)	(0.023)	(0.126)
Post04×Incomplete ×Year=05	-0.271***	0.035	-0.082	0.009	-0.019	-0.062**	-0.151***	-0.064**	-0.213
	(0.049)	(0.438)	(0.065)	(0.028)	(0.023)	(0.026)	(0.024)	(0.028)	(0.189)
Post04×Incomplete ×Year=06	-0.329***	0.195	-0.121	0.034	-0.056***	-0.011	-0.140***	-0.069**	-0.245
	(0.047)	(0.485)	(0.102)	(0.031)	(0.013)	(0.020)	(0.021)	(0.031)	(0.168)
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
Number of Counties	168	168	168	168	168	168	168	168	168

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 8: Policy Effects on Local Government Expenditures: Extended Sample

Unit: RMB per capita

Outcome Variable	(1) Agriculture	(2) Infrastructure	(3) Social Security	(4) Administration	(5) Education	(6) Public Safety	(7) Miscellaneous	(7) Total	(8) Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete	-18.038***	4.806	-3.105**	3.750**	3.738*	-1.232	-10.449***	-16.770	-19.884***
	(5.083)	(6.789)	(1.287)	(1.276)	(1.812)	(0.754)	(3.472)	(13.599)	(6.276)
Mean Dep.Var.	55.168	23.253	16.574	77.250	139.786	31.718	202.530	564.756	54.431
Observations	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855
R-squared	0.896	0.672	0.770	0.934	0.908	0.922	0.924	0.956	0.731
Number of Counties	311	311	311	311	311	311	311	311	311
Panel B: Natural-logs Reduced Form, GLM estimate									
Post04×Incomplete	-0.380***	0.056	-0.120**	0.014	-0.017	-0.057***	-0.070***	-0.047	-0.437*
	(0.059)	(0.402)	(0.049)	(0.029)	(0.024)	(0.009)	(0.023)	(0.032)	(0.231)
Observations	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855
Number of Counties	311	311	311	311	311	311	311	311	311

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province-border level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 9: Policy Effects on Factor Inputs in Agricultural Production

Outcome Variable	(1) Actual Cultivated Area Size	(2) Agricultural Laborforce	(3) Share of Agr. Laborforce	(4) Actual Cultivated Area Size	(5) Agricultural Laborforce	(6) Share of Agr. Laborforce
Unit	Km^2 (100 Hectare)	1,000 Person	% (in total population)	Km^2 (100 Hectare)	1,000 Person	% (in total population)
Panel A: Reduced Form						
After×Treat	-3.125	-0.337	0.005			
	(7.875)	(5.207)	(0.006)			
After×Treat×Year==2004				11.623	-5.699	-0.001
				(14.174)	(5.190)	(0.006)
After×Treat×Year==2005				-13.582	3.995	0.009
				(14.782)	(7.227)	(0.009)
After×Treat×Year==2006				-10.956	1.841	0.011
				(14.413)	(6.784)	(0.008)
Mean Dep.Var.	527.82	365.29	0.48	527.82	365.29	0.48
Observations	888	859	859	888	859	859
R-squared	0.111	0.282	0.191	0.115	0.284	0.194
Number of n_county	168	168	168	168	168	168

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 10: Policy Effects on Gross and Per-capita Agricultural Production

	(1)	(2)	(3)	(1)	(2)	(3)
Outcome Variable	Grain Crops	Oil Crops	Meat Product	Grain Crops	Oil Crops	Meat Product
Panel A: Gross Product						
						Unit: 1,000 ton
After×Treat	-3.366	-0.548	-3.441*			
	(7.386)	(2.796)	(1.881)			
After×Treat×Year==2004				8.089	-0.930	-4.427**
				(7.892)	(1.932)	(1.645)
After×Treat×Year==2005				-15.149*	-0.134	-2.407
				(7.725)	(5.477)	(2.123)
After×Treat×Year==2006				-0.009	-0.558	-3.502
				(7.792)	(1.529)	(3.092)
Mean Dep.Var.	323.63	24.648	53.908	323.63	24.648	53.908
Observations	903	816	840	903	816	840
R-squared	0.601	0.349	0.506	0.605	0.349	0.507
Number of n_county	168	145	151	168	145	151
Panel B: Per-Capita Product						
						Unit: Kg per capita
After×Treat	-14.826	3.150	-2.734			
	(10.412)	(3.904)	(3.103)			
After×Treat×Year==2004				0.327	0.656	-3.370*
				(8.256)	(1.805)	(1.735)
After×Treat×Year==2005				-26.523**	8.195	-1.611
				(11.508)	(9.693)	(3.537)
After×Treat×Year==2006				-17.150	-1.743	-3.842
				(11.954)	(2.162)	(6.088)
Mean Dep.Var.	431.758	30.467	72.688	431.758	30.467	72.688
Observations	903	816	840	903	816	840
R-squared	0.495	0.230	0.519	0.500	0.235	0.520
Number of n_county	168	145	151	168	145	151

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 11: Policy Effects on Farmers' Income

Unit: RMB per capita

	(1)	(2)
Outcome Variable	Farmer's Income	Farmer's Income
Panel A: Change in Magnitude		
After×Treat	-86.237***	
	(26.046)	
After×Treat×Year=2004		-54.287
		(36.759)
After×Treat×Year=2005		-97.054***
		(26.408)
After×Treat×Year=2006		-106.319***
		(27.827)
Mean Dep.Var.	2424.153	2424.153
Observations	1,770	1,770
R-squared	0.674	0.675
Number of n_county	311	311
Panel B: Change in Natural-logs		
After×Treat	-0.025*	
	(0.012)	
After×Treat×Year=2004		-0.017
		(0.012)
After×Treat×Year=2005		-0.030**
		(0.013)
After×Treat×Year=2006		-0.028
		(0.016)
Mean Dep.Var.	7.721	7.721
Observations	1,770	1,770
R-squared	0.646	0.647
Number of n_county	311	311

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 12: Policy Effects on Local Government Revenue by Tenure of Politicians

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form, OLS estimate					
Post04×Incomplete×NewGovernor=0	-36.163***	-41.148**	12.107	1.381	-27.660
	(5.952)	(15.322)	(16.198)	(26.123)	(30.426)
Post04×Incomplete×NewGovernor=1	-30.726***	-34.271**	-6.378	-0.038	-40.688***
	(4.580)	(12.021)	(8.139)	(17.977)	(10.153)
Observations	856	856	856	856	856
R-squared	0.800	0.412	0.681	0.841	0.852
Number of Counties	143	143	143	143	143
Panel B: Natural-logs Reduced form, GLM estimate					
Post04×Incomplete×NewGovernor=0		-0.853**	0.034	-0.049	-0.085
		(0.372)	(0.137)	(0.108)	(0.060)
Post04×Incomplete×NewGovernor=1		-0.806**	-0.028	-0.088	-0.112***
		(0.345)	(0.058)	(0.097)	(0.039)
Observations	856	856	856	856	856
Number of Counties	143	143	143	143	143

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects,year fixed effects× border-segment fixed effects, and fraction of agriculture tax revenue in local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).
Those counties not on the province border is clustered into the same border segment as its closest neighbor county, where the distance is calculated using county seat-to-county seat straight distance.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 13: Policy Effects on Local Government Expenditures by Tenure of Politicians

Unit: RMB per capita

Outcome Variable	(1) Agriculture	(2) Infrastructure	(3) Social Security	(4) Administration	(5) Education	(6) Public Safety	(7) Miscellaneous	(8) Total	(9) Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete×NewGovernor=0	-12.901	1.322	0.063	10.227***	2.260	4.139	-12.876	-0.942	-26.717**
	(11.762)	(10.932)	(2.735)	(3.074)	(3.408)	(2.666)	(11.645)	(27.560)	(10.332)
Post04×Incomplete×NewGovernor=1	-16.602**	6.863	-3.360	1.734	3.501	-1.391	-18.602***	-23.405*	-17.283
	(6.100)	(9.837)	(2.189)	(5.410)	(4.871)	(1.666)	(5.476)	(11.167)	(10.564)
Observations	856	856	856	856	856	856	856	856	856
R-squared	0.507	0.132	0.309	0.652	0.785	0.630	0.787	0.855	0.186
Number of Counties	143	143	143	143	143	143	143	143	143
Panel B: Natural-logs Reduced Form, GLM estimate									
Post04×Incomplete×NewGovernor=0	-0.284**	0.573	0.040	0.111*	-0.028	0.120*	-0.104*	-0.023	-0.649***
	(0.119)	(0.416)	(0.183)	(0.062)	(0.058)	(0.063)	(0.061)	(0.065)	(0.190)
Post04×Incomplete×NewGovernor=1	-0.389***	0.495	-0.091	-0.015	-0.031	-0.062	-0.134***	-0.082**	-0.236
	(0.082)	(0.665)	(0.093)	(0.040)	(0.029)	(0.041)	(0.025)	(0.035)	(0.191)
Observations	856	856	856	856	856	856	856	856	856
Number of Counties	143	143	143	143	143	143	143	143	143

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Appendix

A Notes on Economic Data Converting with OCR

Optical Character Recognition (OCR) is the technology that converts images of typed, handwritten or printed text into machine-encoded text in designated forms. With the development of digital image scanning and processing technology, using OCR software becomes a common method for converting spreadsheet in printed materials (such as books, archives, and reports) to data set that can be directly used in economic research and analysis. A printed spreadsheet consists of the contents (most are numbers), the horizontally and vertically aligned structure, and the frame lines that separate cells. Therefore, apart from the general converting errors, the structure of spreadsheets may introduce specific errors. In this part, we briefly discuss three types of conversion errors in the environment of digitizing spreadsheets, the consequent effects on data quality in terms of measurement errors in estimating average treatment effect, and some ways to fix them.

The first type of error comes from single characters. In most cases OCR works and provides accurate results. However, when the condition of source materials is poor, a single character can be wrongly read. For example, number "0" with a black stain on its bottom right could be read as letter "Q", and number "1" with a horizontal, dirty crease could be read as number "4". Since this type of error occurs randomly, it introduces same bias to data of treatment and control groups, and thus statistically only reduce the precision of estimates.

The second type of error is due to the poor quality of scanning. This is more likely to happen at certain position of pages, even if we place and scan the material in the correct way. For example, when we scan the County Public Finance Statistics Yearbook of China, which is a book of 1,500 pages, the quality of contents near the hinge is poor, because it is hard to flatten that part of a thick book on a book scanner. The impact of this type of error depends on how the spreadsheet is ordered. If variables are listed in columns, scanned variables close to the hinge may have larger measurement errors. On the contrary, if variables are listed in rows but observations are in columns, such measurement errors may fall to certain observations, and we need to test whether it is correlated with treatment assignment.

The last but most critical type of error comes from the frame line. If the numbers are too close to the frame line, the vertical frame line could be converted as part of numbers, leading to an additional digit "1" at the beginning or the end of the original number. For example, a right-aligned number "23456" can be converted to "234561". The lead "1" changes the value by adding 10^N where N is the number of digits in original value, while the lag "1" changes the value by multiplying the original value by 10. This type of error, if not being corrected, usually leads to asymmetric changes in variable distribution of treatment and control group.

Besides manual proofreading, we exploit the balancedness of the budget balance sheet to check for and correct errors. As all tables of revenue, expenditure and subsidy have their total and sub items, we simply check whether the summation of sub items equals to total item. This implementation can rule out most errors listed above. The only remains are those with two same errors in one observation, but such cases are very rare.

B Government Spending and Political Incentives

B.1 Baseline Model

In this part we set up a model for local government behavior in response to the changes in intergovernmental subsidy. Using this model, we are able to develop some testable hypotheses in local government behavior.

Consider a two-period economy with a representative agent and a (local) government. At the very beginning, the government allocates its revenue on public expenditures. Following Alesina and Rodrik (1994), Barro (1990), Devarajan et al. (1996) and Yin and Zhu (2012), we assume that there are two different sector of spending: production-related expenditure (g_1) and welfare-related expenditure (g_2). In order to focus on the role of intergovernmental transfer, different from previous studies, we assume that the government collects no local taxes and the only source of revenue comes from an exogenous transfer, G_0, and the government's budget balance condition is therefore:

$$g_1 + g_2 = G_0$$

In the first period, the representative agent allocate her endowment k_0 onto consumption c_1 and capital stock k, and in the second period, the agent consumes c_2, which comes from the production of capital. Assume that labor supply is fixed, and further assume that the production function is given by:

$$y = \tilde{A}k^{\gamma}(g_1\bar{l})^{1-\gamma} = Ak^{\gamma}g_1^{1-\gamma}$$

Assume that the agent has intertemporal discount factor β, and in each period she utilizes consumption and government's *durable* welfare goods, assume that the utility function is given by:

$$u_i(c_i, g_2) = \ln c_i + \alpha \ln g_2$$

Therefore, given government expenditures, the agent chooses each period's consumption c_1, c_2, and the capital stock k to maximize:

$$\max_{c_1,c_2,k} U^C = u_1 + \beta u_2 = \ln c_1 + \beta \ln c_2 + (1+\beta)\alpha \ln g_2$$

subject to

$$c_1 + k = k_0$$

and

$$c_2 = Ak^{\gamma}g_1^{1-\gamma}$$

we can solve for the equilibrium

$$c_1^* = \frac{1}{1+\beta\gamma}k_0$$

$$k^* = \frac{\beta\gamma}{1+\beta\gamma}k_0$$

$$c_2^* = Ag_1^{1-\gamma}(\beta\gamma)^{\gamma}\frac{k_0^{\gamma}}{(1+\beta\gamma)^{\gamma}}$$

Now, given the representative agent's response function, the government allocates g_1 and g_2 to maximize its utility function. We assume that the government is neutral and benevolent, i.e., maximizes the consumer's utility:

$$\max_{g_1,g_2} U^G = u_1^* + \beta u_2^* = \ln c_1^* + \beta \ln c_2^* + (1+\beta)\alpha \ln g_2$$

subject to

$$g_1 + g_2 = G_0$$

First-order condition implies that

$$\beta\left(\frac{1-\gamma}{g_1}\right) + (1+\beta)\alpha\left(\frac{1}{g_1 - G_0}\right) = 0$$

which solves the optimal share of production-related expenditure

$$\frac{g_1}{G_0} = \frac{1}{1 + \frac{\alpha}{1-\gamma}\left(1 + \frac{1}{\beta}\right)}$$

alternatively,

$$\frac{dg_1}{dG_0} = \frac{1}{1 + \frac{\alpha}{1-\gamma}\left(1 + \frac{1}{\beta}\right)}$$

or

$$\frac{d\ln g_1}{d\ln G_0} = \frac{1}{1 + \frac{\alpha}{1-\gamma}\left(1 + \frac{1}{\beta}\right)}\frac{G_0}{g_1}$$

The derivation implies that, when there is an exogenous change in intergovernmental transfer, local governments are expected to reduce productive expenditure and welfare-related expenditure proportionally, keeping their relative sizes unchanged. It is expected to see identical percentage changes.

Note that, with constant elasticity of substitution (CES) production function and utility function, the results may apply to general cases with multiple sectors. Therefore, if we compare the percentage changes of different categories of expenditure, without flypaper concern and political incentive concern, those estimates are expected to be the same.

B.2 Generalized Case with Political Incentive Concern

One strong assumption in the baseline model is that, the decision maker, i.e., local politician, are neutral and benevolent to maximize local representative agent's utility. In reality, this assumption is usually violated. Existing literature has found empirical evidence that governments' expenditure composition can reflect their ideology. Budge and Hofferbert (1990) examines the

relation between U.S. party programs and federal government expenditures, and concludes that parties do stick to policies on which they are elected. Bräuninger (2005) finds that higher weight on social welfare spending in a party's policy agendas does lead to a significant increase in social security spending. Moreover, a variety of studies discuss about how political incentives or career concerns affect expenditure composition. Drazen and Eslava (2010) finds that under the competitive election system in Colombia, voter-targeted spending rises in election years relative to other categories of spending. Similar results are also discovered by Khemani (2000) for a study in India and Gonzalez (2002) in Mexico.

Different from most republic countries, China's county-level governors are usually appointed or dismissed by upper government. Therefore, for the local governors, they consider about their evaluation from higher level government. Li and Zhou (2005) and Yin and Zhu (2012) find that under the central appointment system in China, local officials put higher priorities on production related spending (for example, agricultural and infrastructure expenditure) over welfare expenditure as their turnovers are largely based on the economic performance (mainly GDP) of their regions. However, this concern, if exists, should apply to counties on both sides of province border. Therefore, in a triple-differences design, it is expected to see no difference in percentage changes between groups.

Appendix Figures and Tables

Table A1: Revenue Sharing between the Central and Local Governments, Detailed

I.Taxes exclusively assigned to the Central and Provincial Governments

1. Excise taxes
2. Income tax of all central government enterprises
3. Taxes collected from the Ministry of Railroads and from the headquarters of banks and insurance companies
4. Income taxes, sales taxes and royalties from offshore oil activities of foreign companies and joint ventures
5. Energy and transportation fund contribution
6. Seventy percent of the three sales taxes collected from enterprises owned by the Ministry of Industry, the Ministry of Power, SINOPEC (petrochemicals), and the China nonferrous metals companies.
7. All customs duty, VAT and excise taxes on imports
8. Enterprise income tax collected from banks and other financial institutions.

II. Taxes shared between the central and local governments

1. Value-added tax (75 percent central, 25 percent provincial)
2. Natural resource taxes (coal, gas, and other minerals if the enterprises are fully State-owned.)
3. Construction tax on the cost of construction of buildings that are outside the plan and financed from retained earnings
4. Salt tax
5. Security and exchange tax (50 percent central, 50 percent provincial)
6. Industrial and commercial tax, and income tax levied on foreign and joint venture enterprises.

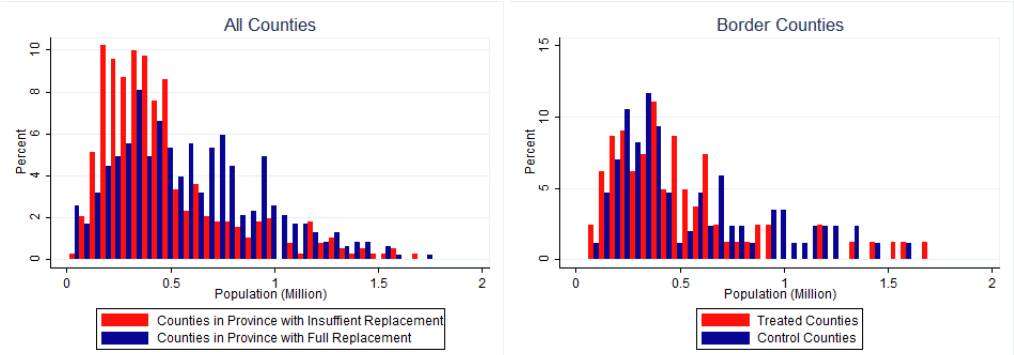
III.Taxes exclusively assigned to local governments

1. Income tax and adjustment tax of locally owned state enterprises, collectives, and private enterprises (including agricultural tax)
2. Business (gross receipts) tax falling on sectors not covered by VAT (transportation and communications, construction, finance and insurance, post and telecommunications, culture and sports, entertainment, hotels and restaurants, and other)
3. Rural market (stall rental) trading tax
4. Urban maintenance and construction tax (a surcharge on the tax liability of enterprises for business tax, consumption tax, and VAT)
5. The urban land use tax
6. Vehicle and vessel utilization tax
7. Thirty percent of the product and VAT revenues collected from enterprises owned by the Ministry of Industry, Ministry of Power, SINOPEC, and the China nonferrous metals companies
8. Individual income tax
9. Value-added tax on land
10. Education surtax
11. Entertainment and slaughter taxes
12. Property tax
13. Surtax on collective enterprises
14. Resources tax
15. Fixed asset investment tax (discontinued in 1999)
16. Fines for delinquent taxes.

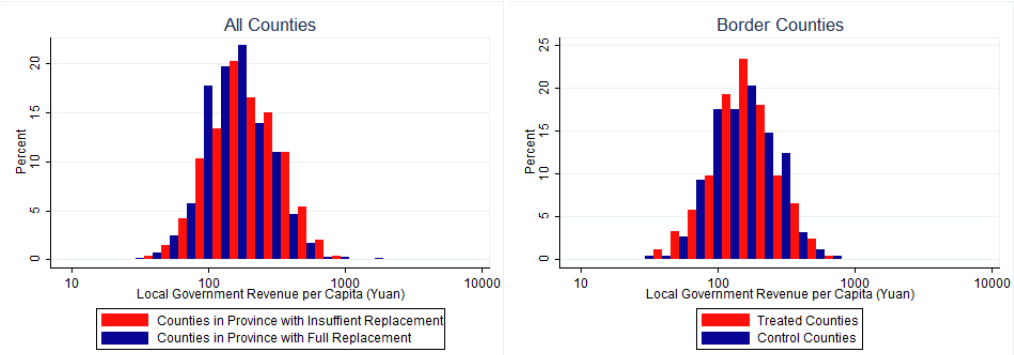
Source: Bahl (1999).

Figure A1: Variable Distribution

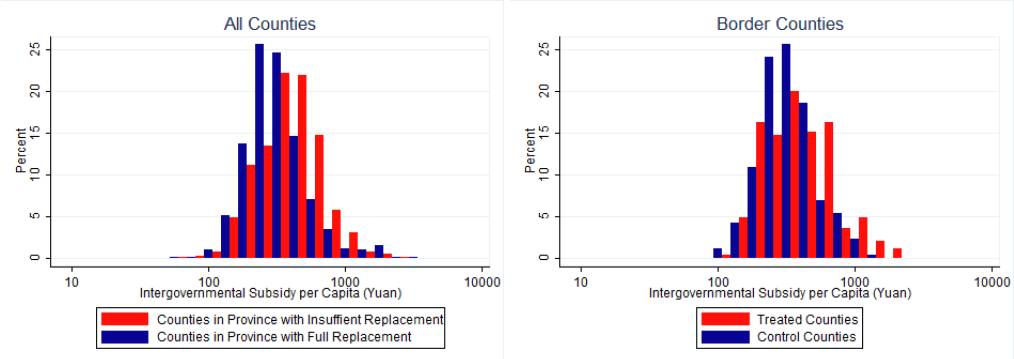
(a) Population



(b) Local Revenue



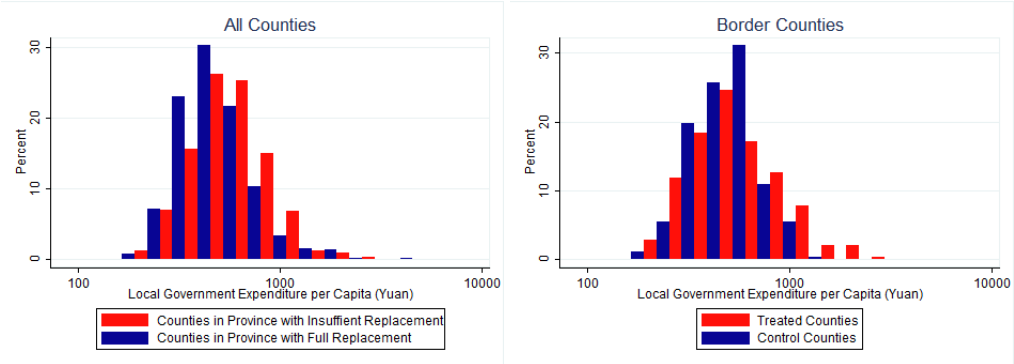
(c) Intergovernmental Subsidy



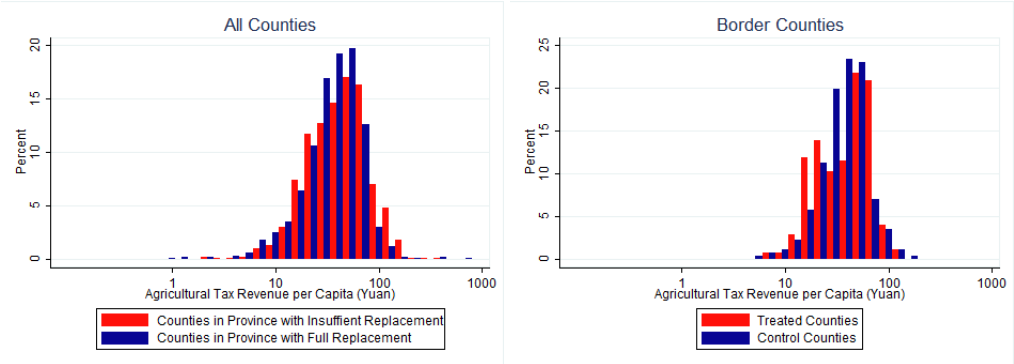
These figures show the distribution of key variables (population, local revenue, and intergovernmental subsidy) on average before 2004 for counties in province with full and incomplete subsidy replacement. By comparing the distributions, it shows that treatment and control counties in border sample are more similarly distributed than those of full sample.

Figure A2: Variable Distribution, Continued

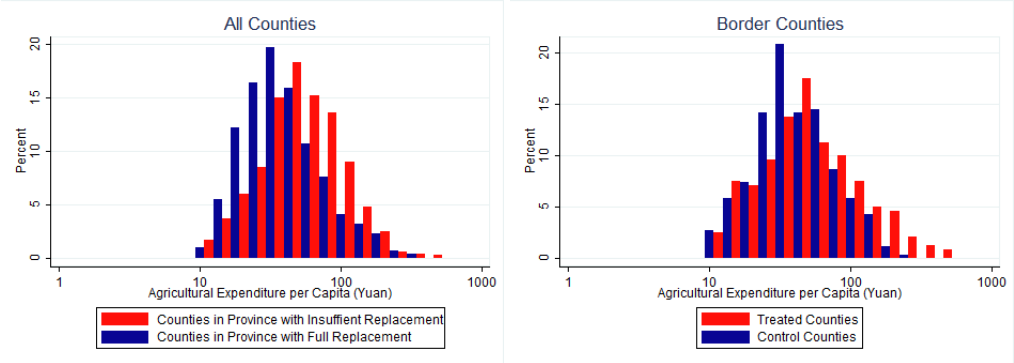
(a) Local Expenditure



(b) Agricultural Tax Income

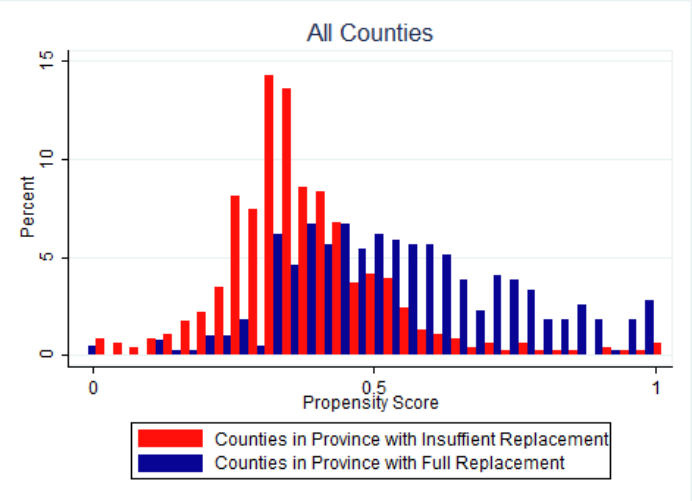


(c) Agricultural Expenditure



These figures show the distribution of key variables (local expenditure, agricultural tax income, and government expenditure on agriculture) on average before 2004 for counties in province with full and incomplete subsidy replacement. By comparing the distributions, it shows that treatment and control counties in border sample are more similarly distributed than those of full sample.

Figure A3: Propensity Score Distribution



This figure shows the distribution of propensity score of treatment and control group counties. Counties in treated and control provinces are matched by population, share of intergovernmental subsidy, and share of agricultural tax income in local revenue. The figure shows unbalanced distributions, which implies the importance of matching to find a comparable counterfactual.

Table A2: Expenditure responsibilities between Central and Local Governments, 2003-2006

	Central Exp/Sub-Item Exp	Local Exp/Sub-Item Exp	Central Exp/Central Total Exp	Local Exp/Local Total Exp
Agriculture	9.4%	90.6%	1.93%	6.60%
Infrastructure	38.8%	62.2%	17.79%	10.26%
Education	7.8%	93.2%	3.11%	15.05%
Health	2.3%	97.7%	0.28%	4.17%
Social Security	12.2%	87.8%	2.55%	6.33%
Pension	0.9%	99.1%	0.07%	2.85%
Administration	16.7%	83.3%	5.44%	9.60%
Public Defense	98.8%	1.2%	29.43%	0.12%

Notes:This table shows partial expenditure responsibilities between central and local government in China. The first two columns represents the percentages in terms of a specific sub item expenditure, while the last two columns show the percentages of total expenditure for that level of government. All the percentages are averaged between 2003-2006. A complete table can be found from Tan (2010).

Table A3: Descriptive Statistics of All Sample

Unit: RMB per capita

	Control Group		Treatment Group	
	Mean	Std.dev.	Mean	Std.dev.
Total Revenue	549.01	323.72	679.70	323.09
Local Revenue	189.70	118.50	215.25	131.16
Agricultural Tax	45.21	35.08	47.33	33.00
Value Added Tax	22.59	22.64	34.38	37.22
Personal Income Tax	8.90	8.47	13.37	18.20
Sales Tax	30.88	26.52	41.97	36.48
Other Income	144.48	100.74	167.91	123.13
Intergovernmental Subsidy	359.32	280.88	464.46	277.62
Total Expenditure	507.19	290.04	625.72	305.78
Agriculture	46.90	41.49	68.22	55.51
Infrastructure	30.39	69.14	23.17	41.36
Education	120.89	52.11	164.13	59.17
Administration	76.95	63.51	92.82	50.49
Social Security	16.67	14.44	12.29	12.17
Public Safety	28.52	17.17	34.96	19.85
Miscellaneous	178.63	103.22	218.30	114.80
Gross Regional Product in				
Primary Sector	1,615.24	968.35	1,634.12	843.9669
Secondary Sector	1,961.14	1,630.95	1,660.58	1,766.45
Tertiary Sector	1,645.70	2,144.5	1,280.19	1,148.22
Population	607,388	341,593	454,708	313,375
Number of Counties	470		391	
Number of Observations	1,409		1,174	

Notes: This table shows the pre-treatment descriptive statistics of counties in treatment group and control group. Revenue, expenditure and gross regional product are in unit of RMB per capita (2004 real price).

Table A4: Policy Effects on Local Government Revenues: Matching

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form, OLS estimate					
Post04×Incomplete	-28.323***	-19.960**	5.002	-11.599	-26.557
	(5.064)	(8.312)	(12.938)	(20.692)	(24.055)
Mean Dep.Var.	13.996	49.295	164.313	415.435	629.043
Observations	4,321	4,321	4,321	4,321	4,321
R-squared	0.761	0.321	0.613	0.698	0.763
Number of Counties	730	730	730	730	730
Panel B: Natural-logs Reduced form, GLM estimate					
After×Treatment		-0.388**	-0.123**	-0.092	-0.120***
		(0.197)	(0.054)	(0.059)	(0.030)
Observations		4,321	4,321	4,321	4,321
Number of Counties		730	730	730	730

Agricultural revenues include agricultural tax revenues and agricultural subsidy revenues (which only exists after 2004).
All regressions are compounded-weighted by 2005 county-level population and caliper matching weights.
All regressions are controlled with county fixed effects, year fixed effects, and fraction of agriculture tax revenue in local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A5: Placebo Test: Policy Effect on Local Government Revenues

Unit: RMB per capita

Outcome Variable	(1) Agr. Revenue (Tax+Subsidy)	(2) Other Local Revenues	(3) Other Central Subsidies	(4) Net Revenue Change
Panel A: Fake Treatment Time: 1 year before				
Post03×Incomplete	-1.6317	-5.0401**	12.7681	6.0963
	(1.3570)	(2.2005)	(7.3006)	(8.7913)
Mean Dep.Var.	47.831	109.461	336.766	494.058
Observations	335	335	335	335
R-squared	0.327	0.367	0.509	0.585
Panel B: Fake Treatment Time: 2 year after				
Post06×Incomplete	-3.0386*	-5.2265	-7.5228	-15.7878
	(1.685)	(7.393)	(14.066)	(17.421)
Mean Dep.Var.	48.735	174.799	542.473	766.006
Observations	335	335	335	335
R^2	0.984	0.987	0.986	0.988
Panel C: Fake Border of Treatment: Within Treatment Group				
Post04×FakeBorder(T)	4.7991*	7.4672	-14.1102*	-1.8438
	(1.9664)	(3.9921)	(6.7973)	(7.3537)
Mean Dep.Var.	39.671	141.283	427.873	608.827
Observations	934	934	934	934
R^2	0.661	0.924	0.958	0.960
Panel D: Fake Border of Treatment: Within Control Group				
Post04×FakeBorder(C)	3.2584	7.6816	15.3143	26.2543
	(2.6468)	(6.7471)	(14.0052)	(19.0888)
Mean Dep.Var.	54.631	137.451	372.534	564.617
Observations	923	923	923	923
R^2	0.845	0.913	0.916	0.923

Agricultural revenues include agricultural tax revenues and agricultural subsidy revenues (which only exists after 2004).
All regressions are weighted by 2005 county-level population.
All regressions are controlled for county fixed effects, year fixed effects, border-specific trends, and fraction of agriculture tax revenue of local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A6: Policy Effects on Local Government Expenditures: Matching

Unit: RMB per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome Variable	Agriculture	Infrastructure	Social Security	Administration	Education	Public Safety	Miscellaneous	Total	Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete	-16.606*	0.668	-3.870	1.798	1.167	0.291	-5.408	-16.783	-9.774
	(8.820)	(8.426)	(2.982)	(3.513)	(4.517)	(2.487)	(10.155)	(20.670)	(12.702)
Mean Dep.Var.	55.992	25.235	16.046	79.627	144.256	32.453	202.646	575.569	53.475
Observations	4,321	4,321	4,321	4,321	4,321	4,321	4,321	4,321	4,321
R-squared	0.426	0.062	0.266	0.591	0.599	0.521	0.725	0.770	0.205
Number of Counties	730	730	730	730	730	730	730	730	730
Panel B: Natural-logs Reduced Form, GLM estimate									
Post04×Incomplete	-0.372***	0.167	-0.159	-0.035	-0.057	-0.070*	-0.109***	-0.098***	-0.137
	(0.076)	(0.392)	(0.138)	(0.023)	(0.036)	(0.042)	(0.042)	(0.034)	(0.091)
Observations	4,321	4,321	4,321	4,321	4,321	4,321	4,321	4,321	4,321
Number of Counties	730	730	730	730	730	730	730	730	730

Agricultural revenues include agricultural tax revenues and agricultural subsidy revenues (which only exists after 2004).
All regressions are compounded-weighted by 2005 county-level population and caliper matching weights.
All regressions are controlled with county fixed effects, year fixed effects, and fraction of agriculture tax revenue in local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A7: Policy Effects on Local Government Revenue by Level of Agricultural Dependence

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form, OLS estimate					
Post04×Incomplete×DepHigh=0	-28.182***	-16.737***	-1.064	-13.376	-31.177
	(3.432)	(4.367)	(15.825)	(24.130)	(29.949)
Post04×Incomplete×DepHigh=1	-35.168***	-45.432***	-10.225	8.750	-46.906***
	(4.695)	(12.500)	(7.809)	(14.761)	(13.354)
Observations	1,002	1,002	1,002	1,002	1,002
R-squared	0.804	0.461	0.645	0.836	0.847
Number of Counties	168	168	168	168	168
Panel B: Natural-logs Reduced form, GLM estimate					
Post04×Incomplete×DepHigh=0		-0.241*	-0.040	-0.181***	-0.147***
		(0.132)	(0.066)	(0.065)	(0.041)
Post04×Incomplete×DepHigh=1		-1.039***	-0.023	0.031	-0.059*
		(0.349)	(0.062)	(0.095)	(0.032)
Observations		1,002	1,002	1,002	1,002
Number of Counties		168	168	168	168

Agricultural Dependence is measured by share of agricultural tax income (pre-treatment) among total local income. Low and high group have mean of 0.171 and 0.376, respectively.

All regressions are weighted by 2005 county-level population.

All regressions are controlled with county fixed effects,year fixed effects× border-segment fixed effects, and fraction of agriculture tax revenue in local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).

Those counties not on the province border is clustered into the same border segment as its closest neighbor county, where the distance is calculated using county seat-to-county seat straight distance.

Standard errors in parentheses are clustered at province level.

*** p<0.01, ** p<0.05, * p<0.1.

Table A8: Policy Effects on Local Government Expenditures by Level of Agricultural Dependence

Unit: RMB per capita

Outcome Variable	(1) Agriculture	(2) Infrastructure	(3) Social Security	(4) Administration	(5) Education	(6) Public Safety	(7) Miscellaneous	(8) Total	(9) Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete×DepHigh=0	-12.479	1.930	-3.855	6.416	8.192	2.685	-19.672*	-5.489	-25.687
	(8.292)	(10.354)	(3.584)	(4.871)	(5.557)	(2.265)	(10.692)	(29.269)	(17.086)
Post04×Incomplete×DepHigh=1	-18.621**	8.531	-2.233	2.512	2.333	-2.105	-19.644***	-28.966*	-17.940*
	(8.243)	(9.151)	(1.858)	(4.732)	(3.999)	(1.438)	(4.787)	(15.532)	(8.599)
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
R-squared	0.494	0.093	0.312	0.648	0.780	0.633	0.770	0.848	0.194
Number of Counties	168	168	168	168	168	168	168	168	168
Panel B: Natural-logs Reduced Form, GLM estimate									
Post04×Incomplete×DepHigh=0	-0.393***	0.198	-0.220	-0.035	-0.056	-0.025	-0.164***	-0.114***	-0.435
	(0.089)	(0.446)	(0.143)	(0.030)	(0.037)	(0.046)	(0.028)	(0.038)	(0.292)
Post04×Incomplete×DepHigh=1	-0.324***	0.861	0.051	0.059**	0.007	-0.031	-0.086***	-0.019	-0.299*
	(0.082)	(0.586)	(0.095)	(0.029)	(0.025)	(0.029)	(0.028)	(0.032)	(0.164)
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
Number of Counties	168	168	168	168	168	168	168	168	168

All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province-border level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A9: Policy Effects on Local Government Revenue by Level of Wealth

Unit: RMB per capita

Outcome Variable	(1) Agr. Subsidy	(2) Agr. Revenue (Tax+Subsidy)	(3) Other Local Revenues	(4) Other Central Subsidies	(5) Net Revenue Change
Panel A: Reduced form					
Post04×Incomplete×Rich=0	-33.398***	-38.478**	-9.758	1.131	-47.105***
	(4.971)	(13.460)	(8.983)	(15.250)	(13.514)
Post04×Incomplete×Rich=1	-31.409***	-29.379**	-1.692	0.763	-30.309
	(5.113)	(12.555)	(17.686)	(30.355)	(33.124)
Observations	1,002	1,002	1,002	1,002	1,002
R-squared	0.801	0.403	0.645	0.835	0.847
Number of Counties	168	168	168	168	168
Panel B: Natural-logs Reduced form, GLM estimates					
Post04×Incomplete×Rich=0		-0.948**	-0.018	-0.030	-0.078**
		(0.408)	(0.079)	(0.100)	(0.037)
Post04×Incomplete×Rich=1		-0.550*	-0.045	-0.120	-0.129**
		(0.288)	(0.069)	(0.094)	(0.052)
Observations		1,002	1,002	1,002	1,002
Number of Counties		168	168	168	168

Richness is measured by county GDP.
All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects,year fixed effects× border-segment fixed effects, and fraction of agriculture tax revenue in local total revenue(subsidy not included, proxy for importance of agricultural tax to local economy).
Those counties not on the province border is clustered into the same border segment as its closest neighbor county, where the distance is calculated using county seat-to-county seat straight distance.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A10: Policy Effects on Local Government Expenditures by Level of Wealth

Unit: RMB per capita

Outcome Variable	(1) Agriculture	(2) Infrastructure	(3) Social Security	(4) Administration	(5) Education	(6) Public Safety	(7) Miscellaneous	(8) Total	(9) Reserves
Panel A: Reduced Form, OLS estimate									
Post04×Incomplete×Rich=0	-16.811*	3.826	-2.519	3.185	6.784	-1.683	-18.915***	-24.577	-22.528**
	(8.463)	(9.850)	(1.919)	(6.027)	(5.541)	(1.737)	(4.457)	(18.025)	(9.090)
Post04×Incomplete×Rich=1	-15.812*	10.876	-3.348	5.228	-0.282	2.011	-21.090*	-13.305	-17.004
	(8.425)	(11.406)	(3.844)	(5.230)	(4.421)	(2.150)	(10.374)	(31.667)	(13.695)
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
R-squared	0.492	0.093	0.311	0.647	0.780	0.630	0.770	0.847	0.193
Number of Counties	168	168	168	168	168	168	168	168	168
Panel B: Natural-logs Reduced Form, GLM estimate									
Post04×Incomplete×Rich=0	-0.328***	0.617	0.013	0.037	0.023	-0.026	-0.103***	-0.035	-0.376**
	(0.088)	(0.766)	(0.094)	(0.028)	(0.032)	(0.039)	(0.031)	(0.037)	(0.175)
Post04×Incomplete×Rich=1	-0.399***	0.464	-0.188	-0.018	-0.085**	-0.030	-0.151***	-0.102*	-0.329
	(0.088)	(0.419)	(0.147)	(0.057)	(0.037)	(0.050)	(0.039)	(0.053)	(0.210)
Observations	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002	1,002
Number of Counties	168	168	168	168	168	168	168	168	168

Richness is measured by county GDP.
All regressions are weighted by 2005 county-level population.
All regressions are controlled with county fixed effects, year-by-border-segment fixed effects, and covariates of per-capita GDP in each sector and share of elementary school/middle school students in all population.
Standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

The Effect of Regulating Political Connections: Evidence from China's Board of Directors Ban

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Abstract

There is a great deal of variation in how countries regulate the relationships between politicians and private sector firms, but little evidence about how such policies affect firm performance. In 2013, China passed a new regulation that banned politicians from serving on the boards of directors of companies. Using a novel data set that links board members, government officials, and forced resignations, I estimate the effect of the policy on the composition of corporate boards and subsequent changes in firm performance and stock returns. I find that the loss of a high-level politician significantly reduces a firm's cumulative stock return and future profits. The analysis provides important evidence about the efficacy of a commonly used policy tool for reducing political influence in the private sector.

Keywords: political connections, government officials, board of directors, corruption.

JEL classification: G38, K20, P26

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1 Introduction

Countries differ significantly in the extent to which they regulate firms' political connections. While a number of countries have no or only minor restrictions on high-level government officials owning shares of or working for private companies (e.g., Belgium, India, Japan, and Mexico), others prohibit such relationships (e.g., Brazil, Ireland, and the Philippines), and several have more moderate policies (e.g., France, Germany, the U.K., and the U.S.)[1] The wide variation in policies across countries suggests that there is little consensus about whether relationships between politicians and firms should be regulated. Further, while a large literature examines how political connections affect firm outcomes, there is far less evidence about whether government policies are effective at eliminating such connections. This paper considers these questions by examining one of the most common policies for regulating political connections: not allowing active politicians to serve on corporate boards. Specifically, I estimate the short- and long-run stock return and firm profit effects of a new policy that bans politicians from serving on corporate boards in China.

The effect of political connectedness on firm value is theoretically ambiguous (Krueger, 1974). A number of studies find advantages for politically connected firms, as connections may distort resource allocation through preferential lending (Mian and Khwaja, 2005; Wu et al., 2008; Chan et al., 2012; Cull et al., 2015), government bailout (Faccio et al., 2006), legal protections (Li et al., 2008), government contracts (Goldman et al., 2013), and exports concentration (Bai et al., 2014; Ding et al., 2017). However, there is some evidence that political connections can harm a company. For example, they may reduce investment efficiency in state-owned enterprises (Chen et al., 2011), or cause firms to lose independence from the government and hinder firm decision-making (Marquis and Qian, 2013). The effects of political connections on social efficiency are also ambiguous. Ferreira (2010) notes that board members with political experience may provide valuable guidance and help firms navigate government requirements. Conversely, Shleifer and Vishny (1994) show that rent-seeking typically occurs when politicians can bring profits to the firm, and a social welfare loss may occur if resource allocation is distorted.

[1] Faccio (2006) assesses the restrictions in each country by considering whether a member of parliament (MP) or a minister is allowed to be an owner or director of a company. For example, in the U.S., both members of Congress and governmental officials are generally not allowed to own or to direct a firm if there exist conflicts of interest, or if the firm may obtain benefits from the government.

There are a number of challenges to identifying the effect of political connections and policies intended to regulate these connections. First, measuring political connectedness can be difficult, as personal relationships are rarely observed in data. Second, it is hard to make valid comparisons across countries due to endogeneity concerns, as countries make their policy decisions in response to local conditions. Likewise, comparing firms with and without political connections within a country may be problematic, as having political connections may be correlated with unobservable factors that cause differences in firm performance, and a political connection might actually form as a result of a firm's performance. In order to generate an unbiased estimate of the impact of a specific policy, we need an exogenous shock that is both observable and not otherwise correlated with firm performance.

This paper examines the effect of a sharp policy change in China. Regulation No.18, which was announced in the autumn of 2013, prohibited government officials from serving on corporate boards and from receiving any income from firms. Firms were given one year to comply with the policy, after which all government officials were expected to have resigned. Focusing on listed firms, I determine whether a company has an independent director who is a politician, the number of directors who are politicians, and the level of those politicians within the government. I examine short-run and long-run outcomes of the new policy using a difference-in-differences design. To allow for heterogeneous effects, I differentiate by the number and importance of the politicians who were affected (where importance is measured using national classification standards).

To conduct the analysis, I create a new data set that links Chinese stock returns with an original data set of board member resignations. In China, listed firms are required to disclose board member resignations by posting resignation reports, and I link each resigning board member with a database of government officials. I find that firms with politicians follow a very similar stock return trajectory to firms without politicians prior to the announcement of the policy. However, after policy implementation, these cumulative returns diverge significantly. In the very short run, the announcement of the regulation does not sharply change the stock returns of firms with politicians on their boards. In the longer run, however, stock returns of firms with high-level political connections fall by 5.4% relative to firms of similar size and industry. The

discrepancy between short-run and long-run results may be explained by limitations in the market's ability to predict long-run effects, or by the fact that long-run changes in stock return are too modest and uncertain relative to typical short-run fluctuations to generate an investor response.

An analysis of treatment heterogeneity shows that the effects are increasing in the number of politicians who resign: cumulative returns decline by 5%, 9% and 17% if firms lose 1, 2 or 3 or more high-level politicians, respectively. There is no significant price effect for firms that lose connections with low-level government officials. The differential effects of high- and low-level politicians suggest that only high level politicians have enough information and influence to generate stock return effects. The results are robust to a number of alternative specifications, such as including firm fixed effects, changing sample periods, and various methods of choosing untreated firms to control for time trends in stock returns.

The estimated policy effect in this paper of about 5.4% is in the middle range of those in the broader political-connectedness literature, indicating that a) the policy effectively reduced political influence, and that b) firms benefit from political connections. For example, Fisman (2001) finds that being connected to President Suharto contributed as much as 23% to firm value in Indonesia, while Fisman et al. (2012) find little effect of having Vice President Cheney as a board member in the U.S. Other estimates of the effect of political connections in the literature include 6% in Italy (Cingano and Pinotti, 2013), 13% in Egypt (Acemoglu et al., 2014), 5% in the U.S. (Goldman et al., 2009), and 2% to 4% across 47 countries (Faccio, 2006). In China, Xu and Zhou (2008) exploit a political scandal and find that related firms experience a 2% reduction in returns. Similar to the lagged response in this paper, Fisman and Wang (2015) find no immediate effects, but share prices of politically connected firms fall by 7% in the 30 trading days following a fatal accident that affects a politician's career. In contrast to this study, Tang et al. (2016) find that the announcement of Regulation No.18 resulted in a 3% reduction in 3- to 5-day short-run returns.[2] A concurrent working paper, Xu (2017), considers a narrower definition of politician in China, but finds longer-run effects of approximately 4%, which is consistent with the baseline result for high-level politicians in this study.

[2]The difference in results is likely to stem from the fact that Tang et al. (2016) use an announcement date of Oct 30, two weeks after the policy was widely reported, and restrict attention to firms that complied with the policy, rather than all firms with politician on the board.

This paper contributes to the literature in several ways. First, because the analysis is based on a sudden change in the law in the world's second largest economy, the resulting estimates reveal the effects of a specific, common policy that governments use to combat the influences of political corruption in the private sector. That is, the analysis provides compelling evidence that such policies reduce the political connectedness of firms. Second, the large number of affected firms (more than 600) allows for precise estimates of the influence of higher and lower level politicians, as well as an examination of whether the benefits of connectedness are increasing in the number of associated politicians. Finally, the analysis considers not only the short- and long-run effects of political connections on stock returns, but whether there are observable changes in firms' profitability and capital structure.

The paper is organized as follows. Section 2 presents background information about China's independent directors, government officials, and Regulation No.18. Section 3 introduces the data set and summary statistics. Section 4 details the empirical strategy. Section 5 presents short- and long-run estimates. Section 6 discusses anticipation and potential mechanisms, and Section 7 concludes.

2 Background Information

2.1 Independent Directors in China

An independent, or outside, director, refers to a board member who does not formally have a material or pecuniary relationship with a company. The duty of an independent director is to help make decisions and to mediate among interests of different shareholders. The role of independent director originated in the U.S. in 1934, and took its current form after the Sarbanes-Oxley Act in 2002.[3] It has long been viewed as a solution to corporate governance challenges such as the residual claim problem (Fama and Jensen, 1983). Outside directors make up 66% of all boards and 72% of S&P 500 company boards in the U.S.[4] Many developed and emerging countries have joined the trend of establishing the practice of requiring independent directors, including China.

[3]Initially, they were known as non-employee directors, although the concept at that time is to some extent different from independent directors today. See The Securities Exchange Act, 1934.

[4]See http://www.wsj.com/articles/SB10667628024874610O.

In August 2001, the China Securities Regulatory Commission (CSRC) issued an opinion to establish independent directors for listed companies. It requires that all companies listed on Chinese Stock Exchanges shall have at least one third of board members be independent directors by 2003.[5] Typically, there are 8 to 10 directors on a board, 3 to 4 of which are independent. Generally, independent directors are not permitted to be employed by the company, but they may own up to 1% of a firm's shares and receive fixed compensation known as sitting fees.[6]

The establishment of the independent director institution constitutes the most comprehensive measure taken to date by the CSRC to regulate internal corporate governance. However, the effectiveness of directors may be limited, as they devote a modest amount of time to the corporation and thus may not form independent judgement.[7] Therefore, Clarke (2006) concludes that there are weak connections between the use of independent directors and the quality of corporate governance. Nevertheless, independent directors may provide an opportunity for firms to develop political connections. The CSRC did not restrict political affiliation prior to 2014, and there were no restrictions on government officials having concurrent jobs as independent directors. Thus, offering the position of independent director could be a way for firms to set up and maintain political connections that increase firm profits, or for politicians to extract rents from the private sector.

2.2 Regulation No.18

Independent directors with political connections may enable corruption. Thus, to regulate politicians' behavior and maintain a good market environment, the Organization Department of the CPC Central Committee issued Regulation No.18 in October of 2013.[8] This regulation prohibited all government officials, including former officials who resigned or retired within the last three years, from holding positions in firms or receiving any payment from firms. The reg-

[5]See China Securities Regulatory Commission, [*Guidance Opinion on the Establishment of an Independent Director Opinion*], sec. 1(3), issued Aug 16, 2001.

[6]Holding up to 1 percent of shares may allow independent directors to have a substantial stake in large, publicly traded companies. However, since non-major shareholders are not required to disclose their trading, we are unable to estimate the exact amount of benefits that politicians can get from firms.

[7]Normally, an independent director spends less than 10 days per year formally working for the firm (Shen and Jia, 2005). Moreover, instead of observing, analyzing and providing independent opinions, their time is usually spent on attending annual/quartely meetings.

[8]See Organization Department of the CPC Central Committee, [*Guidance Opinion on the Regulation of Party and Government Leaders Taking Office in Corporation*], sec. 1, issued Oct 19, 2013. It is informally called Regulation No.18 since it is the 18th regulation announced by CPC Organization Department in that year.

ulation applies to all government departments and all level of officials, and is widely regarded as an important step toward regulating corruption.[9] Although Regulation No.18 did not exclusively target independent directors, they were the largest group affected. There are some cases in which politicians served as executives such as CEO or CFO, but this is far less common than politicians serving on the board of directors.[10] Therefore, this regulation is primarily a restriction on independent directors. A key outcome of this paper is shedding light on whether restricting these formal relationships actually reduces the political connectedness of firms in practive.

Though the market may anticipate restrictions on political connections, it is unlikely that the market would know to what extent government officials would be regulated or the exact timing of a new regulation. Therefore, anticipation is unlikely to be a significant concern.[11] Each listed firm with at least one government official who is an independent board member is affected by the resignation. However, in order to maintain the normal operation of boards, all government officials were given one year from the date of issue of Regulation No.18 to resign from their positions. Based on this pattern of adjustment, the announcement of the regulation leads to two types of changes for each listed firm with government officials on their board. The first stems from the announcement and the anticipation of how this change may affect the firm, and the second stems from the actual resignation of officials. As firms and officials may choose the separation date, the timing of resignation is endogenous. Therefore, I first consider the announcement of the regulation in the short run, and then examine firm outcomes over time in the long run. In addition, since politicians of all administrative levels must comply, the regulation provides a chance to estimate if there are heterogeneous effects due to the number and seniority of politicians affected.

Importantly, this regulation requires compliance by anyone who resigned or retired from a government position within three years. Therefore, it rules out the case in which a politician would leave the government and choose to stay with the firm. Apart from working for the firm,

[9]Some exemptions may be allowed with permission. However, for government officials working with an exemption, receiving payment is prohibited. Also, these officials are subject to closer supervision.

[10]The data reveals 156 resignations of CEOs and CFOs, compared with 1,387 independent director resignations. Moreover, the distribution of CEO/CFO resignations over time does not change around the announcement of Regulation No.18. See Appendix Figure A1.

[11]From the stock return trends prior to the announcement of regulation, there does not appear to be anticipation.

it is less likely that politicians get benefits through other legal channels, since a government official is not allowed to hold or control shares of firms that are under his or her jurisdiction of duties.[12]

2.3 Government Officials and the Measurement of Power

Defining "government official" is a complicated endeavor in China. A narrow definition includes leaders and officers in a strictly defined government organization. However, China's unique political system means that leaders of institutions like public universities may also have some political power. Having connections with these people may have a similar effect to having a connection with a political official in a more narrowly defined sense. Therefore, I use the generalized definition for *officials*: in addition to CPC and government officials, it includes National Parliament Committee (NPC) deputies, Chinese People's Political Consultative Conference (CPPCC) representatives, and leaders of state-owned enterprises and non-profit institutions such as public universities, research institutes, and hospitals, etc.[13]

The power of an official is measured by the administrative level. According to the national standard, there are 12 levels of officials. In practice, people normally categorize them into 5 major tiers: national (Guojia Ji), provincial (Shengbu Ji), bureau (Tingju Ji), county (Xianchu Ji), and township (Xiangke Ji). More broadly, officials are either high or low level: bureau tier or higher are considered as high-level, and vice-bureau tier or lower are regarded as low-level. The high and low division is used by China's government and is consistent with common understanding. This division has been used in previous studies such as Fisman and Wang (2015). Table 1 presents the categorization and gives examples of positions for each tier. I classify a firm as politically connected if one or more government official serves as an independent director on the firm's board at the time of the announcement of the regulation.

[12] See [*Guidance Opinion on the Regulation of Party and Government Leaders Individual Investment Behavior*], sec. 3, issued Apr 3, 2001. Available at http://cpc.people.com.cn/GB/33838/2539927.html.

[13] China is now trying to separate state-owned enterprises and other institutions from government control as well as CPC administrations.

3 Data

3.1 Data Source

The analysis involves the use of three data sets: two firm-level financial data sets, and a newly constructed data set of independent director resignations.

Financial data collected by Wind Information Co., Ltd. includes firm descriptions, issuance information, market data, dividend data, share capital structure, financial and accounting data, and other important information for all listed companies in the stock exchanges of Shanghai and Shenzhen. The trading history consists of daily data about opening, high, low, and closing adjusted prices, trade volume, and other indicators that depict market changes within a day. Listed firms' characteristics come from annual reports that reveal a firm's size, ownership, and accounting indicators such as debt-to-capital ratio and operation cash flows. Wind also has records of company announcements, from which I collect the resignation reports of independent directors. As a complement to Wind, I use Financial China, which is a free-access website that shows listed firms' basic information. Most importantly, the website has a brief profile for each board member. This aids in identifying whether a board member holds a political position.

In addition to firm data, I collected the identity of government officials from publicly available sources. The resulting data set contains detailed personal background for all independent directors who resigned after January 1, 2013, including the political positions he or she held. While Financial China and other Chinese financial websites contain basic information about the directors (age, tenure, education, gender, party membership, etc.), a richer set of variables was collected using Baidu Baike (Baike means encyclopedia), which contains profiles for noteworthy individuals. I find that more than 90% of board members have detailed information listed on the site. In instances where the information was not detailed enough, additional internet searches of newspapers, working homepages, and other websites was conducted until the missing information was collected.[14] The final data set identifies the level of government position held by board members and the stock prices of treated and untreated firms before and after the regulation was announced and implemented.

[14] Truex (2014), where NPC deputy information is collected in the same way, claims that Baidu profiles are quite reliable. To verify data quality, I check the validity of Baidu data for a large sample of directors against official government websites.

3.2 Data Description

I consider all 1,965 listed stocks on the main board of the Shanghai and Shenzhen stock exchange, and collect their daily price history from 2013 to 2015, focusing on trading days and skipping the days when the market is closed.[15] The 1,965 firms are categorized by their highest level of political connection. The number of resignations occurring after the announcement of the regulation is presented in Table 2, Panel A. I find 1,387 cases of resignations after the announcement, and 882 of them are government officials.[16] Panel B and Panel C show how these politicians are distributed among firms: about one-third of firms have political connections, typically one government official, and about 10 percent of firms have multiple officials on their boards. Firms are considered as treated if they are connected with one or more officials. There are 243 firms connected to high-level politicians, 419 firms connected to low-level politicians, and 1,303 firms with no political connection.

Table 3 shows the summary statistics for firms with no political, a high-level political, or a low-level political connection. The data reveals significant differences in the number of employees, the working capital ratio (asset-to-liability ratio), the quick ratio (liquid asset-to-liability ratio), and beta (volatility in comparison to the market) on average across the three groups. Shareholder structure and sector composition are similar across the groups. However, in terms of market value, net profit, and employment scale, firms with high-level political connections have larger scale and firms with low-level political connections have smaller scale than firms without connections. This fact is intuitive, as larger firms have potentially greater capacity to connect with higher-level officials. Additionally, firms with political connections tend to have higher P/E ratios. These differences across connected and unconnected firms suggest potential benefits of verifying that estimates are robust to using a matched control group to determine counterfactual time trends based on similar firms.

[15] There are 2,185 stocks in total at the beginning of 2013. I drop the firms that have key characters missing in annual reports. GEM, SME board, the new OTC market and all the IPOs after Jan 1, 2013 are not included.

[16] See notes in Table 2 for details.

4 Empirical Framework

I first confirm the effectiveness of the treatment, i.e., that Regulation No.18 causes politicians to resign their positions. Figure 1 shows the total number of independent director resignations by month. Before October 19, 2013, there was a stable and modest number of resignations for both officials and non-officials over time. Typically, resignations occur either because the board member's term has expired or due to eligibility changes (for example, the person has become a large shareholder or an executive leader and thus loses independent status). After the regulation was announced, monthly non-official resignations are steady, but instances of government officials' resigning increase dramatically: the number of government official resignations increased from 10 to 50 per month after four months of corporate adjustment, and in November 2014, one year after the announcement, a wave of resignation comes and there are more than 200 resignations in one month prior to the compliance deadline.[17] This evidence indicates that Regulation No.18 generated a large scale increase in resignations of government officials from corporate boards.

The impact of regulating political connections on firms' stock performance may be realized in the short-run or in the long-run. According to Jensen and Johnson (1995), when a regulation is announced (even before full implementation), the market may react by adjusting the price. Alternatively, if markets do not internalize the importance of political connections, or realize the extent of political connections, then it may take time for the returns to respond. Further, if changes in long-run firm performance are small in magnitude relative to short-run stock return fluctuations, then investors may not alter their strategies.

To measure short-run and long-run stock return effects, I employ a difference-in-differences (DID) design in the days before and after the announcement, and over the course of subsequent months and years. To ensure valid comparisons over time, I present results for several alternative methods of selecting control firms with similar pre-treatment characteristics.

[17] There are also some cases of resignations after the designated deadline, because some officials did not realize they should leave until government enforcement. I also include them as treated.

4.1 Identification Strategy: Difference-in-Differences

The identifying assumption for a difference-in-differences specification is that, apart from political connections being cut off, firms with and without politicians on their boards experience the same trends. Hence if we deduct the cumulative returns of control firms from that of treated firms, we can capture the treatment effect. I regress the cumulative return on a post-policy dummy, a treatment dummy, and their interaction:

$$CAR_{i,t} = \alpha + \beta_1 After_t + \beta_2 Gov_i + \beta_3 After_t Gov_i + \varepsilon_{i,t} \tag{1}$$

The dependent variable is each stock's daily cumulative return, i.e. logarithmic difference between daily adjusted closing price and the closing price on October 18, 2013.[18] The binary variable $After_t$ equals 1 if the date t is after the announcement, and Gov_i equals 1 if firm i has at least one government official on the board at the time of the announcement. The coefficient β_1 captures the common trend. β_2 measures the initial difference between treatment and control firms. Our interest is in the coefficient β_3, which indicates the treatment effect. Alternatively, adding firm and time fixed effects, I estimate the following equation:

$$CAR_{i,t} = \alpha_i + \gamma_t + \beta_3 After_t Gov_i + \varepsilon_{i,t} \tag{2}$$

where δ_i and γ_t represent firm and day fixed effects. For the short-run effect, I use the time frame of one or two weeks before and after the announcement, and for the long-run effect, I consider a range of periods in one or two years.

I examine heterogeneity across treatment groups, as it might be the case that a Minister has a different effect than a vice Minister, and losing two politicians may have a greater effect than losing one. Thus, I refine my specification to allow for heterogeneous effects by considering finer categorization of official tiers and the number of officials leaving the board. I treat the number of resignations as a categorical variable that flexibly reveals the effects. Specifically, I estimate

[18] A typical way used in finance is estimating the abnormal return using CAPM or newer model such as Fama-French three-factor model, but once controlled for stock fixed effect in RD and DID design, the raw cumulative return is equivalent, as the expected return and risk-free return are both captured by fixed effect.

the following regression:

$$CAR_{i,t} = \alpha + \beta_0 After_t + \sum_k \gamma_k \delta(Ngov_i = k) + \sum_k \beta_k \delta(Ngov_i = k) After_t + \varepsilon_{i,t} \quad (3)$$

where $Ngov_i$ is the number of high-level or low-level politicians on the firm's board at the time of the announcement. The indicator $\delta(\cdot)$ is defined to be 1 if the condition holds, and 0 otherwise, and the coefficients β_k reveal the effect of losing 1, 2, or 3 or more politically connected board members.

Likewise, instead of having high-treated and low-treated firms only, I assign the level of treatment by the highest level of governmental position of its board members. I define

$$Highest_{k,i} = \begin{cases} 1, & \text{if firm } i \text{ has at least one level-}k \text{ government official but no higher-levels on the board} \\ 0, & \text{otherwise} \end{cases}$$

where k takes the value of all possible official tiers (see Table 1), and estimate the regression

$$CAR_{i,t} = \alpha + \beta_0 After_t + \sum_k \eta_k Highest_{k,i} + \sum_k \beta_k After_t Highest_{k,i} + \delta_i + \gamma_t + \varepsilon_{i,t} \quad (4)$$

The coefficients β_k will capture the heterogeneous effects by political level.

4.2 Choosing Counterfactual Firms

In both the short and long run, we need to assume that treated and untreated firms are similar to each other in terms of their stock price trajectories. However, from the summary statistics in Table 3, we note that firms with high-level, low-level, or no political connections differ in observables and thus may experience different stock price trends. Thus, I present estimates using the full sample and after implementing propensity score matching (PSM) as a method of choosing control firms that are most likely to experience similar outcomes.

The goal of propensity score matching introduced by Rosenbaum and Rubin (1983) and developed by Imbens (2000), Frölich (2004) and Abadie and Imbens (2006) is to estimate an ex-ante probability of being treated, i.e., the propensity score, and to use firms with a similar

propensity score as the counterfactual. While this strategy is generally not valid in a cross-sectional design, it is commonly used to select a control group when a subset of individuals are affected by an exogenous shock in a panel data context. Treated and untreated firms are matched within sector by the available summary variables that measure the performance from annual reports, i.e., market value, net profit, number of employees, P/E ratio, P/B ratio, return on equity ratio, working capital rate, debt-asset ratio, quick ratio, systematic volatility (beta), and share of large shareholders. Similar variables are commonly used in matching listed firms (e.g., Ding et al., 2017). Appendix Figure A2 show the density of propensity scores, revealing that both high- and low-level connected firms have control firms with similar propensity distributions. I use propensity score matching to compare the sample from the common support of distributions using caliper matching, as there are often multiple potential control firms with similar propensity scores. Appendix Table A1 and Table A2 exhibit the weighted summary statistics after matching for high-level and low-level treatments. Compared with their original statistics, the PSM significantly reduces differences in firm characteristics between treatment and control firms.

5 Results

As shown in Figure 1, the announcement of Regulation No.18 leads to government officials resigning from the board of listed firms, potentially reducing firms' political connections. In this section, I will first briefly summarize the results and then provide a detailed discussion of the evidence.

Figure 2 shows the trend of average cumulative returns in the period after the announcement. I cluster and plot the average return by firms' level of political connectedness. Before the regulation was announced, high- and low-treated and control firms follow a nearly identical path, suggesting that they did not anticipate the policy and have similar pretreatment trends. After the regulation, in the short run their trends look similar, but in the long run, while low-level connected and non-connected firms still move together, previously high-level connected firms experience a decrease in cumulative return.

5.1 Short-run Effects

For the short-run impact, Appendix Figure A3 presents a close up of Figure 2 around the date of announcement. The cumulative returns are shown around the announcement of Regulation No.18 (which is centered to $t = 0$), within 14 trading days before and after the announcement. Although the daily return varies substantially, graphically the return of firms in different groups changes nearly identically. While firms with political connections undergo a price reduction, firms without connections experience the same decrease. Therefore, there is no abnormal change in return for politically connected firms in the short run.

Table 4 presents the estimates of the short-run effect. For high-treated firms, column (1) shows the estimates for the full sample. The coefficient on the interaction term of $After$ and $High$ is neither economically nor statistically significant: the size of the abnormal return is less than $\pm 1\%$. Column (2) shows similar estimates for the matched sample: I use caliper matching (with radius $r = 0.01$) within sector, and compare firms with similar characteristics.[19] Column (3) and (4) display the analogous short-run estimation for low-level politically connected firms, which also reveals no effect of the regulation announcement on abnormal returns for these firms. Therefore, the announcement of the regulation does not appear to have an immediate impact on firms connected to either high- or low-level politicians. In addition, the results are robust to alternative choices of pre- and post-bandwidth from 7 trading days to 28 trading days, as presented in Appendix Tables A3.

5.2 Long-run Effects

Table 5 shows the estimated long-run effects for firms that lose high-level politicians due to the policy. I use the time window of June to September of 2013 as the pre-treatment period, and September to December of 2014 as the post-treatment period. The former time window is just before the announcement and the latter corresponds to the designated deadline for government officials to leave their boards (one year later). In column (1), the difference-in-difference estimates show that the resignation of a high-level government official has a long-run negative effect

[19] Generally speaking, caliper matching will involve larger sample sizes due to including more control firms and thus has more precision. However, since caliper matching allows less similar matches, it potentially introduces more bias. Pairwise matching, in contrast, reduces biasedness but is less precise due to the reduction in sample size. I have run all regressions using pairwise-matched sample, and the results are the same. Pairwise-matched results are not shown.

of about 5.4% on the cumulative return. Column (2) replicates the estimate using propensity score matched control groups. The matching process may be important for long-run outcomes, since the probability of divergence of corporate performance between firms with different characteristics is higher. The result with caliper matching (5.9%) is vary similar to the all sample estimate. The specification is also robust to changing the time frame that stock prices are measured after the announcement (see Appendix Tables A4).

The negative effect indicates that the political connectedness has been reduced, i.e., the policy was effective. The magnitude of the estimate is consistent with Fisman and Wang (2015), who find a 3-day negative abnormal return of politically connected firms of 1.4%, and 30-day abnormal negative return of 7%, after an exogenous shock that may reduce a firm's connectedness. The estimate is smaller than Fisman (2001) but greater than Faccio (2006) and Fisman et al. (2012). These magnitudes are consistent with the intuition that the value of political connections may be higher in countries with higher corruption levels.

Column (3) and (4) reveal that the resignation of low-level politicians does not significantly affect a firm's stock return. This is consistent with lower level politicians providing a weaker political connection. Notably, the difference between high- and low-treated firms indicates that the high-level effect is not driven by a turnover effect. That is, the stock return effects for high level politicians do not appear to stem simply from increased turnover of independent directors due to the policy shock.

An important consideration is how the effect sizes evolve over time. To examine this, I use every four month period from September 2014 to December 2015 to estimate the effect of resignations and present the results in Table 6. For high-level politically connected firms, the estimate of price loss increases from 5.9% at 12 months, to 7.2% at 16 months, and 7.1% at 20 months. Thus the statistical significance of the effect is not due to the specific choice of when the outcome is measured. However, firms with low-level connections do not exhibit any significant market value loss during any of these time periods.

5.3 Heterogeneous Effects

Table 7 presents the results based on the number of resignations experienced by firms with high-level political connections. The full sample and caliper-matched sample reveal that the loss of one, two, and three or more high-level officials accounts for a 5%, 9% and 17% negative abnormal returns, respectively. This pattern is consistent with the intuition that political connections have some de facto effect, whereby the more politicians that leave from the board of a firm, the more value the firm loses. Hence, the positive relation between magnitude of abnormal return and number of officials leaving strengthens the interpretation of the value of political connections. Analogous estimates for low-level connected firms are shown in column (3) and (4): the loss of one, two, or more low-level officials has no significant negative effect on stock returns.

Table 8 presents estimates for treatment by the level of the official. Since there are no national level officials involved, I estimate the effect from the provincial-level to the township-level. I find that for high-level connected firms (provincial, vice-provincial, or bureau-level officials), on average the abnormal return is about 5%, and for low-level connected firms (vice-bureau, county and vice-county level), the treatment effect is quite modest. These effect sizes support the segregation of high-level and low-level officials in the primary specification. This finding also reveals that the effects are not due simply to turnover of the board, in which case we should observe similar sized effects for high- and low-level connected firms.

Table 9 shows the estimation for different types of firms. I first consider ownership, i.e., whether the firm is state-owned or private. A publicly traded firm is state-owned if the central or local government holds more than 50 percent of shares. Since there are more direct interactions between state-owned firms and the government, it is possible for them to have political connections in different ways, and thus directors as a single channel of connection may have less effect. Column (1) and (2) indicate that the average treatment effect for privately-owned firms is 7.5%, somewhat larger than for state-owned firms, 4.6% (though the difference is not statistically significant). For low-level officials, the effects for privately-owned firms are larger, though the results are statistically insignificant.

Finally, I consider heterogeneous effects by sector. That is, which industries benefit most from having political connections. Because a detailed segmentation by sector does not provide sufficient statistical power to generate precise estimates, I divide the sample into manufacturing and non-manufacturing sectors. The results are shown in column (3) and (4), Table 9. This reveals that political connections have the largest effect on stock return for non-manufacturing firms, which might be a consequence of the larger room for rent-seeking in emerging sectors.

6 Anticipation and Mechanisms

In this section I examine two possible explanations for the pattern of results: 1) policy anticipation; and 2) long-run changes in profitability and access to capital.

6.1 Policy Anticipation

Under the efficient-market hypothesis raised by Hayek (1945) and Fama et al. (1969), if political connections have effects, the price should immediately adjust at the time the information is revealed. However, as shown above, this is not what we observe empirically: there seems to be no short-run effect, but there are significant long-run effects for firms connected to high-level politicians. Similar time-delayed results are also found in other studies such as Fisman and Wang (2015). One concern is that the short-run effects are attenuated if the market anticipated the policy change and adjusted the price prior to the announcement of the regulation. If there was some anticipation, the most likely time is in March 2013 when President Xi Jinping presented other, more minor, anti-corruption measures.[20] Appendix Table A5 presents a placebo test, assuming there was some anticipation by the market in March 2013. I find no significant effect at this time.

Alternatively, the investors do not *pay attention* to the political connections. Even if the information is public, they just neglect it. This could explain the market indifference after the regulation was announced. However, in this case, it should change when the board members actually resign. To test for this explanation, I examine the effect on stock return when a politician actually leaves the board. Although the exact date of resignation is endogenously made by the

[20] Xi was elected as the General Secretary of CPC Central Committee on October 15, 2012, and was then elected as the President of China on March 14, 2013.

firm, it might provide some insight into the effectiveness of the market. For each firm affected by the Regulation No.18, I identify the date when its first government official resigned from the board, and thus have 189 high-level official resignations and 338 low-level official resignations out of 917 in total.[21] By aligning the stock returns to the dates of resignation, I examine the market sensitivity when a resignation occurs. Specifically, I estimate the following model for the sample of high-level and low-level firms, respectively, controlling for time trends:

$$CAR_{i,t} = \alpha_i + \beta Resign_t + \gamma t + \varepsilon_{i,t} \tag{5}$$

where t represents the number of days after the resignation and $Resign_t$ is a dummy variable that takes value 1 if it is after the resignation. Appendix Figure A4 shows the cumulative return discontinuities on the day of resignation. There is no obvious discontinuity of stock return before and after the resignations. The econometric results are shown in Appendix Tables A6, which reveals no significant changes immediately after the leaving of politicians in various specifications. Therefore, when investors observe the actual resignations of politicians, there is no immediate effect on stock returns.

Based on the arguments above, the following explanations for the discrepancy between short- and long-run results are possible. First, the market is aware of the resignations but does not believe the connections would be cut off. For instance, the connections might remain but not in the public view. Second, the market may not believe that the government regulation will be completely enforced. In such a case the stock return will not vary immediately after the announcement of Regulation No.18 due to the enforcement uncertainty, and as more and more politicians have resigned, the spill-over of enforcement belief gradually results in the abnormal return. Third, the anticipated effect on stock prices in the long run is modest relative to short-run variation in the market. Even if the investors know there will be a price effect, the predictable part is too small to make profitable adjustment at the time of announcement.

[21] For firms with only one politicians on board, this is exactly the date when he or she left. For firms with more than one politicians, I only consider its first resignation, assuming that shareholders, if not aware of the political connectedness, would realize at the time when the first resignation occurs.

6.2 Profitability and Access to Capital

Understanding the mechanism behind the value of political connections is potentially helpful for informing policy. In this part I briefly discuss potential channels and test alternative hypotheses using available data.

Firms can benefit from political connections in various, direct or indirect ways. Direct benefits may involve politicians helping firms win contracts with the government (Goldman et al., 2013), reducing the cost of dealing with bureaucratic issues such as the waiting time, decreasing the frequency of government inspections (Fisman and Wang, 2015), enjoying lower applicable tax rates or higher tax returns (Wu et al., 2012), helping firms get special permissions, providing legal protection for firms (Li et al., 2008), bringing internal information (such as a new regulation) to firms before it was publicly revealed, or providing bailout by the government during recessions (Faccio et al., 2006). Apart from these direct benefits, connected firms may also be placed at an advantage when dealing with third parties. For example, commercial banks and other investors may believe that politically connected firms are more reliable, and thus these firms would get loans more easily (Mian and Khwaja, 2005; Wu et al., 2008; Chan et al., 2012; Cull et al., 2015). Thus political connections may decrease profitability, or reduce the relative cost of capital. I consider these channels explicitly.

To examine changes in firm profitability, I directly estimate the following equation

$$\log NetProfit_{i,2014} - \log NetProfit_{i,2013} = \alpha + \beta \cdot Gov_i + \varepsilon_i \tag{6}$$

where β shows the relative percentage change in firm's net profit. The results are shown in Table 10. Compared with untreated firms, politically connected firms appear to experience gradual profit declines: while the immediate effects are modest, the profits of connected firms are 10 to 15 percent lower one or two years after the regulation. However, the decrease in profitability are not statistically significant, and the timing is not matched with the change in stock returns. Therefore, the relation between decreasing stock returns and profitability changes remains plausible.

Compared with examining profitability, the relative factor price effect is more indirect. Since the actual factor price faced by firms is hard to observe, it is necessary to proxy for that using observable variables. Suppose that a firm produces with capital and labor and allocates its resource optimally. If the relative factor price changes, we should observe the firm changing its factor inputs. Specifically, assume that the local-monopoly firm has a constant elasticity of substitution (CES) production function with $\gamma \leq 1$. Given factor prices w and r, a firm maximizes its profit

$$\max_{K,L} A[\alpha K^{\gamma} + (1-\alpha)L^{\gamma}]^{\frac{1}{\gamma}} - wL - rK$$

and the F.O.C. implies that

$$\frac{r}{w} = \frac{\alpha}{1-\alpha}\left(\frac{K}{L}\right)^{\gamma-1}$$

Taking the log difference we have

$$-(1-\gamma)\Delta \log\left(\frac{K}{L}\right) = \Delta \log\left(\frac{r}{w}\right)$$

where the left hand side is the change in factor allocation and the right hand side shows the percentage changes in relative factor prices. If political connections affect the relative factor price, when the connection is terminated, we should observe an abnormal change in capital-labor ratio (K/L) of politically connected firms. I proxy the capital by market value (MV) and labor by number of employees (NE), which come from listed firms' annual reports, and then estimate the following equation

$$\log\left(\frac{MV_{i,2014}}{NE_{i,2014}}\right) - \log\left(\frac{MV_{i,2013}}{NE_{i,2013}}\right) = \alpha + \beta \cdot Gov_i + \varepsilon_i \tag{7}$$

where β shows the abnormal relative price change for politically connected firms.[22] Note that $\beta < 0$ indicates that political connections reduce the relative price of capital.

Table 11 shows the result. There are no significant abnormal changes in capital-labor ratios for high- and low-level connected firms when their political connections were cut off. Also, compared with the trend effect, the magnitude is negligible. Therefore, it seems that changes

[22]However, this estimation only gives the direction of change. We cannot quantitatively interpret the results, as γ is unknown.

in relative factor prices is not the main channel of benefit for political connections.[23]

7 Conclusions

In October of 2013, a new regulation that restricts connections between politicians and firms was announced in China. This study exploits the resulting exogenous shock as an opportunity to examine the effectiveness of regulating political connections. With an original data set that consolidates resignation reports and other sources of personal information about politicians, I find credible estimates of the effect of a widely used government policy on firm outcomes. Using a regression discontinuity design, I do not find an immediate effect after the announcement of the regulation. However, with a difference-in-difference design, I find effects one year later and beyond: the stock returns of firms that lose political connections with one or more mayor-equivalent or higher level official decrease by 5.4% on average, while the stock returns of firms that lose connections with lower level politicians remain unaffected. The sizes of the effect are increasing in the number of lost officials: stock prices decrease by 5%, 9% and 17% if firm lose 1, 2, and 3 or more politicians. These results are robust to the choice of control firms and are exclusive to high-level politicians. The long-run effects are supported by a reduction in firm profitability in the year after the policy was announced.

This paper extends beyond the literature to examine whether a common government policy effectively reduces the influence of political connections on firm outcomes. The large number of affected firms results in precise estimates and allows a detailed heterogeneity analysis. The analysis considers not just short- and long-run effects of political connections on stock prices, but potential mechanisms through observable changes in firms' profitability and capital structure. The results suggest that considering additional regulations, such as restricting stock ownership or overseas investment, are likely to be fruitful avenues of research.

[23] It is possible that political connection change both price of capital and price of labor. If the factor prices decreases together, the price ratio may stay unchanged, in which case we would observe no effect.

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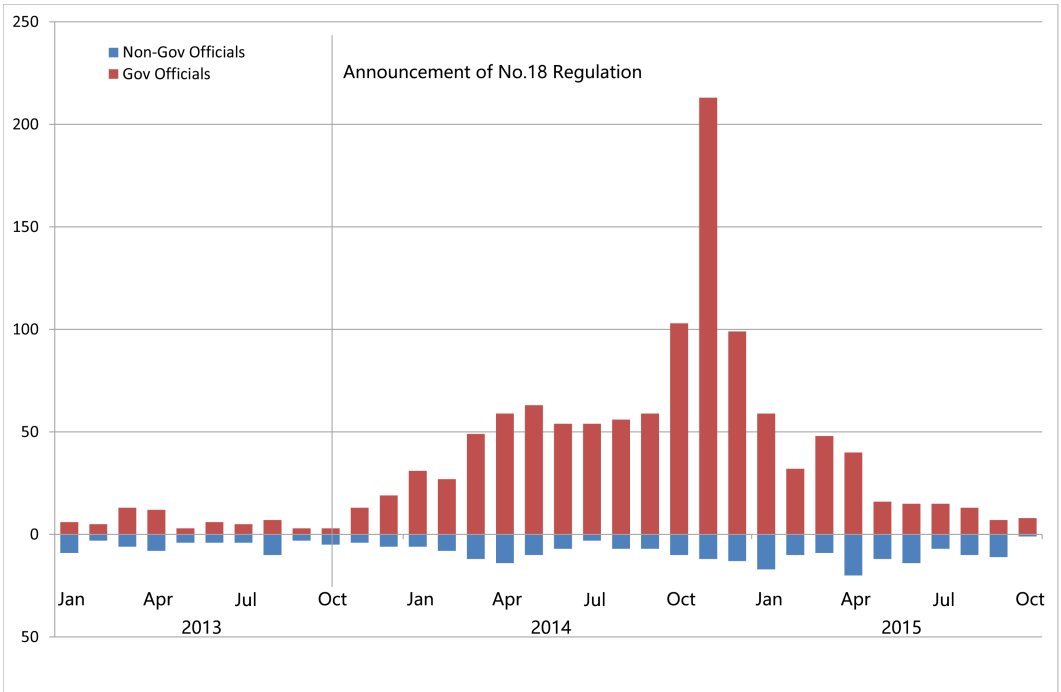
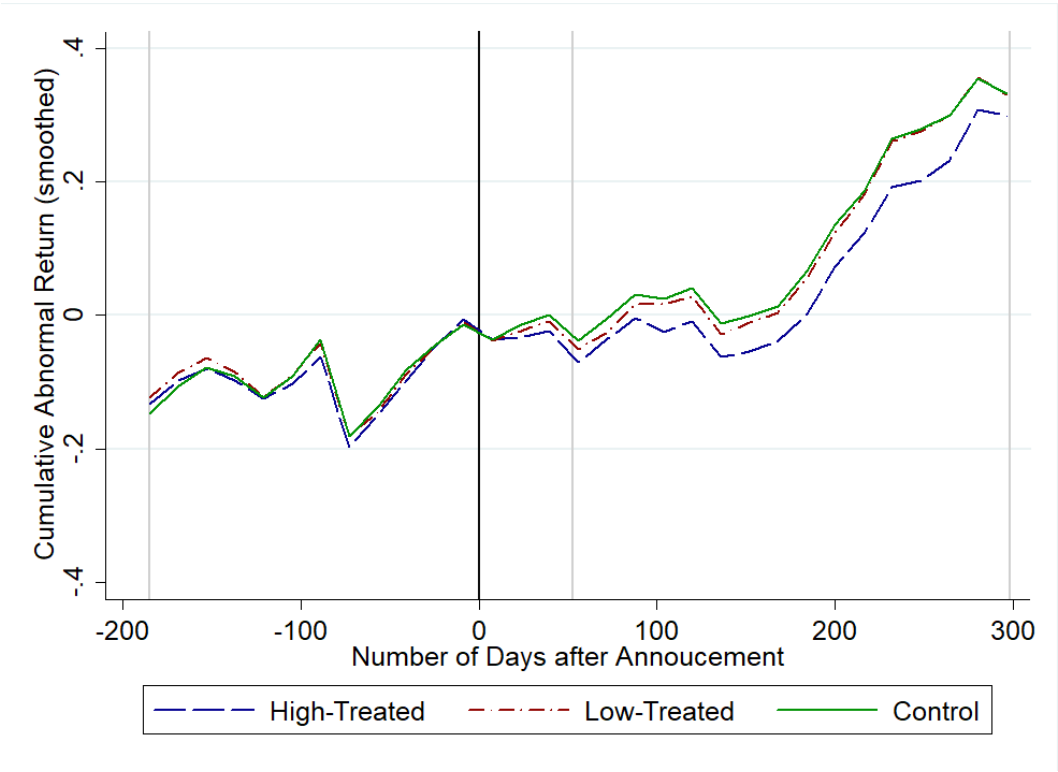
Figure 1: Number of Board Resignations



Notes: This figure shows board resignations by month. While the monthly non-official resignations are steady, the the instances of government officials' resignations increases from 10 to 50 per month after four months of corporate adjustment, and there are more than 200 resignations in one month prior to the deadline of one-year grace period. After that, the number of monthly resignations gradually decreases.

Figure 2: Average Price Trend, by Group



Notes: This figure shows the local polynomial-smoothed average cumulative returns for treated and control firms. Before the regulation, they have similar return fluctuations. However, after the regulation was announced, return of high-level connected firms (blue dash) experience a decline compared with low-level connected firms (red dash-dot) and control firms (green solid). The thick vertical line shows the announcement and the four lighter lines show the beginning of year 2013, 2014, and 2015, respectively.

Table 1: Examples of Official Tiers

Categorization	Tier	GB/T Level	Examples
High	National	1,2	Prime Minister
			Supreme Court President
			CPPCC Chairman
	Provincial	3,4	Minister
			Provincial Governer
			National University Principal
	Bureau	5	Mayor
			Department Chair
Low	Bureau	6	Vice Mayor
	County	7,8	County Head
			Provincial University Department Chair
	Township (lower)	9,10,11,12	(Omitted due to unimportance)

Notes: This table only gives some example of each tier of officials, but does not list all positions in corresponding tier. Generally, the tier simply combine a level with its vice level. Most vice positions lie in the same tier, while for bureau level, the mayor and its equivalence are regarded high-level positions but the vice-mayor and its equivalence are regarded low-level. For detailed information, please refer to the national standards. The number of Resignation is summarized till Dec 31, 2014, and the number if parentheses shows the resignation in vice positions. Source of Official Tier: Standards China 2008, *Duty Level Codes* [*zhiwu jibie daima*], GB/T 12407-2008.

Table 2: Distributions of Political Connections

Panel A: Number of Resignations by Level of Position		
Provincial	6	0.68%
Vice-Provincial	46	5.21%
Bureau	230	26.08%
Vice-Bureau	204	23.13%
County	273	30.95%
Vice-County	116	13.15%
Township and lower	7	0.80%
Total Number of Official Resignations	882	

Panel B: Firms by Number of Politicians on Board		
0	1,303	66.31%
1	489	24.89%
2	135	6.86%
3	30	1.53%
4	7	0.36%
5	1	0.05%
Total Number of Firms	1,965	

Panel C: Firms by Highest Level of Connection		
Provincial	6	0.31%
Vice-Provincial	41	2.09%
Bureau	196	9.97%
Total:High	243	12.37%
Vice-Bureau	155	7.89%
County	191	9.72%
Vice-County	71	3.61%
Township and lower	2	0.10%
Total:Low	419	21.32%

Notes: This table shows the distribution of political connection across firms. I found no national-level or vice-national-level connected firms, thus these levels are omitted in the following analysis. Note that the number in this table is number of firms after trimming. The firm base of 2,185 is selected on Jan 4 2013. New IPOs are not included in the sample. From Oct 19, 2013, to Oct 31, 2015, these firms have announced 1,387 cases of board resignation, 1,144 of which are related to government officials. I exclude 262 resignations in which the resigner joined the board after the announcement of Regulation No.18, or the linked firm has extreme characteristics and has been excluded from sample.

Table 3: Summary Statistics

Level of Treatment	High	Low	None
Market value	24.801 [11.853] (39.755)	16.278 [8.739] (26.252)	19.615 [8.876] (76.843)
Net profits	0.673 [0.148] (2.474)	0.415 [0.089] (2.085)	0.557 [0.104] (4.776)
Number of employees	9.766 [2.896] (22.280)	4.921 [2.429] (9.445)	6.281 [2.216] (23.170)
P/E ratio	69.547 (161.969)	66.915 (117.821)	58.896 (112.094)
P/B ratio	2.806 (2.529)	3.372 (4.888)	2.949 (3.016)
ROE	6.121 (13.688)	5.293 (13.264)	6.851 (11.600)
Working capital ratio	1.901 (2.030)	2.249 (2.248)	2.025 (1.783)
Debt asset ratio	49.899 (21.420)	45.400 (21.547)	46.975 (20.624)
Quick ratio	1.447 (1.843)	1.723 (2.031)	1.475 (1.569)
Beta	0.676 (0.289)	0.620 (0.259)	0.606 (0.269)
Concentration	40.010 (22.318)	37.155 (20.777)	39.033 (22.039)
IPO price	11.702 (11.773)	12.53 (13.06)	12.440 (12.287)
Composition of Sector Distribution			
Manufacture	144 (59.26%)	276 (65.87%)	825 (63.32%)
Wholesale and retail	12 (4.94%)	27 (6.44%)	103 (7.90%)
Real estate	10 (4.12%)	20 (4.77%)	92 (7.06%)
Energy	14 (5.76%)	19 (4.53%)	42 (3.22%)
Transportation	16 (6.58%)	17 (4.06%)	36 (2.76%)
Other	47 (19.34%)	60 (14.33%)	205 (14.63%)
N	243	419	1,303

Notes: This table shows the summary statistics of all sample. Standard deviations in parentheses. For skewed distributions, medians are shown in brackets. Market value and number of employee measure firms' scale. Net profit and ROE describe profitability. P/E ratio, working capital ratio and debt asset ratio measure the capital structure. P/B ratio represents market expectation. Quick ratio shows liquidity and beta shows the direction of relation between individual stock and the market. Market value and net profit are in unit of billion yuan (CNY), nominal price in 2013. Number of workers employed is in unit of thousand people. Market value is taken on Jan 1st, 2013. P/E and P/B ratio are measured on Jan 1st, 2013 and matched with previous year's annual report. Net profit, number of workers, ROE ratio, working capital ratio, debt asset ratio and quick ratio are from 2013 annual report. The beta is calculated with weekly data from Jan 1, 2013, to Dec 31, 2014. General market movements is measured by CSI 300 index. Firm are categorized according to SCF standard. Concentration is measured by the percentage of share held by the top ten largest shareholders, comes from 2013 Annual Report.

Table 4: Short-run Difference-in-Difference Estimation

Dependent variable: Cumulative Abnormal Return				
	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
After× Treat	-0.0082	-0.0087	-0.0065	-0.0071
	(0.0053)	(0.0059)	(0.0043)	(0.0049)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	-0.0171	-0.0169	-0.0176	-0.0180
Observations	44,805	38,193	49,909	45,646
R^2	0.191	0.195	0.191	0.184

Notes: Estimates show the short-run effects of losing political connections. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Sample: 14 trading days before and after the announcement of Regulation No.18. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Long-run Difference-in-Difference Estimation

Dependent variable: Cumulative Abnormal Return

	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
After× Treat	-0.0535***	-0.0585**	-0.0012	-0.0047
	(0.0200)	(0.0231)	(0.0160)	(0.0172)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.0968	0.0847	0.1021	0.1055
Observations	251,650	214,568	280,420	256,459
R^2	0.590	0.560	0.602	0.614

Notes: Estimates show the long-run effects of losing political connections. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Sample: Jun-Sept, 2013 and Sept-Dec, 2014. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Treatment Effects over Time

Dependent variable: Cumulative Abnormal Return			
	(1)	(2)	(3)
Post-Treated Period	Sept-Dec 14	Jan-Apr 15	May-Aug 15
Panel A: Treatment Effects with High-level Officials			
After×High	-0.0590**	-0.0718***	-0.0714**
	(0.0231)	(0.0271)	(0.0354)
Mean Dep.	0.0847	0.1929	0.3096
Observations	214,568	209,226	218,359
R^2	0.409	0.604	0.605
Panel B: Treatment Effects with Low-level Officials			
After×Low	-0.0047	-0.0051	-0.0158
	(0.0172)	(0.0200)	(0.0247)
Mean Dep.	0.1055	0.2039	0.3271
Observations	256,459	250,011	261,008
R^2	0.466	0.634	0.646
Time FE	X	X	X
Stock FE	X	X	X

Notes: Estimates show the long-run effects of losing political connections over time. Column (1), (2) and (3) shows the effect in 12 months, 16 months and 20 months, respectively. Panel A shows the treatment effects with high-level officials and panel B is with low-level officials. The pre-treated sample is Jun-Sept, 2013. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Effects by Number of Officials

Dependent variable: Cumulative Abnormal Return				
	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
After×Number=1	-0.0457**	-0.0514**	-0.0002	-0.0045
	(0.0213)	(0.0242)	(0.0169)	(0.0180)
After×Number=2	-0.0929	-0.0946	0.0035	0.0048
	(0.0570)	(0.0676)	(0.0415)	(0.0435)
After×Number≥3	-0.1556***	-0.1789***	-0.0461	-0.0552
	(0.0548)	(0.0633)	(0.0626)	(0.0676)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.0968	0.0847	0.1021	0.1055
Observations	251,650	214,568	280,420	256,459
R^2	0.591	0.561	0.602	0.614

Notes: Estimates show the heterogeneous effects by number of officials. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Sample: Jun-Sept, 2013 and Sept-Dec, 2014. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Effects by Level of Officials

Dependent variable: Cumulative Abnormal Return			
	(1)	(2)	(3)
	All Sample	High-Matched Sample	Low-Matched Sample
After×ViceProvincial	-0.0367	-0.0370	
	(0.0369)	(0.0454)	
After×Bureau	-0.0572**	-0.0625**	
	(0.0228)	(0.0254)	
After×ViceBureau	0.0076		-0.0014
	(0.0263)		(0.0276)
After×County	-0.0123		-0.0118
	(0.0199)		(0.0212)
After×ViceCounty	-0.0042		-0.0104
	(0.0322)		(0.0334)
Day FE	X	X	X
Stock FE	X	X	X
Mean Dep.	0.0974	0.0847	0.1055
Observations	319,947	214,568	256,459
R^2	0.594	0.560	0.620

Notes: Estimates show the heterogeneous effects by level of officials. Column (1) shows the effect using all sample, and column (2) and (3) use caliper matched sample for high- and low-treated firms, respectively. Note that coefficients for provincial level and township level and their interactions are omitted due to limited sample size: only 6 firms are categorized as "provincial" and 9 firms as "township". Sample: Jun-Sept, 2013 and Sept-Dec, 2014. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Effects By Firm Types

Dependent variable: Cumulative Abnormal Return				
	(1)	(2)	(3)	(4)
	State-Owned	Private	Manufacturing	Non-Manufacturing
		Panel A: High-level Firms		
After×High	-0.0457	-0.0705*	-0.0138	-0.1317***
	(0.0279)	(0.0423)	(0.0285)	(0.0385)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.0716	0.1086	0.1024	0.0554
Observations	109,270	91,280	155,399	59,169
R^2	0.564	0.582	0.573	0.555
		Panel B: Low-level Firms		
After×Low	0.0167	-0.0152	-0.0187	0.0275
	(0.0218)	(0.0287)	(0.0204)	(0.0317)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.00895	0.1256	0.1208	0.0705
Observations	133,476	107,009	176,019	80,440
R^2	0.603	0.645	0.623	0.602

Notes: Estimates show the heterogeneous effects by firm type. Column (1) shows the effect of State-owned firms and column (2) shows the effect of private firms. State-owned firms are public-traded firms with more than 50 percentage of shares being hold by central or local government. Private firms are public-traded firms with more than 50 percentage of shares being hold by non-governmental domestic investors. There are 1,187 state-owned firms and 854 private firms. Firms with other ownerships are not included. Column (3) shows the effect of manufacturing firms and column (2) shows the effect of non-manufacturing firms. The following sectors are not included due to insufficient sample size: General, Education, Finance, Science and Technology, Medical and Social Work. Sample: Jun-Sept, 2013 and Sept-Dec, 2014. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[1]

[2] Caliper-matched samples. Clustered standard errors in parentheses.

[3] * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[4] Sample: Jun-Sept 2013, Sept-Dec 2014.

Table 10: Change in Net Profit

Dependent variable: Log difference of Net Profit				
	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
Panel A: Post-treatment 2014				
Treat	-0.0236	-0.0566	-0.0202	-0.0659
	(0.0589)	(0.0442)	(0.0481)	(0.0420)
Constant	0.0419*	0.0711**	0.0419*	0.0797***
	(0.0233)	(0.0310)	(0.0234)	(0.0256)
Observations	1,273	1,083	1,406	1,302
R^2	0.000	0.002	0.000	0.002
Panel B: Post-treatment 2015				
Treat	-0.1746**	-0.1525**	-0.0018	-0.0349
	(0.0837)	(0.0680)	(0.0672)	(0.0606)
Constant	0.1834***	0.1294***	0.1834***	0.2171***
	(0.0333)	(0.0480)	(0.0330)	(0.0429)
Observations	1,233	1,050	1,368	1,259
R^2	0.004	0.005	0.000	0.000
Panel C: Post-treatment 2016				
Treat	-0.1714*	-0.1407*	-0.0929	-0.1050
	(0.0953)	(0.0735)	(0.0801)	(0.0716)
Constant	0.4493***	0.3860***	0.4493***	0.4732***
	(0.0380)	(0.0521)	(0.0389)	(0.0504)
Observations	1,297	1,103	1,427	1,320
R^2	0.002	0.003	0.001	0.002

Notes: Estimates show the changes in firm's net profits. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Panels have different post treatment time period. Pre-treatment is 2013. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

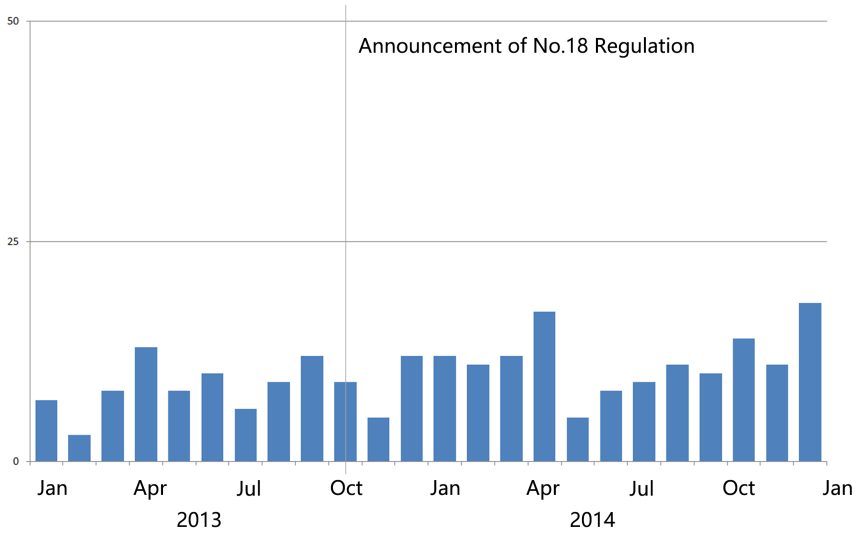
Table 11: Change in Capital-Labor Ratio

Dependent variable: Log difference of K/L ratio				
	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
Panel A: Post-treatment 2014				
Treat	0.0120	0.0024	0.0101	0.0056
	(0.0260)	(0.0199)	(0.0215)	(0.0183)
Constant	-0.4775***	-0.4689***	-0.4775***	-0.4779***
	(0.0103)	(0.0141)	(0.0106)	(0.0129)
Observations	1,546	1,317	1,722	1,574
R^2	0.000	0.000	0.000	0.000
Panel B: Post-treatment 2015				
Treat	-0.0550	-0.0079	0.0224	0.0327
	(0.0465)	(0.0380)	(0.0366)	(0.0332)
Constant	-0.0112	-0.0535**	-0.0112	-0.0233
	(0.0185)	(0.0269)	(0.0181)	(0.0234)
Observations	1,546	1,317	1,722	1,574
R^2	0.001	0.000	0.000	0.001
Panel C: Post-treatment 2016				
Treat	-0.0727	-0.0134	0.0115	0.0303
	(0.0556)	(0.0422)	(0.0452)	(0.0406)
Constant	-0.1178***	-0.1690***	-0.1178***	-0.1370***
	(0.0221)	(0.298)	(0.0223)	(0.0287)
Observations	1,546	1,317	1,722	1,574
R^2	0.001	0.000	0.000	0.000

Notes: Estimates show the changes in firm's capital-labor ratio. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Panels have different post treatment time period. Pre-treatment is 2013. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

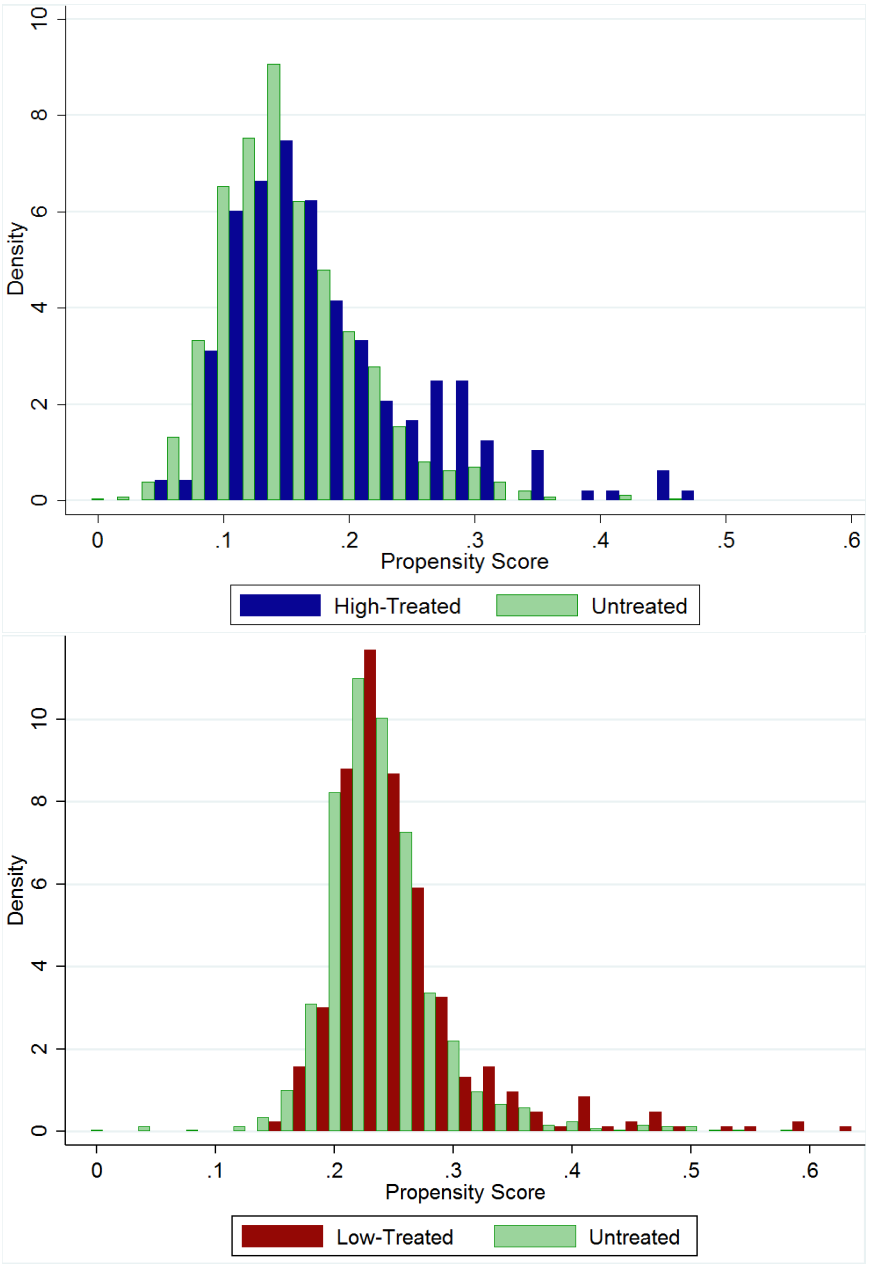
Appendix

Figure A1: Number of High Level Executive Resignations

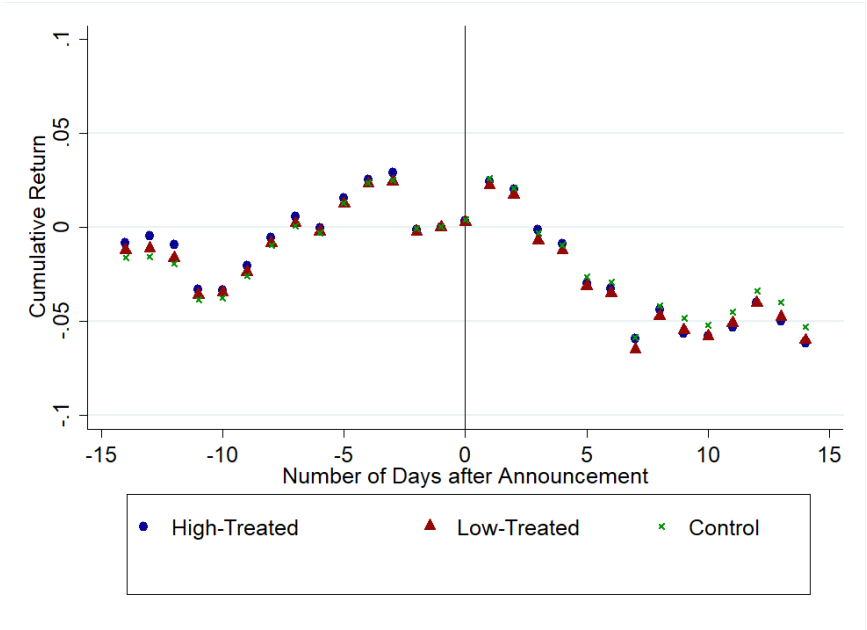


Notes: This figure shows high level executive resignations by month. There is no significant change in trend of resignations pre and post treatment. Meanwhile, the number of monthly executive resignations is much less than that of board member resignations. Therefore, high executives are not the main channel of political connections.

Figure A2: Propensity Score Density for High- and Low-Treated Firms

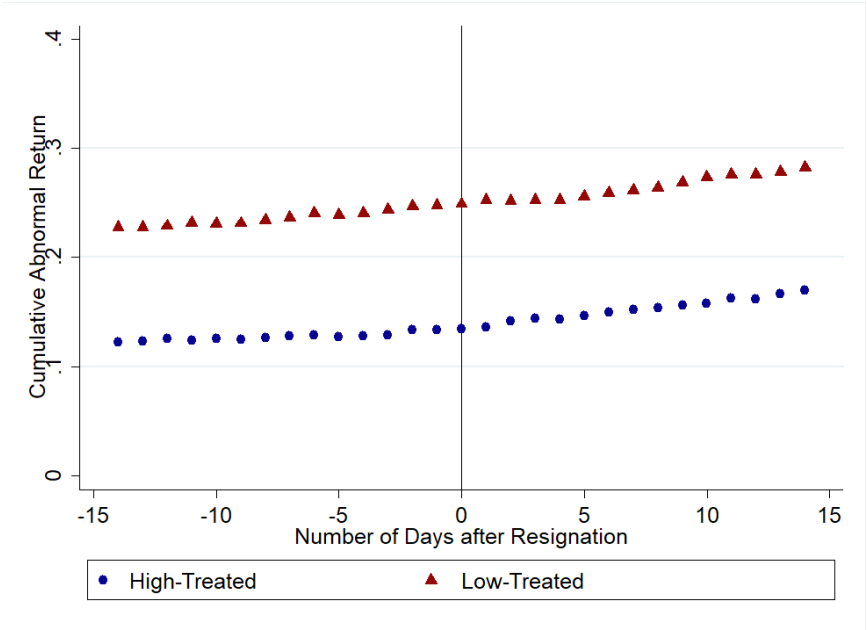


Notes: The figures show the distributions of propensity scores of high- and low-treated firms, along with corresponding controlled firms. There are large common ranges of propensity score, which confirms the validity for using matched samples as counterfactual.



Notes: The figure shows the immediate effect of the announcement of the regulation. High- and low-treated firms (blue and red, respectively) do not present different price discontinuities than control firms (green). Trading day is used as running variable, centering at $t = 0$ for October 18, 2013.

Figure A3: Cumulative Returns around the Day of Announcement



Notes: The figure shows the immediate effect of the revealing of resignation reports. High-treated (blue) and low-treated firms (red) do not present sharp price changes at the time of disclosing resignation reports. Trading day is used as running variable, data is aligned at $t = 0$ for the day of disclosing resignation reports.

Figure A4: Cumulative Returns around the Day of Announcement

Table A1: Summary Statistics After Matching: High-level Official

Level of Treatment Weight	High High	Control High	Difference
Market value	21.756 [10.823] (35.180)	21.086 [11.744] (32.702)	0.670 (2.771)
Net profits	0.485 [0.136] (1.537)	0.506 [0.137] (1.823)	-0.021 (0.127)
Number of employees	7.021 [2.802] (11.264)	7.874 [2.707] (14.399)	-0.853 (1.168)
P/E ratio	65.292 (154.825)	59.360 (11.039)	5.932 (11.142)
P/B ratio	2.843 (2.589)	2.773 (2.616)	0.070 (0.192)
ROE	5.887 (13.872)	6.811 (12.569)	-0.924 (1.058)
Working capital ratio	1.950 (2.081)	1.883 (1.788)	0.067 (0.156)
Debt asset ratio	49.354 (21.148)	47.612 (20.258)	1.742 (1.623)
Quick ratio	1.489 (1.888)	1.437 (1.614)	0.052 (0.142)
Beta	0.661 (0.281)	0.661 (0.286)	0.000 (0.023)
Concentration	40.224 (21.908)	40.033 (21.694)	0.191 (1.694)
IPO price	12.122 (12.056)	11.942 (12.441)	0.180 (0.931)
Composition of Sector Distribution			
Manufacture	140 (62.22%)	679.44 (62.22%)	
Wholesale and retail	10 (4.44%)	48.48 (4.44%)	
Real estate	10 (4.44%)	48.48 (4.44%)	
Energy	12 (5.33%)	58.24 (5.33%)	
Transportation	15 (6.67%)	72.80 (6.67%)	
Other	38 (22.34%)	184.56 (22.34%)	
N	225	1,092	
Sum of Weight	225	225	
N: Out of Support	11	211	

Notes: This table shows the summary statistics of matched sample. Standard deviations in parentheses. For skewed distributions, medians are shown in brackets. Market value and number of employee measure firms' scale. Net profit and ROE describe profitability. P/E ratio, working capital ratio and debt asset ratio measure the capital structure. P/B ratio represents market expectation. Quick ratio shows liquidity and beta shows the direction of relation between individual stock and the market. Market value and net profit are in unit of billion yuan (CNY), nominal price in 2013. Number of workers employed is in unit of thousand people. Market value is taken on Jan 1st, 2013. P/E and P/B ratio are measured on Jan 1st, 2013 and matched with previous year's annual report. Net profit, number of workers, ROE ratio, working capital ratio, debt asset ratio and quick ratio are from 2013 annual report. The beta is calculated with weekly data from Jan 1, 2013, to Dec 31, 2014. General market movements is measured by CSI 300 index. Firm are categorized according to SCF standard. Concentration is measured by the percentage of share held by the top ten largest shareholders, comes from 2013 Annual Report.

Table A2: Summary Statistics After Matching: Low-level Official

Level of Treatment Weight	Low Low	Control Low	Difference
Market value	15.895 [8.940] (25.175)	14.434 [8.745] (17.273)	1.461 (1.384)
Net profit	0.406 [0.091] (2.055)	0.284 [0.092] (0.906)	0.122 (0.107)
Number of employee	4.832 [2.462] (8.371)	4.379 [2.136] (7.492)	0.453 (0.475)
P/E ratio	65.693 (114.433)	62.896 (119.265)	2.797 (7.059)
P/B ratio	2.969 (2.994)	2.826 (2.769)	0.143 (0.176)
ROE	5.946 (11.596)	5.778 (11.841)	0.168 (0.741)
Working capital ratio	2.174 (2.071)	2.205 (2.026)	-0.031 (0.133)
Debt asset ratio	45.611 (20.904)	44.812 (20.729)	0.799 (1.275)
Quick ratio	1.633 (1.820)	1.664 (1.791)	-0.031 (0.119)
Beta	0.614 (0.252)	0.612 (0.264)	0.002 (0.015)
Concentration	37.428 (20.913)	37.814 (22.116)	-0.386(1.289)
IPO price	12.668 (13.193)	12.663 (11.921)	0.005 (0.784)
Composition of Sector Distribution			
Manufacture	273 (69.64%)	823.17 (69.64%)	
Wholesale and retail	23 (5.87%)	69.35 (5.87%)	
Real estate	18 (4.59%)	54.28 (4.59%)	
Energy	18 (4.59%)	54.28 (4.59%)	
Transportation	13 (3.32%)	39.20 (3.32%)	
Other	47 (11.99%)	141.72 (11.99%)	
N	392	1,182	
Sum of Weight	392	392	
N: Out of Support	27	121	

Notes: This table shows the summary statistics of matched sample. Standard deviations in parentheses. For skewed distributions, medians are shown in brackets. Market value and number of employee measure firms' scale. Net profit and ROE describe profitability. P/E ratio, working capital ratio and debt asset ratio measure the capital structure. P/B ratio represents market expectation. Quick ratio shows liquidity and beta shows the direction of relation between individual stock and the market. Market value and net profit are in unit of billion yuan (CNY), nominal price in 2013. Number of workers employed is in unit of thousand people. Market value is taken on Jan 1st, 2013. P/E and P/B ratio are measured on Jan 1st, 2013 and matched with previous year's annual report. Net profit, number of workers, ROE ratio, working capital ratio, debt asset ratio and quick ratio are from 2013 annual report. The beta is calculated with weekly data from Jan 1, 2013, to Dec 31, 2014. General market movements is measured by CSI 300 index. Firm are categorized according to SCF standard. Concentration is measured by the percentage of share held by the top ten largest shareholders, comes from 2013 Annual Report.

Table A3: Short-run Difference-in-Difference Estimation with Alternative Time Frames

Dependent variable: Cumulative Abnormal Return				
	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
Panel A: ±7 Days				
After× Treat	-0.0029	-0.0001	-0.0041	-0.0038
	(0.0039)	(0.0043)	(0.0031)	(0.0034)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	-0.0019	-0.0008	-0.0018	-0.0021
Observations	23,175	19,755	25,815	23,610
R^2	0.244	0.240	0.249	0.245
Panel B: ±14 Days				
After× Treat	-0.0082	-0.0087	-0.0065	-0.0071
	(0.0053)	(0.0059)	(0.0043)	(0.0049)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	-0.0171	-0.0169	-0.0176	-0.0180
Observations	44,805	38,193	49,909	45,646
R^2	0.191	0.195	0.191	0.184
Panel C: ±28 Days				
After× Treat	-0.0115*	-0.0131*	-0.0061	-0.0088
	(0.0063)	(0.0070)	(0.0054)	(0.0062)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	-0.0257	-0.0262	-0.0258	-0.0260
Observations	88,065	75,069	98,097	89,718
R^2	0.124	0.129	0.122	0.119

Notes: Estimates show the short-run effects of losing political connections with alternative time frames. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Long-run Difference-in-Difference Estimation with Alternative Time Frames

Dependent variable: Cumulative Abnormal Return

	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
Panel A: Aug-Sept 2013, Nov-Dec 2014				
After× Treat	-0.0505**	-0.0692***	0.0001	-0.0038
	(0.0203)	(0.0235)	(0.0160)	(0.0173)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.1364	0.1284	0.1409	0.1440
Observations	129,694	110,585	144,521	132,173
R^2	0.595	0.566	0.607	0.618
Panel B: Jun-Sept 2013, Sept-Dec 2014				
After× Treat	-0.0535***	-0.0585**	-0.0012	-0.0047
	(0.0200)	(0.0231)	(0.0160)	(0.0172)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.0968	0.0847	0.1021	0.1055
Observations	251,650	214,568	280,420	256,459
R^2	0.590	0.560	0.602	0.614
Panel C: Apr-Sept 2013, Jul-Dec 2014				
After× Treat	-0.0535***	-0.0529**	-0.0046	-0.0078
	(0.0198)	(0.0228)	(0.0157)	(0.0170)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	0.0665	0.0545	0.0715	0.0753
Observations	381,297	325,095	424,878	388,569
R^2	0.513	0.482	0.526	0.538

Notes: Estimates show the long-run effects of losing political connections with alternative time frames. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Placebo Test for Anticipation

Dependent variable: Cumulative Abnormal Return

	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Matched Sample	All Sample	Matched Sample
After× Treat	-0.0105	0.0011	-0.0186	-0.0155
	(0.0196)	(0.0224)	(0.0139)	(0.0150)
Day FE	X	X	X	X
Stock FE	X	X	X	X
Mean Dep.	-0.0791	-0.0780	-0.0773	-0.0737
Observations	117225	99897	130566	119394
R^2	0.059	0.051	0.060	0.054

Notes: Estimates show the placebo test. I define $After = 1$ if the date is after Mar 14, 2013; otherwise, $After = 0$. Column (1) shows the effect of high-level officials using all sample, and column (2) uses caliper matched sample. Column (3) and (4) shows the effect of low-level officials. Sample: Jan-Feb 2013, Aug-Sept 2014. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Effects on Days of Resignation

Dependent variable: Cumulative Abnormal Return				
	(1)	(2)	(3)	(4)
	High-level Officials		Low-level Officials	
	All Sample	Weighted Sample	All Sample	Weighted Sample
announce	0.0028	0.0057	-0.0042	-0.0040
	(0.0042)	(0.0044)	(0.0040)	(0.0036)
Stock FE	X	X	X	X
Mean Dep.	0.1229	0.1256	0.2536	0.2605
Observations	5,829	5,423	12,470	10,904
R^2	0.067	0.069	0.041	0.054

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimates show the the effects on the days of official resignation. Column (1) shows high-level official resignation effect, and column (2) uses weighted sample. Analogously, column (3) shows the low-level official resignation effect and column (4) weights the estimate. All regressions control for linear time trends. Sample: 14 trading days before and after the days of resignation. For firms with multiple politician resignations, only the first is counted. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

How Fundamentalism Takes Root: A Simulation Study*

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Abstract

We report agent-based simulations of religiosity dynamics in a spatially dispersed population. Agents' religiosity responds to neighbors via direct interactions as well as via club goods effects. A simulation run is deemed fundamentalist if the final distribution contains a cohesive group of very high religiosity. We investigate whether such distributions are more prevalent when model parameters are shifted to reflect the transition from traditional societies to the modern world. The simulations suggest that the rise of fundamentalism in the modern world is aided by weaker attachment to the peer group, greater real income, and less substitutability between religious and secular goods, and arguably also by higher relative prices for secular goods and lower tolerance. Surprisingly, the current model suggests little role for the rise of long distance communication and transportation.

JEL-Classification: Z12, D79, D85, H49
Keywords: fundamentalism, club goods, agent-based models

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1 Introduction

In 1920, Curtis Lee Laws, an editor of the American Baptist publication *Watchman-Examiner* first coined the word "fundamentalism" to describe groups eager to defend what they saw as the fundamentals of the Christian Protestant faith (Hood et al., 2005). Since then, the word has been applied more broadly to include a Shia branch of Islam in Iran after the 1979 revolution, Hindutva adherents in India in the 1990s, and many other groups. Indeed, all major religions now have a vocal (and in some cases, violent) strand of adherents who reject much of modern world culture and urge a return to the pure fundamentals of their faith. Although the groups — which include Catholic traditionalists, Jewish haredim, Sunni salafi, and even groups of Buddhists in Burma and Japan — seem likely to remain minorities within their religions, they demand our attention. Some of these groups have an outsized influence in national politics, and several are pivotal in some of the world's most intractable international conflicts.

Why did fundamentalism take root in so many parts of the world during the late 20th century? What underlying forces determine the size and influence of fundamentalist groups? These are deep questions unlikely to be answered fully in any single investigation. In the present paper, we seek insight from a simulation model.

Simulation models seem especially appropriate for assessing a wide range of possible answers to our questions. The researcher builds known features into the simulation and looks for emergent behavior that, although sometimes surprising at first glance, can on reflection build intuition and insight. Simulations complement but do not substitute for other approaches including case studies, econometric analysis of historical data and analytical models.

Our simulation model traces the "religiosity" of individual agents over time in a spatially dispersed population. The agents interact directly with others and also within peer groups. In the direct interactions—motivated by psychology literature dating back at least to Lord et al. (1979)—the agents are intolerant of those with very different religiosity, and consequently their religiosity moves even further apart. On the other hand, when sufficiently similar agents interact directly, they become even more similar. The interactions within peer groups come from the club goods approach

of Iannaccone (1992), and reflect the idea that people who contribute to a religious community also benefit from the contributions of other members. The simulation model features several parameters that can capture some aspects of modernity, such as the decline of social capital, the progress in communication and transport technology, or the growing incompatibility of religious and secular activities. The objective of this paper is to see how shifts in these underlying parameters can affect the long-run distribution of religiosity in our simulations and whether they increase the proportion of simulations deemed fundamentalist.

Section 2 discusses the definition of fundamentalism and the changes in society that are associated with modernity, and then reviews related literature. Section 3 introduces the simulation model. Section 4 presents simulation results showing the comparative static impact of key parameters, and connects those parameters to contrasts between traditional societies and the modern world. Section 5 summarizes the insights gleaned from the exercise, and suggests future research directions.

Appendices A, B and C contain supplementary material. Appendix A provides a summary of the parameters of the model. Appendix B briefly outlines the emergence of four major movements: Protestant fundamentalism in the United States, Hindu fundamentalism in India, Islamic fundamentalism in Egypt and Iran, and Pentecostalism in Latin America, and then identifies ten main characteristics of fundamentalist movements. Appendix C describes the simulation code in greater detail and includes additional comparative static results.

2 Background and Related Literature

It would be desirable to begin with a generally accepted operational definition of fundamentalism, but unfortunately none seems to exist. Iannaccone (1997) notes that even the multi-volume *Fundamentalism Project* by Marty and Appleby (1991) was criticized for failing to provide a clear definition of fundamentalism and objective criteria for categorizing religious movements as fundamentalist or non-fundamentalist. However, in our reading, the key characteristics shared by most fundamentalist movements include a belief in the inerrancy of scripture, an unwillingness to compromise, setting sharp boundaries between members and non-members, behavioral require-

ments, militancy, charismatic leadership, and other factors (see, e.g., Emerson and Hartman 2006). Appendix A.2 presents a longer and more detailed list.

For present purposes, we distill fundamentalism down to two key characteristics. First, fundamentalists are characterized by an extremely high level of religiosity in comparison to the rest of the society. That religiosity is usually expressed by an unwavering attachment to a set of core beliefs, e.g., in the inerrancy of scripture. Second, fundamentalists form a relatively cohesive group in terms of the level of religiosity. This cohesion is typically achieved by introducing a set of behavioral requirements — e.g., for worship, attire, and diet — for the members and by setting sharp boundaries between members and non-members.

Modernity refers to a large and interconnected set of modifications to traditional societies. Our simulation study focuses on the following subset of modifications.

(1) Decline of social capital. This process was famously studied by Putnam (1995, 2000), who found that at the end of 20th century people belonged to fewer civic organizations and met with family and friends less often than in earlier decades.

(2) Progress in communication and transport technology. Over the last 200 years, the world has witnessed an unprecedented progress in these two domains, with developments of the telephone, radio, television, the Internet, trains, automobiles, planes, etc.

(3) Increase in wealth. Most of the world saw an unprecedented growth in per capita wealth and improving living standards in the 20th century and early 21st century.

(4) Growth of secular and religious opportunities. Modernity has brought many new opportunities both in the secular (e.g., in entertainment and tourism) and the religious (e.g., televised worship events, more affordable travel to pilgrimage sites) domains.

(5) Religious activities becoming less compatible with the demands of secular activities. Educating children, observing holidays, and assisting those in need are examples of activities that traditionally combine religious and secular motives, but in the modern world these activities tend to occur in separate spheres. Also,

the pace of modern life increases the opportunity cost of religious behavioral requirements.

(6) Impact on tolerance. Modernity has arguably had an impact on how tolerant people are towards those who are different from them, e.g., in terms of the level of religiosity.

Our simulations try to capture such modifications via shifts in parameters, and then show the impact on the long-run distribution of religiosity.

Our paper adds to a rapidly maturing literature on the economics of religion (Iyer, 2016). We draw on club goods models of religion, following the seminal paper by Iannaccone (1992). In Iannaccone's model, individuals choose how much effort and other scarce resources to allocate to secular activity and how much to the participation in the religious club. Each individual benefits from the quality of the religious club, which is determined by the members' overall participation level. By imposing behavioral requirements, religious clubs increase the cost of secular activity, which can be thought of as a tax on such activity. The paper shows that, despite imposing unproductive costs, these behavioral requirements can in fact increase the club members' equilibrium welfare. More recent club models of religion include Berman (2000) and Chen (2010), among others. Iannaccone (1997) discusses his club model of religion in the context of religious fundamentalism.

We extend Iannaccone's (1992) model in three important ways. First, our agents interact via a spatial network, in which each individual agent is affected most by nearest neighbors. Second, besides club interactions, our agents interact directly with their neighbors. Finally, our simulation is dynamic, and we trace how the religious participation of individuals evolves over time as they interact with each other in the network.

Our paper also adds to the literature on religious extremism and fundamentalism, which includes club models of religious fundamentalism (Iannaccone 1997, Berman 2000), and models of religious strictness (McBride 2015, Levy and Razin 2012), and connects with the literature on secularization and on simulation models of religion (Shy 2007). Within these strands of literature, our paper is most closely related to studies that model the emergence and spread of religious extremism or fundamental-

ism. We are aware of only five such papers, as follows.

Arce and Sandler (2003) study the evolutionary stable equilibria of a game in which members of a general subpopulation are matched with members of a fundamentalist subpopulation and the matched pair then plays a Nash demand game. The Nash demand game could be interpreted as a game in which players decide on their shares of social control (over norms, religion, etc.). Arce and Sandler (2009) consider a similar model and introduce assortativity of pairwise matching, which allows them to study the role of isolation of fundamentalist groups.

Epstein and Gang (2007), like us, model religiosity as a single continuous variable that reflects the level of observance. They consider a population which consists of a leader of a sect and his followers. The leader faces a trade-off when choosing the optimal required level of observance: increasing the level of observance increases the followers' dependence on him, but as the level becomes higher and higher, some people may choose to leave because the costs are too high.

Makowsky (2012) is the paper most closely related to ours, because he also spatially embeds a club model of religion. Unlike us, he uses a cellular automaton, with agents located on a fixed, regular two-dimensional lattice. Rather than a continuous variable for religiosity, he assumes a fixed set of religious groups, each of which requires a particular level of sacrifice from its members, and labels as "extremist" the groups with the highest levels of required sacrifice. Initially, agents are randomly assigned to groups, but in each later round, an agent evaluates all groups in her neighborhood in the lattice and joins the utility-maximizing one. The model suggests that extremist groups are most successful when religious groups can produce goods that are close substitutes to secular goods. Makowsky (2011) omits the spatial aspects but otherwise has a setup similar to Makowsky (2012). Our own analysis focuses instead on how a bimodal distribution of agents' commitment to their religious clubs can emerge in the population.

3 Simulation Model

Our model traces the behavior over time of a fixed number of *agents*, stylized representations of individuals or families. Each agent $i = 1, ..., N$ is described at any time

$t = 1, ..., T$ by her physical location L_i and her degree of religiosity $r_i \in [0, 1]$. In this paper, we hold L_i constant over time but simulate adjustments in religiosity r_i due to interactions with other agents. The analysis focuses on the distribution of religiosity in the long run, after the distribution seems to have reached stochastic equilibrium.

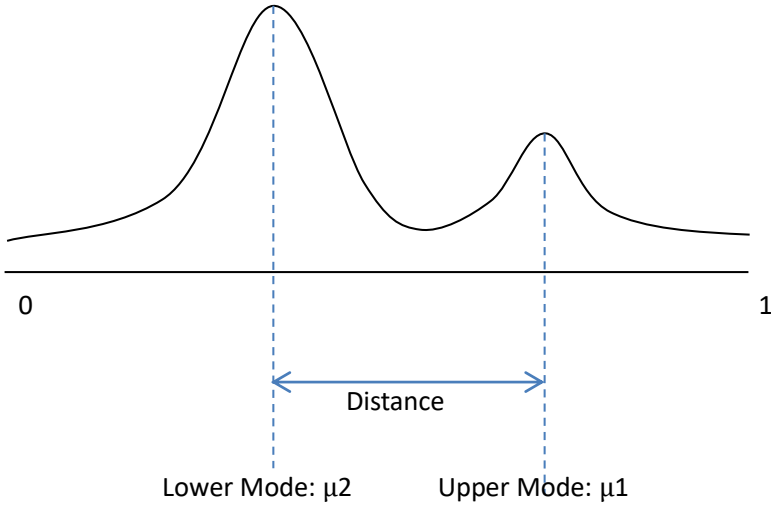

Figure 1: Operational Definition of Fundamentalism. A religiosity distribution exhibits fundamentalism ($F = 1$) if μ_1 and distance are each sufficiently large.

Our verbal definition of fundamentalism combined the group trait "extremely high level of religiosity in comparison to the rest of the society" with "cohesive ... in terms of the level of religiosity." To operationalize that definition, we use a standard statistical package (the R algorithm expectation maximization, EM) to estimate a mixture of two normal distributions for a simulation's final religiosity levels $r_i(T)$, $i = 1, ..., N$. Let μ_1 and μ_2 denote respectively the upper and lower estimated modes. Then we say that the distribution exhibits *(weak) fundamentalism* ($F = 1$) if

i. $\mu_1 > 0.8$, i.e., the upper mode has a high typical level of religiosity, and

ii. $\mu_1 - \mu_2 > 0.2$, i.e., the upper mode of religiosity is noticeably higher than the lower mode.

If either condition fails, we will say that the distribution fails to exhibit fundamentalism ($F = 0$). It will sometimes be helpful to say that a distribution exhibits *strict fundamentalism* ($\hat{F} = 1$) if, in addition to conditions i and ii above, we also have

iii. the standard *dip test* of Hartigan and Hartigan (1985) for bimodality rejects the null (unimodal) hypothesis at p-value less than 0.10.

Condition iii ensures that the two groups are separated, not just by distance between typical members as in ii, but also in terms of coherence: there is a relatively small overlap of the members' level of religiosity. The critical p-value does not seem very important; p = 0.05 produces qualitatively similar results. See Figure 1 for a schematic illustration.

Our definition of (weak) fundamentalism captures religious extremism, both in absolute and relative sense. That is, for a distribution to exhibit (weak) fundamentalism, there must be a substantial group of agents who have an extremely high level of religiosity in absolute terms as well as relative to the rest of the population. A high level of religiosity can be understood here as a high attachment to the set of core beliefs, e.g., in the inerrancy of scripture, and high involvement in the religious community, e.g., through participation in religious and social events, active evangelization, etc. An important implication of this definition is that a population where all agents are very religious is not classified as fundamentalist. While in principle we could treat such a population as fundamentalist, such uniformity rarely poses political and social unrest. Fundamentalism is a major concern when it appears in the presence of a sizable subpopulation of lower religiosity.

Our definition of strict fundamentalism requires that fundamentalists form a group that is not only extremely religious in absolute and relative sense, but is also cohesive in terms of religiosity. Thus, presence of agents with extreme religiosity is not enough; they also need to have a relatively similar level of religiosity. Such similarity is often achieved by fundamentalist movements through imposing behavioral requirements in domains such as worship, attire, and diet, and through setting sharp boundaries between members and non-members.

3.1 Overview of Simulation Procedure

The model begins by assigning initial locations and religiosities. The initial locations are assigned randomly and uniformly on the unit sphere, and directed links are created according to geodesic distance, using parameters described below. Locations and link

strengths are permanent. Initial religiosities are independently uniformly distributed over the range $[0, 1]$. Figure 2 shows a small example with $N = 20$ agents.

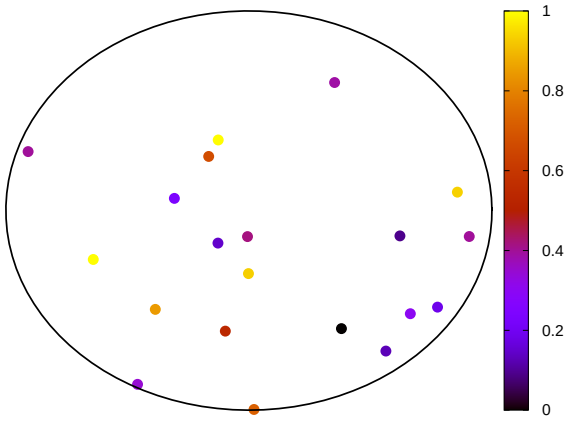

Figure 2: An Example of Simulation Initialization. The surface of the sphere is shown in Mollweide projection, a pseudo-cylindrical view that preserves areas but (especially towards the poles) distorts angles. Religiosities are color-coded from yellow (near 1.0) to dark violet (near 0.0).

Once initialized, the simulation updates agents' religiosities as follows. In each iteration, a directed link (from agent A, say, to agent B) is selected at random, with probability proportional to the link strength. The religiosity of agent A is then updated via an independent normally distributed random "noise" term n; a direct interaction term D that involves the religiosity of agent B; and peer group or "club goods" term C that involves the religiosity of all A's neighbors. Then another iteration is performed by selecting another link at random.

Each iteration transforms the chosen agent A's religiosity $r \in [0, 1]$ to a value $R \in [-\infty, \infty]$ via the log odds function $R = \ln \frac{r}{1-r}$, then updates to $R' = R + C + D + n$, and finally transforms back to obtain agent A's new religiosity $r' = \mathcal{L}(R') \in [0, 1]$ via the inverse (or logit) transformation $\mathcal{L}(x) = \frac{\exp(x)}{1+\exp(x)} = (1 + \exp(-x))^{-1}$. The transformations make the updates essentially multiplicative and keep religiosity within the interval $[0, 1]$. The next two subsections explain the update terms C and D in more detail.

Figure 3 tracks religiosities in a sample simulation of $N = 20$ agents for $T = 1$

million iterations. Note that two distinct groups emerge in the first quarter of the simulation, but they never become widely separated and the top group always has mean religiosity less than 0.8. Hence, according to our definition, fundamentalism did not emerge in this simulation ($F = 0$).

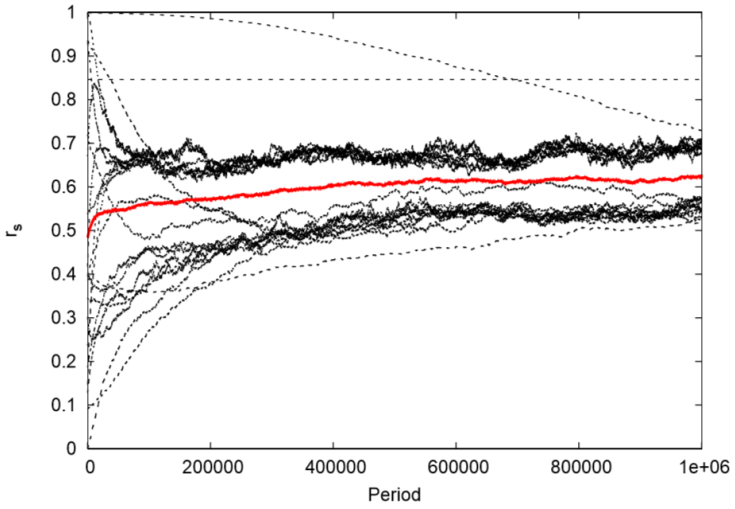

Figure 3: Simulation Example. Number of agents is $N = 20$, with $T = 1,000,000$ iterations; other other parameters are at default values. Black dotted lines trace religiosities for each agent, and the red solid line is their overall mean.

3.2 Direct Interaction Parameters

The direct interaction term D arises from an agent's links to neighboring agents, and the size of the neighborhood is governed by parameter $K \in [0, 1]$. An agent has a link to every other agent located within geodesic distance $d \leq K$ so, for example, everyone in the same hemisphere is a neighbor when $K = 0.5$. The default value when $N = 100$ is $K = 0.16$, implying that a typical agent has about three neighbors.

Link strengths decrease in the distance d between a pair of agents; the strength is proportional to d^{b_d}, where the distance sensitivity parameter $b_d \in [-3, 0]$ has default value -1.0. We use the "small world" technique (Watts and Strogatz 1998) of breaking each local link with probability $\beta \in [0, 0.5]$ and replacing it with a link to an agent selected at random irrespective of distance. The idea is that a few long distance links can greatly shorten the maximum path length, i.e., put agents on opposite sides of

the world into much closer indirect contact. To avoid automatic attenuation of that effect, we introduce a new distance sensitivity parameter $b_{sm} \in [-3, 0]$ that applies to such links; the no-attenuation default is $b_{sm} = 0$. Thus link strength is governed by parameters K, β, b_d and b_{sm}.

The tolerance parameter $\lambda \in [0, 1]$ plays an important role. Once the link ij is chosen for updating (with probability proportional to its strength), the direct interaction effect is given by the equation

$$D = q(r_i - r_j)[(r_i - r_j)^2 - \lambda^2]. \tag{1}$$

If the religiosities of the two agents differ by more than λ, the expression in square brackets is positive, so D increases r_i when it exceeds r_j and decreases it otherwise. In other words, the direct interaction drives i's religiosity further away from j's. The intuition is that j is a negative role model, and his lack of religiosity (or excessive religiosity) drives i to become more (or less) religious. On the other hand, if the two agents' religiosities differ by less than λ, then the interaction effect I brings them closer together. The idea behind the tolerance parameter λ goes back at least to the psychology literature on biased assimilation. For example, Lord et al. (1979) reports evidence that people are more likely to be influenced by someone whose opinion is close to theirs, and they often reject opinions which are very far from their own.

The parameter $q \in [0, 1]$ in equation (1) governs the importance of direct interactions relative to peer group effects, to which we now turn.

3.3 Club Goods Parameters

The other term C in our simulation model is based on the club goods model of Iannaccone (1992). The peer group (or "club") consists of all agents linked to the given agent; let Q be the link strength-weighted average of their religiosities. The model assigns to each agent the utility function and the budget constraint

$$U(r, S|Q) = [S^b + cr^{ab}Q^{(1-a)b}] \text{ s.t. } p_r r + p_s S = I. \tag{2}$$

Thus, utility is a constant elasticity of substitution (CES) function of secular activity S and religious subutility,[1] where the latter is a Cobb-Douglas function (with pa-

[1] CES production functions raise the bracketed expression in (2) to the power $1/b$. That transformation is unnecessary here because, for the parameter values $b > 0$ used below, it is monotone

rameter a) of own religiosity r and the mean religiosity Q in the peer group. The substitution elasticity between S and religious subutility is $\eta = \frac{1}{1-b}$. Note that $\eta > 0$ for $b \in (0,1)$ and $\eta \to \infty$ as $b \to 1^-$. That is, secular and religious goods are imperfect substitutes for $b < 1$ and become perfect substitutes at $b = 1$. For $b > 1$ we see that $\eta < 0$, i.e., the two sorts of goods are anti-substitutable.[2]

The simulation normalizes nominal income $I = 1$, and considers changes in real income $Y = I/P$ by varying the price level $P = p_s$, holding constant the price ratio $p = p_r/p_s$. It also considers changes in the price ratio holding constant the real income. Default values are $b = 0.8,\ a = 0.3,\ Y = I = 1,\ P = p_s = 1$, and $p = p_r = 0.6$.

The convention in equation (2) is that the budget constraint always binds, so we can write $S = \frac{I - p_r r}{p_s} = Y - pr$ and rewrite the payoff function (2) as

$$\phi(r|Q) = (Y - pr)^b + cr^{ab}Q^{(1-a)b}. \tag{3}$$

The peer group update C then is the scaled payoff gradient

$$C = 4(1-q)\frac{\partial \phi(r|Q)}{\partial r} = 4(1-q)[abcr^{ab-1}Q^{(1-a)b} - bp(Y - pr)^{b-1}]. \tag{4}$$

The update (4) thus captures the idea that agents adjust their religiosity incrementally to improve their sense of well being, taking into account the relative benefits of both secular activity and also (given their peer group) religious activity,[3] and also taking into account the relative costs and their available resources. The factor 4.0 accounts for the way the logit function scales at midrange (where $r = 0.5$), and the factor $1 - q$ again reflects the importance of peer group update C relative to direct interpersonal influence D.

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increasing and so the resulting utility functions represent the same underlying preferences as U.

[2] Anti-substitutable means that compared to two distinct bundles of the goods that bring equal satisfaction, a middling bundle brings lesser satisfaction. More formally, if $U(X) = U(Y)$ for two bundles $X \neq Y$, then for any mixture $Z = mX + (1-m)Y$ with $0 < m < 1$, we have $U(Z) < U(X) = U(Y)$ when $b > 1$. Of course, when $0 < b < 1$, we have the usual convexity property that $U(Z) > U(X) = U(Y)$, meaning that mixtures are preferred.

[3] In the simulations reported below, the variable c in equation (4) is tuned so that in equilibrium each player's religiosity r will equal Q, that of her peer group. See Appendix C for details.

3.4 Incentives, Optimization and Equilibrium

In what sense do agents in our model respond to incentives? The club goods elements of our model provide exactly the same sort of incentives as in other models in the Iannaccone (1992) tradition. The direct interaction elements create the incentive to have religiosity more like close neighbors who are not too different, but to contrast even more sharply with sufficiently dissimilar neighbors.

As in most dynamic agent-based models, agents in our model respond incrementally to incentives. They do not fully optimize immediately, but rather move in a direction and at a rate determined by the net impact of incentives. Eventually, as behavior settles down after sufficiently many iterations, some sort of equilibrium is achieved.

How many is 'sufficiently many,' and what sort of equilibrium? In preliminary work, we increased the number of iterations until it seemed that the religiosity distribution had settled down, and then typically doubled it to 4 million for the main results presented below. A more formal name for a settled distribution is 'stochastic equilibrium.' The stochastic element, embodied in a small positive value of the parameter σ, keeps the simulation from getting stuck at unrepresentative local equilibria, and thus ensures some robustness. In this long run equilibrium, we may not have all agents precisely optimizing their religiosity given the incentives created by their neighbors, but the agents will closely and robustly approximate such optima.

4 Results

We begin by showing the impact of varying key parameters one at a time from baseline values $N = 100,\ T = 4,000,000,\ K = 0.16,\ \beta = 0.05,\ b_d = -1,\ b_{sm} = 0,\ \lambda = 0.2,\ q = 0.8,\ a = 0.3,\ b = 0.8,\ I = 1,\ p_s = 1,\ p_r = 0.6$, and $\sigma = 0.0005$. Most of these have already been explained; here we note that (given the typical neighborhood size), $q = 0.8$ seems to roughly equalize the impact of the C and D effects, and noise level $\sigma = 0.0005$ seems sufficient to avoid meaningless stagnation while keeping negligible the impact of particular random realizations.

The figures in the next subsection report summaries of 40 Monte Carlo simulations for each parameter vector. The first panel plots the final (period T) estimated

upper and lower modes with a small dot and their average across all 40 simulations with a large dot. The second panel plots the fraction of the simulations deemed fundamentalist and strictly fundamentalist.

4.1 Comparative Statics

Panel B of Figure 4 indicates that, near default values of parameters, the prevalence of fundamentalism is surprisingly sensitive to the balance between direct interaction and club goods. Increasing the weight q on direct interactions to 0.90 (from its default value of 0.80) increases the fraction of Monte Carlo trials exhibiting strict fundamentalism, $\hat{F}$, from under 5% to nearly 80%, with similarly dramatic increase in weak fundamentalism, F. On the other side, when q is below 0.75, hardly any trials exhibit fundamentalism of either sort. Panel A shows how increasing q sharply increases bimodality, as the more religious group moves towards maximal religiosity, and the lower group towards atheism. Evidently, unless tempered by club goods effects, direct interactions tend to push towards polarization (and hence fundamentalism) in our model with baseline parameters.

To better understand the push towards fundamentalism, consider the impact of varying the typical size of a neighborhood. Panel B of Figure 5 shows a sizable increase in weak fundamentalism (from around 10% to around 30%) as the neighborhood radius K increases from the default value of 0.16 to 0.22, which corresponds to about $(.22/.16)^2 \approx 1.5$ times the area, i.e., about 50% more neighbors than in the baseline. In contrast, strict fundamentalism appears to be unaffected and stays very low. As we can see in Panel A, interaction with a greater neighborhood occasionally drives the estimated upper mode towards very high religiosity, which results in weak fundamentalism. Evidently, with a greater neighborhood, there is a higher probability of a direct interaction with an agent of much lower religiosity. However, in general, the estimated upper and the lower modes tend to get closer to each other and heavily concentrate around religiosity between 0.60 and 0.80, which precludes bimodality (and thus strict fundamentalism). Evidently, as neighborhoods expand, the overlap between the agents' neighborhoods increases and so they end up choosing similar religiosity through the peer group interactions. Reducing K to 0.10 implies that a substantial fraction of the population has no neighbors, and thus retains its

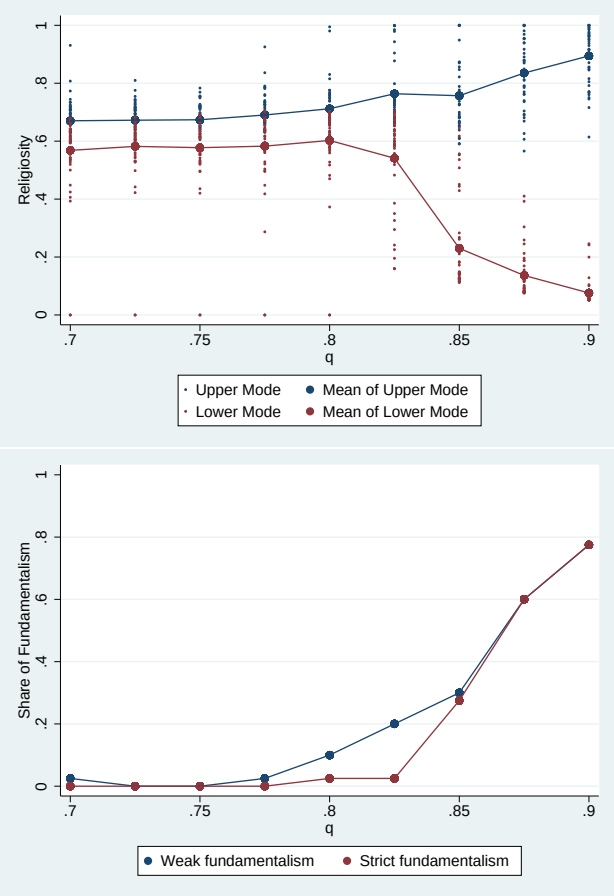

Figure 4: The impact of parameter q (weight of direct interactions) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

initial religiosity. The result is often a very diffuse final distribution which is sometimes (around 20% of trials) classified as exhibiting weak fundamentalism but rarely (around 5% of trials) as exhibiting strict fundamentalism.

Another parameter controlling the influence of more distant agents is the long-distance rewiring parameter β. Default parameter values ensure that the long-distance links have about the same weight as the local links. Panel B of Figure 6 shows that increasing the prevalence of long-distance links from 0 to 10% tends to modestly increase weak fundamentalism. On the other hand, there seems to be a small negative effect on strict fundamentalism. Panel A reveals that while an increase in parameter β sometimes pushes the estimated upper mode to an extremely high level of religiosity, the distance between the estimated upper and lower on average

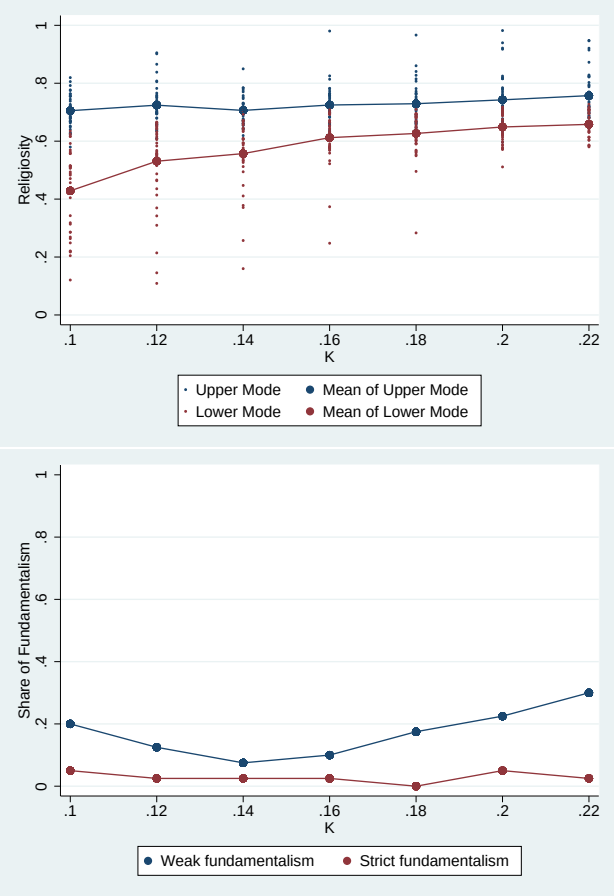

Figure 5: The impact of parameter K (neighborhood radius) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

becomes smaller, and hence there is no bimodality and no strict fundamentalism (for similar reasons as in the case of the size of neighborhood K). Overall, surprisingly, the two parameters that measure the influence of distance (K and β) appear to have a very limited effect on the emergence of (weak) fundamentalism and almost no effect on strict fundamentalism.

Let us now examine the tolerance parameter λ. Figure 7 shows that it plays a major role. Recall that direct interactions tend to push neighbors' religiosity towards each other when λ is large, and indeed Panel A suggests that distributions become more moderate (and unimodal) as λ increases. As λ goes above 0.20, less than 5% of trials exhibit any sort of fundamentalism. With λ at its default value of 0.2 or less, however, we see more polarized distributions. For these values, a substantial proportion of trials (over 20% for $\lambda = 0.1$) exhibits weak fundamentalism, but very

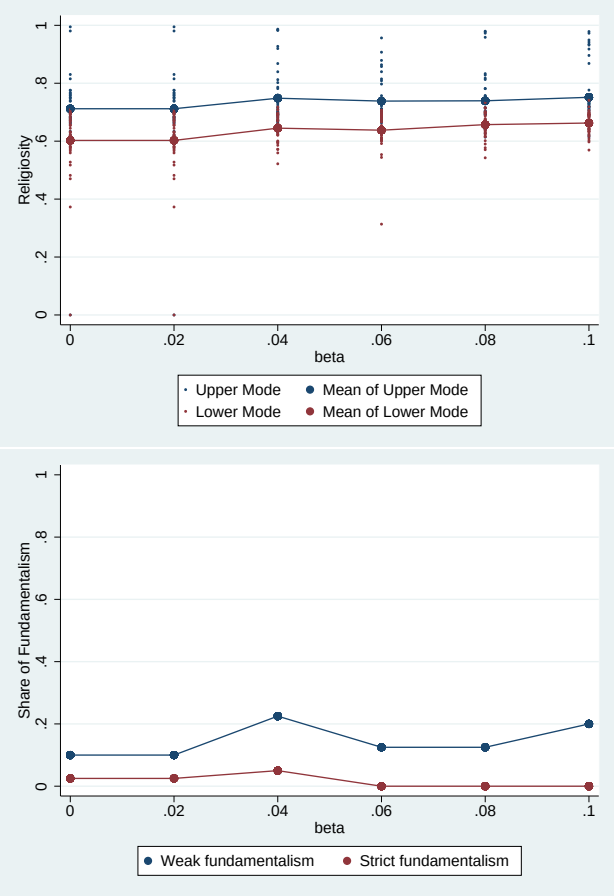

Figure 6: The impact of parameter β (probability of long-distance connections) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

few exhibit strict fundamentalism. This might help explain the puzzle of parameter q: the baseline direct interactions tend to be polarizing and hence as the weight of direct interactions increases, so does fundamentalism.

Turning to parameters concerning the peer group effects, we see from Figure 8 that fundamentalism of both sorts virtually disappears when the relative price $p = p_r/p_s$ is above its default value of 0.6. Panel A shows the proximate cause: the religiosity distribution becomes unimodal and increasingly moderate. A deeper reason is the budget constraint: for p near 1, an agent with religiosity near 1 would have almost nothing left for secular goods, so the C term then would push such an agent towards a mixed bundle of religious and secular goods, as under the default parameter value of $b = 0.8$ the two goods are imperfect substitutes. The impact of lower p is even more

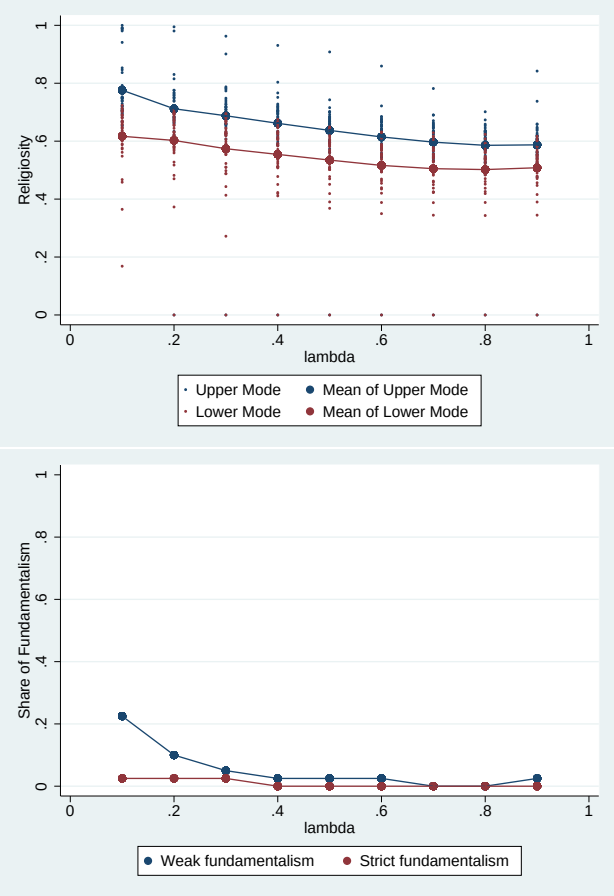

Figure 7: The impact of parameter λ (tolerance) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

interesting — some agents adopt very high levels of religiosity, whereas others choose very low religiosity despite its affordability. Evidently, a low price of the religious good allows them to buy an amount the religious good that is desired for a mixed bundle, while still leaving plenty of budget for an ostentatious amount of the secular good. As a result, fundamentalism (both weak and strict) becomes very frequent for values of p lower than 0.5.

Figure 9 shows the impact of real income $Y = I/p_s$. Fundamentalism (and to a lesser extent, strict fundamentalism) increases for higher real incomes and decreases for lower real incomes. The proximate reason, seen in Panel A, is that lower income enforces a unimodal moderate distribution of religiosity, while higher income results in some agents choosing more extreme levels of religiosity (or secularity) and in an increased bimodality. Evidently, poor people cannot afford ostentation in religious (or

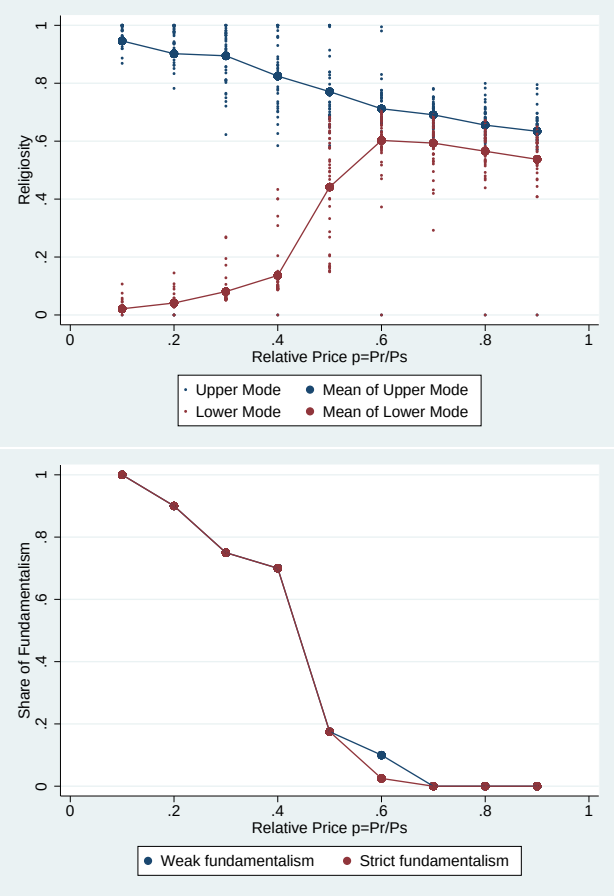

Figure 8: The impact of parameter p (relative price of religious goods) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

secular) display, while polarizing forces have more room to operate at higher income levels. When the income level is high, agents can afford a mixed bundle of the two goods that involves a very high consumption of one of the goods.

Figure 10 shows that, when the CES parameter b is less than its default value of 0.8 (and other parameters are at default settings), there is again a tendency towards unimodal distributions of moderate religiosity. The estimated upper and lower modes of religiosity are not far apart and even the former is usually less than 0.8, so fundamentalism is rare. However, as b increases above 1, there is a strong effect: the population tends towards polarization, and most simulations are deemed fundamentalist, both in the weak and the strict sense. For b above the value of 1.10, over 75% of trials exhibit strict fundamentalism. We attribute this to anti-substitutability

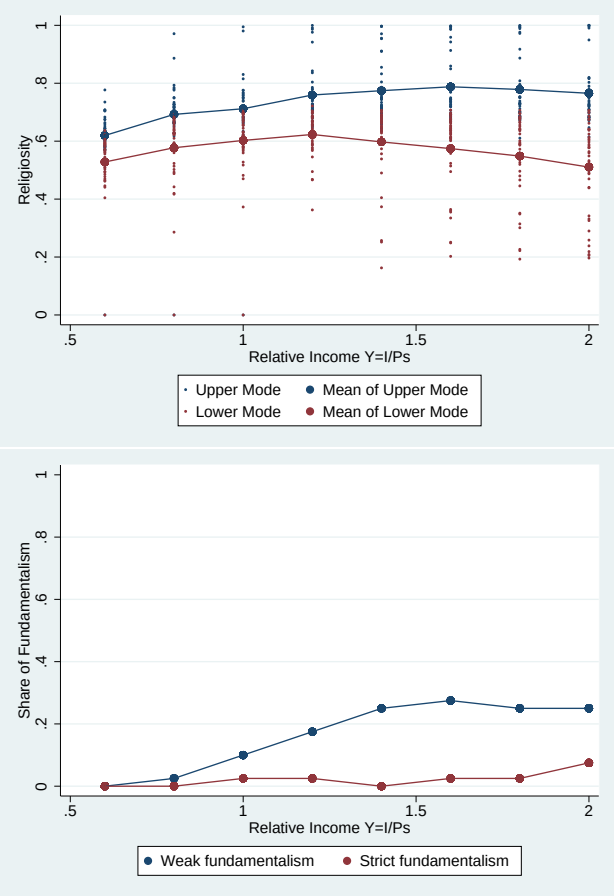

Figure 9: The impact of parameter Y (real income) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

which, as discussed in Section 3.3, makes agents prefer to focus on consumption of one good than to consume a mixed bundle. This tends to push towards corner solutions, with some agents choosing extreme religiosity and others extreme secularity. Panel A confirms the resulting extreme polarization.

Finally, Figure 11 shows the impact of the Cobb-Douglas parameter a in religious subutility. Higher a puts less weight on the peer group's average religiosity and more on own religiosity. Panel B shows that there is substantially more fundamentalism when a increases much above its default value of 0.3. Evidently, putting lesser weight on the peer group once again enhances polarization, as shown in panel A. On the other hand, putting greater weight on it promotes a unimodal distribution of moderate religiosity. That is, as a decreases, the peer group's average religiosity plays a bigger role in each agent's consumption decision and — through the club good interactions in

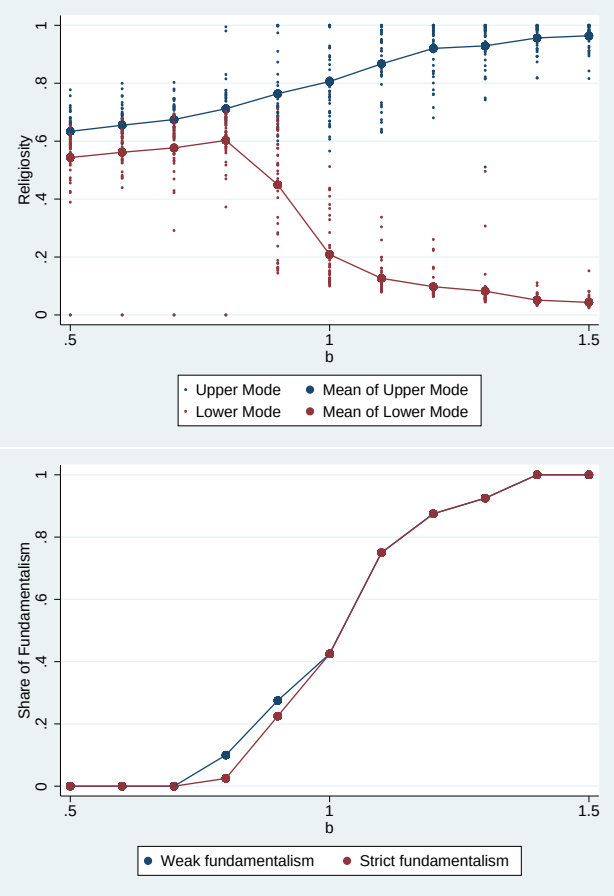

Figure 10: The impact of parameter b (substitutability of secular for religious goods) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

their overlapping neighborhoods — agents tend to choose a similar level of religiosity.

4.2 Modernity

The baseline parameter values were chosen to illuminate how the model responds, and they perhaps best capture a world hovering between traditional society and modernity. To capture the transition to modernity, then, we consider shifts in the key parameters from values below baseline to values above it, or the reverse.

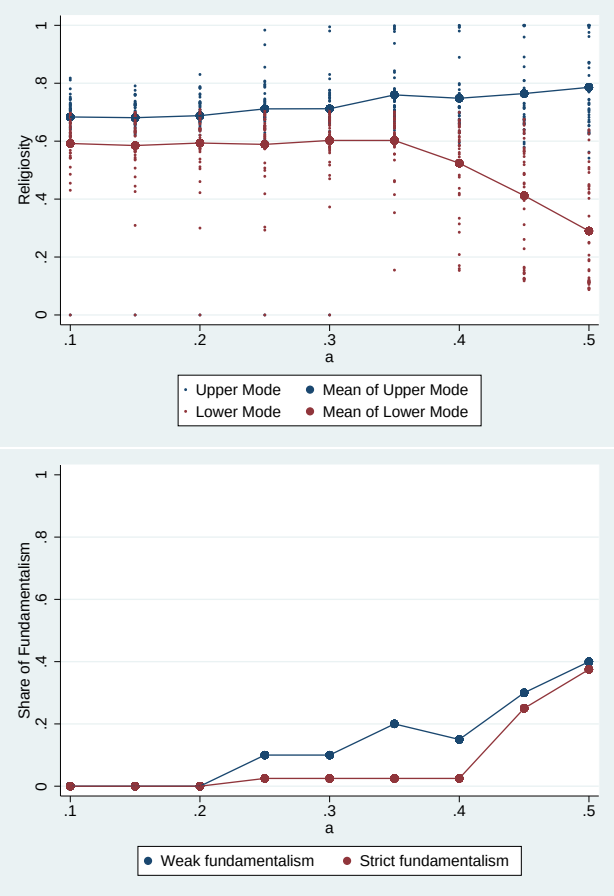

Figure 11: The impact of parameter a (weight on own (vs peer group) religiosity) on the estimated upper and lower modes of religiosity (Panel A) and on the frequency of fundamentalism (Panel B).

4.2.1 Decline of social capital

It has been argued, most famously by Putnam (1995, 2000), that there has been a significant decline in the social capital over the last few decades. In his works, Putnam studied the changes to the social capital in the United States based on over 500,000 interviews over 25 years. He found that fewer and fewer people belong to civic organizations and that people know their neighbors less and meet with their family and friends less often. Putnam offers several potential explanations for these changes: suburbanization leading to more time spent by people on travelling than on social activity, changes in the family structure such as a higher number of single and childless people, and the technological transformation of leisure leading to the

"individualization" of leisure.

Our simulations capture social capital loss via increases in parameters a (personal vs group subutility) and q (importance of direct interactions relative to peer group interactions). The comparative static results show that increases in either of these parameters above baseline values greatly encourage fundamentalism.

4.2.2 Progress in communication and transport technology

Over the last 200 years, the world has witnessed an unprecedented progress in communication and transport technology. Communication was revolutionized in the 19th century by the inventions of the electrical telegraph and the telephone. In the 20th century, radio and television developed and became widespread around the world. Finally, the last few decades saw rapid development of mobile phones and the Internet. The Internet usage increased from 11% in 1997 to 81% in 2016 of the developed world population and from 2% in 1997 to 47% in 2016 of the global population.[4] This was accompanied by extensive growth of media, including the so-called social media such as Facebook and Twitter. The progress in transport technology has been similarly impressive over the last 200 years. It included the development of trains, automobiles, and planes, and their widespread usage around the world.

The developments in communication and transport undoubtedly improved the flow of information over long distances and increased the amount of interaction between people from distant parts of the world. In terms of the model, it seems reasonable to say that parameters β (probability of long-distance connections) and K (neighborhood size) have increased. A surprising implication of our model is that both of them have a very modest impact on the emergence of (weak) fundamentalism, and almost no impact on strict fundamentalism.

The reasoning for this modest impact is as follows. An increase in either of these parameters raises the probability of a direct interaction with a distant agent, who might have a very different level of religiosity — in which case the agents become even more different in terms of religiosity. However, another effect of an increase in either of these parameters is that there is a greater overlap in the neighborhoods of distant agents, and so their religiosity becomes more similar through to the peer

[4]International Telecommunication Union data.

group effects. One should note that our model does not allow for the link weights and the agents' locations to evolve. Allowing for them would significantly complicate the model, but it could reverse the surprising non-result on the role of long distance communication and transport.

4.2.3 Increase in wealth

An important aspect of modernity is the increase in wealth and improvement of living standards around the world. The 20th century witnessed unprecedented growth in real global GDP: it rose about 19-fold, which corresponds to an average annual rate of growth of 3 percent.[5] Data from the most recent decades confirms that poverty has been reduced significantly: the proportion of global population living for under 1.90$ per day (2011 PPP) has decreased from over 42% in 1981 to less than 11% in 2013.[6] At the same time, living standards have been raised to a great extent, mostly thanks to technological and economic changes. Many indicators of well-being have improved such as life expectancy and education.[7]

It is important to note that the income parameter Y in the model can have a more general interpretation than just monetary wealth. It can be conceived of as the amount of resources (such as money or time) that people can devote to secular and religious activities. Yet, given the improvements in wealth and living standards, the value of Y has arguably increased in modern times. As we have seen, in our simulations, an increase in Y from subsistence levels is quite conducive to the emergence of fundamentalism (and to a lesser extent, strict fundamentalism).

4.2.4 Growth of secular and religious opportunities

Modernity has arguably improved both secular and religious opportunities. Put differently, it has lowered the price p_s of secular goods and the price p_r of religious goods. On the one hand, mass production, trade, and progress in communication and transport surely lower p_s. Many opportunities in domains such as entertainment and tourism have become more readily available than before. On the other hand,

[5]IMF World Economic Outlook 2000.

[6]World Bank data: http://data.worldbank.org/topic/poverty.

[7]IMF World Economic Outlook 2000.

advances from Gutenberg's Bible to televangelism and mobile messaging have also lowered p_r. For example, it has become easier to participate in worship (e.g., through television) or to travel to pilgrimage sites.

Overall, the effect of modernity on the relative price $p = p_r/p_s$ is arguable. To the extent that the net effect is a decrease in p, we have an additional economic explanation for fundamentalism in the modern world, as our simulations show that fundamentalism becomes very frequent as p falls below 0.5, but is very rare otherwise at baseline parameter values.

4.2.5 Growing incompatibility of religious and secular activities

In modern times, religious activities are becoming less compatible with the demands of secular activities. Educating children, observing holidays, and assisting those in need are examples of activities that traditionally combine religious and secular motives, but in the modern world tend to occur in separate spheres. This is partly because religious behavioral requirements are becoming more difficult to satisfy, especially given the variety and scope of new secular opportunities. Some of the requirements that concern participation in the religion can make it difficult to reconcile religious and secular activities (e.g., Pentecostals are required to participate in services and to tithe, Muslims are required to pray, give alms and, if they can afford it, make a pilgrimage to Mecca). Moreover, religion often requires its members to follow certain rules that cover many aspects of secular life, which again makes religious and secular activities difficult to reconcile (e.g., Muslims need to fast during the Ramadan, follow the Shari'a law as well as many rules specified in the Quran, including prohibitions on certain foods, a number of legal rules concerning family law, criminal law, and commercial regulations (Ruthven 2012)).

Another channel through which the incompatibility of religion and the modern world increases is secularization, which has been imposed by authorities in many parts of the world. An example is Iran under the reign of Reza Shah Pahlavi, whose policy concentrated on de-emphasizing the Islamic component in education and other domains (Marty and Appleby 1991). Secularization inevitably leads to a greater role of secular activities in people's lives (e.g., secular education), which may be difficult to reconcile with continued engagement in religion.

Makowsky (2011, 2012) argues that increases in the substitutability between religious and secular goods will increase bimodality of the population, and increase the percentage of extremists. Our simulations confirm that the substitutability parameter b has those sorts of impact. Indeed, going a bit further, we argue that the modern world may be characterized by *anti-substitutability* ($b > 1$). The point is that it is harder than ever to mix religious and secular education, and that the distinction has never been sharper between secular state provision and religious community provision of health care, disaster insurance and other public goods. Our simulations show that anti-substitutability sharply increases the frequency of fundamentalism. With anti-substitutability between religious and secular activities, the agents are more keen to choose a very high (or very low) level of religiosity rather than an intermediate one, which contributes to the definition of fundamentalism being satisfied more frequently.

4.2.6 Impact on tolerance

Modernity has arguably had an impact on people's tolerance towards others who differ from them, e.g., in terms of religiosity; however, there seems to be too little data to make strong claims about the direction and strength of this impact. Surveys show that the public support for civil liberties, such as freedom of religion and expression, has risen in the United States over the last few decades. For example, the support for allowing an anti-religionist (somebody who is against all churches and religion) to make a speech rose from 66.1% in 1972 to 76.4% in 2012. However, the impact varies across demographic groups. For those with education at college level or higher, the proportion has slightly fallen from 92% in 1972 to 88.9% in 2012.[8] Overall, one might expect that the impact of modernity on tolerance varies significantly across and within societies.

In our model, it seems reasonable to say that the impact of modernity on the tolerance parameter λ is ambiguous. We see cross-currents, with possible increases in some places offset by decreases elsewhere. Given the comparative static results of the simulations, we can conclude that wherever the net effect is a decrease, we have yet another explanation for the emergence of fundamentalism.

[8]General Social Survey 2012 Final Report, "Trends in Public Attitudes about Civil Liberties", by NORC at the University of Chicago.

5 Discussion

Why has fundamentalism become so prevalent in the modern world? Our approach to this question can be summarized briefly. We say that fundamentalism is present when there is a coherent minority of the population that is highly religious, and substantially more so than the majority. We compare the prevalence of fundamentalism across simulations of our model as we vary parameters defining direct interactions and peer group interactions.

The simulations suggest that several aspects of modernity may play an important role. The modern world is characterized by higher real income and lower social capital, and the corresponding simulation parameters greatly boost fundamentalism. Modernity has made secular and religious activities less complementary, and perhaps even "anti-substitutable," which again boosts fundamentalism. Other aspects of modernity are less clear in our simulation model. Tolerance and the relative price of religious versus secular goods are important drivers of fundamentalism, but it is harder to say which way modernity pushes them. Modernity clearly increases the potential span of personal networks, but the current version of the simulation suggests that those parameter shifts have little effect on fundamentalism.

The approach presented here can be extended in several respects. One can tweak the numerical expressions used to define fundamentalism, and the baseline parameters. The initial locations of agents need not be isotropic; there could be clusters to capture oceans, mountains or other natural barriers. Simulations could also capture network dynamics, which for simplicity we have neglected. The link weights, and perhaps agents' locations, could be allowed to evolve, to capture the idea that most people prefer to associate with like-minded individuals. This increased complication regarding direct interactions probably would require streamlining, or perhaps even dropping, the peer interactions, but it might be worthwhile. Indeed, it might reverse our surprising non-result on the role of long distance communication and transportation. Another important limitation is that we consider only a single religion. More complicated simulations might consider the interaction of alternative faiths.

Thus, we do not regard the present simulation model as the final word, but rather as an exemplar of a promising approach. In connection with other approaches, we

hope that it gives new insight into many questions regarding the distribution of religious behavior within a population, including how and when fundamentalism can take root.

Appendix A: Summary of Parameters of the Model

Notation	Meaning	Default
	Network and simulation parameters	
N	number of agents on the sphere	100
K	size of each agent's neighborhood	0.16
β	probability of an agent's neighborhood link being deleted and rewired with a random agent on the sphere	0.05
b_d	sensitivity to distance in neighborhood links (the higher the absolute value, the less weight agents attach to interactions over longer distances)	-1
b_{sm}	sensitivity to distance in rewired ("small world") links (the higher the absolute value, the less weight agents attach to interactions over longer distances)	0
T	number of iterations of the simulation	4,000,000
σ	noise in the adjustment of an agent's religiosity level in each iteration	0.0005
q	weight attached by each agent to direct interactions (relative to peer group interactions)	0.8
	Direct interaction parameters	
λ	tolerance of each agent towards an agent with a different level of religiosity (the higher the value, the higher the propensity to move closer to the other agent in terms of the level of religiosity)	0.2
	Peer group interaction parameters	
a	weight attached by each agent to own religiosity (relative to the average religiosity of connected agents)	0.3
b	substitutability between religious and secular goods (the goods are imperfect substitutes for $b < 1$, perfect substitutes for $b = 1$, and anti-substitutable for $b > 1$)	0.8
p_r	price of the religious good	0.6
p_s	price of the secular good	1
I	nominal income of each agent	1

Appendix B: Further Background

Case Studies of Religious Fundamentalism

Originally, the term "fundamentalism" was coined to describe a group of theologically conservative American Protestants in the late 19th and early 20th century. It is thought that the term was first used in 1920 by Curtis Lee Laws, who was an editor of *Watchman-Examiner*, a conservatist Baptist publication. It was meant to describe those Protestants "who were ready to defend the fundamentals of the faith" (Hood et al. 2005). Since then, the term has often been used in the context of movements in other parts of the world in other periods of time, such as Iran after the 1979 revolution and India in the 1990s.

As part of the present project, we have conducted case studies of four movements which can be described as "fundamentalist." We now briefly outline each of them in terms of doctrine, history, and distinctions from other movements.

1. Protestant fundamentalism in the United States

This movement developed in the United States from around 1870 to 1925 (Emerson and Hartman 2006). The main characteristic of Protestant fundamentalists is their belief in the inerrancy of the Bible in all aspects, including the creation of the world, the virgin birth of Jesus Christ, and the promise of his eventual return. These and other central beliefs were outlined in a series of essays entitled *The Fundamentals: A Testimony to the Truth*, which were published between 1910 and 1915 (Hood et al. 2005). It was this title which later helped establish the terms "fundamentalism" and "fundamentalists". The movement began to lose on importance from 1925 when the American Protestant fundamentalists were humiliated in the famous trial of John Scopes, a young biology teacher who was accused of teaching evolution in schools in Tennessee (Marty and Appleby 1991). Woodberry and Smith argue that only a small part of today's conservative Protestants in the US can be described as "fundamentalists." Instead, as Hood et al. (2003) writes, many conservative Christians in the US use the term "evangelicals" to describe themselves, and most academics agree that "fundamentalists" and "evangelicals" constitute two different groups, despite some similarities.

2. Islamic fundamentalism

Defining "fundamentalism" in the context of Islamic religion is problematic because the belief in inerrancy of the Muslims' sacred text, the Quran, is not a good criterion. The reason is that, as Ruthven (2012) points out, "virtually all believing Muslims — not just those described as 'fundamentalists' — see the Quran as the eternal unmediated Word of God." Lewis (1998) argues that Islamic fundamentalists "base themselves not only on the Quran, but also on the Traditions of the Prophet, and on the corpus of transmitted theological and legal learning." Fundamentalism in the Sunni branch of Islam developed for example in Egypt. As Marty and Appleby (1991) write, the beginnings of modern fundamentalism in Egypt can be traced back to the first decades of the 20th century and to the establishment of the Muslim Brotherhood in 1928. The Muslim Brotherhood was one of the sources of members for the Egyptian fundamentalist movement, which was still rather weak during the presidency of Gamal Abdel Nasser in the 1950s and 1960s. The movement grew in power in the 1970s under Anwar Sadat's presidency and in the 1980s. The assassination of Sadat by fundamentalists in 1981 is often seen as a symbol of Islamic fundamentalism in Egypt (Marty and Appleby 1991). Fundamentalism in another branch of Islam – Shi'ism – developed in Iran as a reaction to secularization under the reign of Reza Shah Pahlavi (Almond et al. 2003) and grew rapidly after the Iranian revolution in 1979 under the charismatic leadership of Ayatollah Khomeini. It should be mentioned that there are also other terms which are often used in similar contexts to "Islamic fundamentalism," e.g., "Islamism", "political Islam", and "militant Islam" (see Kramer (2003) and Sonn (2006)).

3. Hindu fundamentalism in India

The movement is represented by two non-governmental organizations: the RSS (Rashtriya Swayamsevak Sangh) and the VHP (Vishna Hindu Parishad), as well as by a major political party - the BJP (Bharatiya Janba Sangh), which is closely linked to the RSS. Hindu fundamentalism differs from Abrahamic (i.e. Jewish, Christian, and Islamic) fundamentalisms in that there is no unified scripture, inerrancy of which members could believe in. However, the book Hindutva, written by Vinayak Savarkar, the

leader of the RSS, and published in 1922, provides a doctrine for Hindu fundamentalists in a similar way to the Bible for Christians or the Quran for Muslims. The book describes the concept of "Hindutva" ("Hinduness") which "defines the geographic, racial, and religious boundaries of Hinduism" (Almond et al. 2003). Hindu fundamentalism's origins can be seen in nineteenth-century movements like Brahmo Samaj and Arya Samaj (Keddie 1998). The movement grew rapidly in the 1980s, which is shown by an increase in active membership in the RSS from 1,000,000 in 1979 to 1,800,000 in 1989 (Marty and Appleby 1991). The BJP party won the largest number of seats in the Indian parliament for the first time in 1996. Despite a decline in popularity in the 2000s, it won over 51 percent of seats in the 2014 elections.

4. Pentecostalism

There is no consensus whether Pentecostalism is a "fundamentalism". It is undoubtedly a distinct movement from the original Protestant fundamentalism but it has several characteristics of a fundamentalist movement, including the belief in inerrancy of the scripture (i.e. the Bible). Hood et al. (2005) mention that some Pentecostals even describe themselves as "fundamentalists". What makes Pentecostals different from the original Protestant fundamentalism is that the former attach more importance to the direct experience of God through the Holy Spirit, which takes the form of, for example, speaking of tongues, healing, and prophesying (Robbins 2004). Put briefly, "fundamentalists emphasized doctrine; Pentecostals - experience" (Woodberry and Smith 1996). Pentecostalism emerged at the beginning of the 20th century from the Holiness movement, which was a branch of evangelicalism (Woodberry and Smith 1996). The so-called Asuza Street Revival in 1906-1909 (i.e. the preaching by William Seymour in an abandoned church on Asuza Street in Los Angeles) is considered by scholars as the birth of Pentecostalism (Robbins 2004). Currently, Pentecostalism is growing rapidly in many parts of the world, especially Latin America and Africa.

Characteristics of Religious Fundamentalism

In this section we aim to summarize the main characteristics of movements which can be described as "fundamentalist." This analysis is based on Almond et al. (2003),

Emerson and Hartman (2006), and the preceding discussion of four fundamentalist movements. It should be emphasized that this list is not exhaustive; however, most of the fundamentalist movements share the vast majority of these characteristics, if not all.

1. Belief in inerrancy of scripture. Fundamentalists believe that their scripture has divine origin and is true in all aspects (Almond et al. 2003). This refers to sacred texts such as the Bible for Christian fundamentalists and the Quran for Islamic ones, but also to the "Hindutva" for Hindu fundamentalists.

2. Unwillingness to compromise. Fundamentalists are often unwilling to compromise not only on religious issues but also on the secular ones. This is connected with the belief in inerrancy of the scripture. For example, the Quran and the Shari'a law are seen by Islamic fundamentalists as rules which cover all areas of life and cannot be changed regardless of the circumstances.

3. Separatism. It is a standard practice of fundamentalists to set sharp boundaries between members and non-members. This dualistic worldview is an important feature of, for instance, the "Hindutva": everyone who acknowledges ties to ancient India is included in the movement (even Sikhs, Jains, and untouchables), but Christians and Muslims are considered enemies (Keddie 1998). For Islamic fundamentalists, it is the Western culture in general which is seen as an enemy.

4. Behavioral requirements. Members of fundamentalist movements are required to follow specific behavioral requirements in various domains, such as worship, attire and diet. There are plenty of examples of such requirements, e.g., prohibitions on certain foods in Islam and the requirement to tithe and give offerings in Pentecostalism.

5. Militancy and active evangelization. Fundamentalists often engage in active evangelization (e.g., Protestant fundamentalists in the US and Pentecostals), which can even be considered as militant. However, this militancy does not necessarily mean that violence is being used.

6. Authoritarian organization and charismatic leadership. It is common for fundamentalist movements to have a more authoritarian structure than other religious movements and that they are centered around a charismatic figure. The leader can be more global (like Ayatollah Khomeini for Islamic fundamentalists) or

more local (like local preachers in Pentecostal churches in Brazil).

7. Millenialism and messianism. Many fundamentalist movements believe that the world will have a miraculous and positive end. The end will be accompanied by a golden age of 1000 years (hence "millenialism") and by the coming of a Messiah (hence "messianism"). This is particularly characteristic of Abrahamic religions (Almond et al. 2003).

8. Provision of social life and welfare services. Fundamentalist movements strive to provide benefits for their members, which can take various forms, such as building schools (e.g., by Protestant fundamentalists in the US) or even simply organizing regular occasions for group life (e.g., neighborhood meetings in the RSS in Hindu fundamentalism and exuberant worship services in Pentecostalism).

9. Alienation from the rest of the society. Alienation of fundamentalists from the rest of the society arises mainly for two reasons. First, new members are often drawn from isolated subpopulations by offering them better life. In most cases, this refers to lower classes of the society (e.g., in Pentecostalism), but in the case of Iran it was the educated young middle class that was alienated by the modernization and secularization program of Reza Shah Pahlavi and subsequently attracted by Sunni fundamentalists. Second, the alienation is a result of the already mentioned practice of setting sharp boundaries between members of the movement and the others.

10. Reaction to modernity and secularization. The emergence of fundamentalism is often considered a response to modernity and secularization. For example, the Protestant fundamentalism in the US is said to have emerged "in reaction to rapid urbanization and industrialization, the spread of secular education and science, the decline of belief in sacred texts and religious tradition, and attenuating religious discipline" (Almond et al. 2003). Sunni fundamentalism in Egypt grew as a response to secularization efforts of Nasser in the 1970s, whereas the Shi'ite fundamentalism in Iran was largely triggered by rapid secularization under the reign of Reza Shah Pahlavi.

Appendix C.1: Code Description

The model is implemented in C++ and we describe the operation of the code here.

Inputs

As inputs the code takes two or three data files, plus several parameter values.

- The first data file specifies the initial state of the network, i.e., the initial religiosity levels, $\{r_i\}$, of the agents in the network.
- The second input file contains the various model parameters: q (weighting for direct interactions versus club); λ (parameter characterizing direct interaction); a, b, p_r, p_s (parameters characterizing club good interaction) and σ (standard deviation of the noise term).
- The third optional input data file is the description of the network. This is a list of node pairs plus weights describing the links that exist in the network and the relative probability of an interaction occurring. If this file is omitted the code assumes we want to use a completely connected network, i.e., every node has a link to every other node and these links are all equally weighted.
- In addition, the user provides the name of an output data file, the number of iterations (model updates) to perform and a random seed that will be used to initialize the random number generators required for the probabilistic model updates to ensure reproducibility of the results. The user can also optionally supply the value of the distance weighting parameter, b_d, used to specify the strength of the network links.

Variables

As the model runs, various network properties are tracked. These include the network characteristics, i.e., all the links that exist in the network and their weights. In the simulations described in this article, the network characteristics do not evolve over the simulation, but the code supports that capability. The code also tracks various properties of each node. This includes their current religiosity, the location of their neighbours and the average religiosity of their neighbours, used as the parameter Q in the club-good part of the update model. The code also has the capability to support heterogeneous networks, with different values of the model parameters, such as λ,

a, b, p_r and p_s, for each agent, but again that feature was not used for the results reported in this article. The code also keeps track of various average properties of the network.

Code Operation

The code structure is as follows.

- **Initialization:** on starting the code performs various initialization operations
  - Read parameters from the command line.
  - Read parameters describing the model from the model parameter file and initialize the corresponding variables in the model.
  - If a network file is provided, read the network description from the file and create the network array structures to store the details. If not, generate network structures describing a completely connected network.
  - Create the arrays for storing the node properties. Read in the initial states of the nodes from the input file and initialize the arrays.
  - Opens files for output.
  - Compute mean properties of the network and derived node characteristics, such as the mean religiosity of neighbours for each node, as per the particular model specification. Create arrays for storing network and node characteristics and initialize.
- **Iteration:** after initialization the code performs the number of iterations specified by the user. This was $T = 4,000,000$ for the runs described in this article. On each iteration the code performs the following steps
  - Choose a link in the network at random, with weighting according to the current weights of the various network links. This specifies the two nodes that interact at this iteration and a direction, i.e., which node is "A" and which is "B". After the interaction, only the religiosity of A changes, but the size of the change depends on the states of both A and B and the average state of neighbours in the network.

– Update the religious adherence of Node A according to the interaction model described in Sections 3.2 and 3.3. This is a combination of the direct interaction, D, given in Eq. (1), the club good interaction, C, given by Eq. (4), and the normal noise term, n. These give the update to the logit-transformed religiosity of agent A, which is then converted to the new religiosity of the agent. Note that the club good update depends on the mean religiosity parameter, Q, which is computed as a weighted average over all nodes linked to agent A, with weights equal to the weights on the corresponding legs of the network.

– Update the mean field parameters and derived node characteristics based on the new state of the network.

– Write new state of network to output files.

The code runs for the specified number of iterations and then the files are post-processed to compute the quantities required to assess if the final state of the network meets the criteria for Fundamentalism as defined at the start of Section 3.

The parameter c that enters the club good utility function, Eq. (2) was not specified in the body of the text. This parameter affects where the maximum utility appears for a given mean field religiosity, Q. The club good model pushes agents towards conforming to the mean, but if the parameter c is set to 1 as in Iannaccone (1992), the maximum utility does not occur at $r = Q$. The effect of this in simulations was that, in the absence of the direct interaction term, the network would homogenise, but then the religiosity of all the nodes would drift over subsequent iterations of the network. This was deemed to be an undesirable feature and so we introduced the parameter c which was fixed to ensure that the maximum utility occurs at $r = Q$. Solving the relevant first order condition, we obtain

$$c = \frac{p_r}{a p_s} \left[\frac{I - p_r Q}{p_s Q} \right]^{b-1} . \tag{5}$$

This value of c was used in all simulations described in this paper.

Appendix C.2: Supplementary Simulations

The reported simulations rather arbitrarily fix the number of agents at $N = 100$. To check robustness of our results to that choice, we ran simulations with other values of N as shown in Figure 12. We vary K so as to hold constant the expected number of neighbors,[9] and vary T proportionately with N so as to keep roughly constant the average number of updates of each agent.

Panel B of Figure 12 shows a modest rise in the fraction of simulations deemed (weakly) fundamentalist and no substantial effect on the fraction deemed strictly fundamentalist. This is likely due to random fluctuations, as we can see that the estimated upper mode does not vary much and stays below 0.80, while the lower mode declines very modestly. We attribute the rise in weak fundamentalism to slightly more dispersion around the modes with larger N, possibly due the larger (absolute) number of individuals with weak links that are seldom updated. However, we do not see any systematic changes in the way religiosity evolves in simulations with $N > 100$.

[9]The expected number of neighbors is given by $N(1-\cos(\frac{\pi K}{2}))$, the relative spherical area times the number of agents; with default values $N = 100, K = 0.16$ this implies just over 3 neighbors on average. The simulations vary K inversely with N so as to keep that number constant.

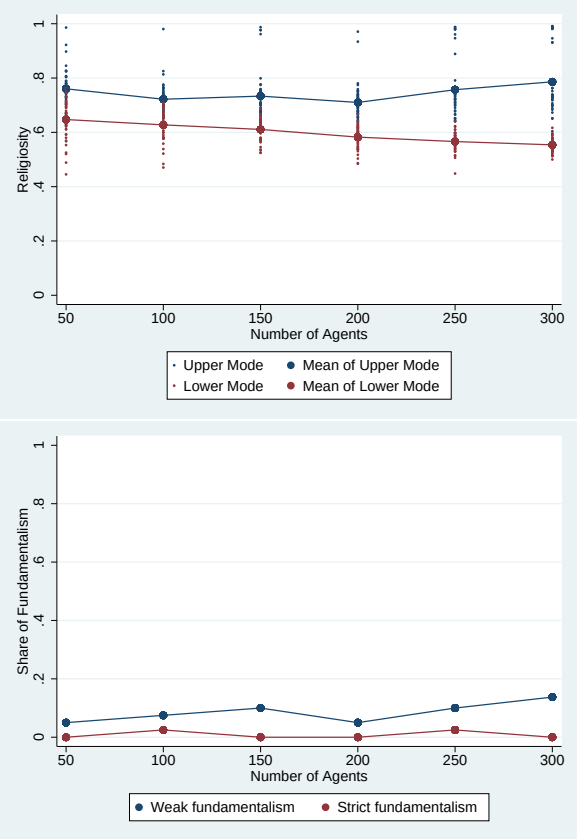

Figure 12: The impact of parameter N (number of agents) on mean religiosity (Panel A) and on the frequency of fundamentalism (Panel B), holding constant the expected number of neighbors.

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