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**Corporate Taxes and Labor Market Informality
Evidence from China**

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ABSTRACT

This paper examines the association between corporate income taxes and labor market informality. We present a theoretical framework showing that a higher tax enforcement can push firms to pass on the burden to workers by reducing their social security compliance as well as downsizing and lowering wages. The model propositions are tested using a regression discontinuity design that exploits a national corporate tax reform in China. We find that for every one percentage point increase in the effective tax rate, firms reduce their probability of making basic social security contributions by 0.8%, their compliance rate by 1.4 percentage points, and the probability of making supplementary contributions by 0.6%, while the number of workers and wages fall by 4.4% and 0.7%, respectively. We observe that the effects are more salient among firms privately owned and controlled, large businesses, and in locations where social security contributions are directly collected by the social security administration. The findings suggest that workers not only bear part of the higher corporate taxes faced by firms, but an increase in firms' tax burden contributes to social security evasion and informality in labor markets.

JEL Codes: H32, H55, J30, J23, H25

Key Words: Corporate taxes, tax burden, labor market informality, social security contributions, personnel costs, tax reform, China

1. Introduction

Corporate taxes constitute an important source of revenue for governments, particularly in developing regions. According to a recent report from the Organization for Economic Cooperation and Development (OECD, 2022), corporate tax revenues accounted for around 15% of total tax revenues across the globe in 2019, compared to 12% in 2000, and reached 16% to 19% in Latin America, Asia and the Pacific, and Africa versus less than 10% among OECD countries. Higher corporate taxes, however, can also alter firms' decision-making, including their labor demand and wages (Desai et al., 2007; Fuest et al., 2018). A heavy tax burden and regulation may additionally encourage social security evasion and informality in labor markets, especially in developing countries where several enterprises fail to comply with their basic social security obligations (Ulyssea, 2020).

In this paper, we evaluate the extent to which firms pass through corporate income taxes to workers in terms of social security contributions in the extensive and intensive margin, labor size, and wages. We first develop a basic theoretical framework showing that higher tax enforcement can push firms to pass on the burden to workers by reducing their social security compliance as well as downsizing and lowering wages. We then test our theoretical propositions using a regression discontinuity design that exploits the 2002 national corporate tax reform in China, which meant a more stringent tax supervision and collection for targeted firms. We similarly explore possible heterogeneous effects by firm characteristics and type of agency collecting social security contributions.

China offers an interesting setting to evaluate the association between corporate income taxes and labor market informality. In this country, roughly three in every four enterprises fail to fully comply with their social security contributions, including incomplete coverage and untimely payments, and about 21% do not make any contributions.¹ A possible explanation for this extensive undercompliance is the high social security burden as these contributions

¹ 2022 Chinese Enterprise Social Security White Paper (<https://max.book118.com/html/2022/1214/8054125142005021.shtml>, accessed January 2024, in Chinese).

constitute an important share of enterprises' personnel (labor) costs, combined with a lower collection enforcement. The five mandatory contribution or insurance schemes that are part of the Chinese social security system (pension fund, medical, unemployment, work-related injury, and maternity) represent more than 30% of gross wages, which ranks China thirteen among 173 countries and is 4.6 times higher than in neighboring countries in East Asia and twice the average level for Brazil, India, and Russia.² Prior to 2018, basic social security contributions were also collected by tax authorities in fewer provinces and in most places they were directly collected by the social security department that had less efficient cross-checking and collection systems.³

In addition, Chinese enterprises bear heavy tax burdens. According to a 2018 global tax report prepared by the World Bank Group and PwC, China's total tax and contribution rate is 59.2 % versus 36.6% in the United States.⁴ Corporate taxes are the main source of tax revenue in China, and corporate income taxes alone represent around 19-20% of the national tax revenue (Xu, 2018; Chen et al., 2021).⁵ It is thus relevant to analyze whether in a context of high labor market irregularities and avoidance of social security contributions, the burden of corporate income taxes is further contributing to labor market informality by passing on part of the burden to workers through social security evasion as well as downsizing and lower wages.

The 2002 national corporate tax reform in China provides a natural experiment to assess the pass through of income taxes to workers across several channels. The reform, implemented at the beginning of 2002, changed the classification of corporate income taxes of domestic (mainly private) firms from local to a shared tax with the central government and stipulated that the state tax bureau will start collecting these income taxes for all new firms established on or after

² National Development and Reform Commission (https://www.gov.cn/xinwen/2016-08/29/content_5103151.htm, accessed January 2024, in Chinese).

³ Starting in 2019, all basic social security contributions started to be collected by tax authorities in a unified manner. Despite additional reforms in the social security system, reductions in the statutory social security contribution rate (from 41% in 2015 to 37% in 2018), and the comprehensive plan to lower social insurance premium rates (including retirement, unemployment, and work-related injury insurance) issued by the General Office of the State Council in 2019, the compliance rate was still at 30% in 2019 and 31% in 2020.

⁴ https://www.pwc.com/gx/en/paying-taxes/pdf/pwc_paying_taxes_2018_full_report.pdf, accessed January 2024.

⁵ Corporate income taxes are the second major source of tax revenues in China after domestic value-added taxes.

January 2002; the local tax bureau will, in turn, keep collecting income taxes for firms established prior to 2002, as it was too difficult to transfer the tax collection for existing firms (due to different recording systems used by state and local bureaus). The reform overall resulted in a higher income tax burden for firms established after 2002 relative to those established earlier such that we can evaluate differences in social security contributions, workforce, and wages.

The estimation results show that for every one percentage point increase in the effective tax rate, firms reduce their likelihood of making basic social security contributions by 0.8%, their compliance rate by 1.4 percentage points, and the likelihood of making supplementary contributions by 0.6%, while the number of workers and wages fall by 4.4% and 0.7%, respectively. Several robustness checks support our main findings. We also find that the effects are more salient among firms privately owned and controlled (i.e., limited liability companies and firms owned by natural persons), large businesses, and in locations where the basic contributions are directly collected by the social security administration. The findings indicate that firms not only share part of the higher corporate tax burden with workers, but also reduce their participation in the social security system that contributes to labor market informality.

The study contributes to several strands of literature. First, the analysis adds to the general literature documenting possible factors contributing to firm and labor market informality. In an earlier comprehensive survey, Schneider and Enste (2000) point to increasing taxation and social security contributions plus rising regulations and corruption, in some contexts, as likely driving forces of the size of the informal sector (shadow economy). Ulyssea (2020) offers a more recent review of the causes (and consequences) of informality where informal firms and workers are defined as those operating at the margin of laws and regulations (see also Perry et al., 2007). The author stresses that informality should be understood both as a micro and macro phenomenon and discusses multiple probable causes of informality that include registration and formalization costs and enforcement of laws and regulations as well as the tax structure and burden, development of formal credit markets, and trade reforms. Ulyssea (2018) remarks that firm

informality (i.e., not registering the business) and labor informality (i.e., hiring workers “off the books”) do not necessarily move in the same direction with a policy change, such that reducing firm formalization costs, for instance, can lead to a substantial reduction of informal firms but there is no effect on the share of informal workers.⁶ We formally document the effect of a corporate tax reform on firms’ labor informality decisions through (non)compliance of social security contributions.

In the same line, the paper relates to the specific literature examining the determinants of firms’ social security participation. Previous studies have especially focused on three main factors: contribution rate and enforcement, labor costs, and the institutional framework.⁷ In the case of China, Nyland et al. (2006) and Feng (2013) argue that the legal contribution rate plays certain role in social security participation of enterprises and point to a negative association between the contribution rate and level of participation and effective contributions; Liu et al. (2020) document a negative correlation between minimum wages (and enforcement) that vary across locations and firms’ social security participation; and Liu (2011), Shen et al (2020), and Tang and Feng (2021) show that local tax authorities are more effective in collecting social security contributions than social security agencies. We contribute to this literature focusing on the impact of corporate income taxes on the extensive and intensive participation of firms in the social security system, which constitutes an important impact channel that has received less attention.

The study similarly adds to the ongoing discussion in China about alleviating firms’

⁶ Ulyssea (2020) also notes in his review that the most effective policy to reduce informality appears to be intensifying enforcement, although increasing enforcement on the extensive margin (i.e., registered firms) can have different aggregate implications in terms of output and productivity than increasing enforcement on the intensive margin (i.e., workers with formal contracts). In the case of enforcement policies to directly reduce labor informality, Almeida and Carneiro (2012) argue that increased enforcement of labor market regulations can promote the flow of workers from informal to formal (low paid) sector jobs, while Meghir et al. (2015) show that increasing enforcement does not necessarily contribute to higher unemployment and can enable a better allocation of workers to higher productivity jobs.

⁷ There is also an extensive literature worth mentioning that studies wage and employment responses to increases in firms’ social security contributions and payroll taxes and most of them find a negative correlation (e.g., Murphy, 2007; Nielsen and Smyth, 2008; Bennmarker et al., 2009; Cruces et al., 2010; Anton, 2014; Ma et al., 2014; Zhao et al., 2016; Bozio et al., 2017; Saez et al., 2019; Tang and Feng, 2019; Benzarti and Harju, 2021).

noncompliance of social security contributions, which is still high and there is not a unified conclusion or recommendation among academicians and policymakers (Nielsen and Smyth, 2008; Gao and Rickne, 2014; Han et al., 2014). Better understanding the evasion of social security obligations requires a broader look at the whole tax burden faced by enterprises rather than concentrating on the social security institutional framework and burden.

In addition, the paper contributes to the literature on the impact of corporate taxes on wages, employment, and welfare. Recent examples include Arulampalam et al. (2012) who assess the impact of capital taxes on wages across nine European countries; Liu and Altshuler (2013) who analyze the burden of corporate income taxes under imperfect competition on labor in the United States; Azemar and Hubbard (2015) who evaluate the incidence of capital taxation on wages based on a cross-country analysis; Suarez Serrato and Zidar (2016) who examine the effect of local tax cuts on wages, workers' location decisions, and welfare in the United States; Chen et al. (2018) who analyze the effect of corporate income tax cuts on unemployment in the United States; and Fuest et al. (2018) who assess the incidence of corporate taxes on wages in Germany. These studies generally find that labor bears a substantial share of the corporate tax burden.⁸ Similar to this strand of the literature, we assess the impact of a higher corporate tax burden on workforce (number of employees) and wages, but additionally assess effects on social security contributions that have important welfare implications for workers in the medium and long term.

Lastly, the study relates to the broader literature on the impact of corporate taxes on firms' decision-making. Recent studies include Zwick and Mahon (2017) examining the effect of taxes on firm investment; Moretti and Wilson (2017) on location decisions; and Mukherjee et al. (2017), Cai et al. (2019), Akcigit et al. (2021), and Chen et al. (2021) on innovation.

The remainder of the paper is organized as follows. Section 2 briefly discusses the evolution of the corporate tax system in China and the 2002 reform. Section 3 presents the theoretical

⁸ Two relatively recent studies in China show, however, that corporate taxes are negatively associated with the wages of corporate executives and ordinary employees but do not affect employment levels (Wang et al., 2013; Han et al., 2016). In a related line, Autor et al. (2007) and Bartelsman et al. (2016) examine labor regulation in the United States and Europe, respectively, and find that employment protection may reduce employment (and productivity).

framework showing how firms can pass on the income tax burden to workers and derives testable propositions. Section 4 describes the data and empirical approach used in the analysis. Section 5 reports and discusses the estimation results, while Section 6 concludes.

2. The corporate tax system in China and 2002 reform

China's tax administration system has undergone several reforms since its inception but can be roughly divided into three stages.⁹ The first stage, referred to as the unified revenue collection and expenditure system, was between 1949 and 1978 when China's private economic activity was limited, and most taxes originated from profit transfers of public firms. At this stage, local governments were responsible for the tax collection, but all revenues were controlled and managed by the central government who then redistributed the revenue based on local needs.¹⁰

The second stage was between 1980-1993, which followed the start of the economic reform in 1979. This stage is referred to as the fiscal responsibility system that implied moving to a structure with "separate categories of taxes, established scope of revenues and expenditures, and local governments taking full responsibility for their finances." During this stage, local taxes collected were divided between the central and local governments according to pre-established sharing schemes that could be frequently revised; yet local protectionism and diversion of local revenue from budgetary to extra-budgetary revenue, which was not required to be shared with the central government, resulted in excessive local expenditures and investments that severely limited the fiscal capacity of the central government. The share of fiscal revenue to Gross Domestic Product (GDP) ended up declining from 25% in 1980 to 12% in 1993.

As a result, the central government implemented a new tax reform in 1994 intended to strengthen their control of the tax revenues. The reform gave rise to the third stage of the tax administration system where taxes started to be classified into central (e.g., all consumption tax,

⁹ See Cai et al. (2019), Cao et al. (2021), and Chen et al. (2021) for additional details of China's corporate tax system.

¹⁰ In 1960, the central government started to use quotas, which changed every year, to share the total tax revenue with local governments.

tariffs, corporate income tax from foreign and centrally owned enterprises), local (e.g., corporate income tax for domestic and state-owned enterprises, personal income tax, real estate tax, land use tax), and shared (e.g., value-added taxes) with a specific sharing rule.¹¹ A state tax bureau was similarly created to collect central and shared taxes, while the local tax bureau continued to collect local taxes. Until mid-2018, both state and local tax bureaus had offices (branches) at the province, city, and county levels but local governments did not have influence at any level of the state tax bureau; state and local tax bureaus were then consolidated into one state bureau in each locality.

Despite the reform establishing a more systematic revenue sharing between the central and local governments, some complications eventually emerged. As local tax bureaus are managed by local governments, local authorities interfered, for example, in the collection of local corporate income taxes through tax incentives and favorable policies as a result of their informal competition with other local governments to attract economic activities and investment to their area (Guo and Li, 2009; Xu, 2011; Cao et al., 2021); they also reduced tax collection enforcement, provided refunds after collection, and wrongly identified enterprises as high-tech enterprises to qualify for targeted tax subsidies from the central government (Fan and Tian, 2013; Wu et al., 2013), leading to a considerable loss of tax revenues.

In this context, the central government decided towards the end of 2001 to implement an additional reform to further improve the administration and efficiency in the tax collection and distribution of fiscal revenues, including reducing the financial gap across regions to support the development of China's western region. On December 31, 2001, the State Council issued the "Reform of Income Tax Sharing Notice", which became effective on January 1, 2002.¹² The

¹¹ Centrally owned firms are large public enterprises managed by the State-owned Assets Supervision and Administration Commission of the State Council; currently, there are only 96 centrally owned firms across the country. State-owned firms are public firms managed by local governments that were authorized by the central government to establish a provincial or municipal State-Owned Assets Supervision and Administration Committee. The sharing rule for shared taxes was 75:25 in favor of the central government until 2019 and then changed to 50:50.

¹² The formal translation is the "State Council Notice on Printing and Distributing the Reform Plan for Income Tax Revenue Sharing" (http://www.gov.cn/gongbao/content/2002/content_61880.htm, accessed January 2024, in Chinese).

reform changed corporate income taxes that were classified as local to a 50:50 shared tax, which was then modified (after 2003) to a 60:40 central-local government ratio. The State Council also issued an “Income Tax Collection Notice” in January 2002, which determined that the state tax bureau will start collecting these corporate income taxes (as in the case of other shared taxes), but only for new firms established on or after January 1, 2002;¹³ income taxes on existing firms remained collected by the local tax bureau given the complexities to transfer their tax collection as local and state tax bureaus use very different tax collection and recording systems. The policy thus affected all new private domestic firms and state-owned enterprises established after 2002 whose income taxes were previously classified as local.¹⁴

The reform meant that similar firms established before and after 2002 were exposed to different tax collection and enforcement systems, providing an exogenous change in the tax burden faced by firms. We should generally expect a higher tax burden among firms established after the reform as the state tax bureau has stronger incentives to enforce tax rules and less incentives to protect local firms than local bureaus. However, the reform also reduced the share of corporate income taxes received by local governments causing either an increase in local tax collection efforts (due to the higher local fiscal pressure) or a reduction in their collection efforts (due to the lower revenue sharing). Fan and Tian (2013), Xie and Fan (2015), Li et al. (2018), and Du et al. (2021) show that the reform effectively increased the tax rate of new firms using data from the Chinese Annual Survey of Manufacturing Firms for different sample periods, while Cai et al. (2019) and Fang et al. (2022) find the opposite using the same data source.¹⁵ Tian and Fan (2016) similarly show that the subsequent 2003 change in the sharing rule of corporate

¹³ The formal translation is the “State Administration of Taxation Notice on the Scope of Tax Collection and Administration after the Reform of the Income Tax Revenue Sharing System” (<http://www.chinatax.gov.cn/chinatax/n362/c10/content.html>, accessed January 2024, in Chinese).

¹⁴ The taxes of foreign and centrally owned enterprises (classified as central since 1994) were already collected by the state tax bureau. The 2002 reform also changed the classification of personal income tax from local to a shared tax, which started to be collected by the state tax bureau.

¹⁵ Fan and Tian (2013), Xie and Fan (2015), Li et al. (2018), and Du et al. (2021) consider the period 1998-2009, 2002-2007, 2003-2007, and 2002-2007, respectively, whereas Cai et al. (2019) and Fang et al. (2022) consider the period 2002-2007.

income taxes between central and local governments from 50:50 to 60:40, led to a larger tax evasion among enterprises whose taxes remained collected by the local tax bureau; the authors argue that the decline in the tax sharing revenue enjoyed by local governments resulted in lower collection efforts by local tax authorities. Cao et al. (2021) use stock market and accounting data and find that private firms whose income taxes remain collected by local tax bureaus after the reform (i.e., firms established prior to January 1, 2002) bribe more and enjoy a lower tax burden than similar firms whose taxes are collected by state tax bureaus (i.e., firms established on January 1, 2002 or beyond).

In light of these findings and key to our identification strategy, we first show that the reform indeed resulted in a higher tax rate paid by firms established on or after January 2002, compared to those established earlier. We accordingly then examine the impact of a higher tax burden on firms' social security contributions, workforce, and wages. The tax reform was overall a sudden change for firms (Li et al., 2018), where the time elapsed between the promulgation (with all the details of the new tax collection procedure) and implementation of the reform was very tight that is relevant for our empirical approach, but we also discuss below potential firms' anticipated behavior and manipulation of their registration time and perform several robustness checks.

3. Theoretical framework

This section presents a simple theoretical framework to formally show how more stringent tax supervision and collection can induce firms to pass on part of the burden to workers through a reduction in labor costs. We focus on social security contributions, workforce size, and wages. When the tax burden increases, firms can transfer part of the burden to their workers by limiting their social security participation and cutting wages, as well as by adjusting their labor demand. We derive three propositions for empirical testing.

3.1 Tax burden, social security participation, and firm profits

Let γ be the statutory social security contribution rate and $\lambda \in [0,1]$ the social security avoidance ratio or proportion of workers for which the firm does not comply with their social security obligations. Hence, for share λ of workers the firm only pays wage w , while for share $1 - \lambda$ of workers the firm pays both wages and social security $(1 + \gamma)w$. If the total number of workers equals L , the firm's labor costs are given by,

$$c_L = \lambda wL + (1 - \lambda)(1 + \gamma)wL.$$

According to the Chinese corporate tax law and social security regulatory framework, social security contributions can be deducted from the firm's taxable income. This implies that firms may not only directly reduce labor costs by not paying social security premiums, but indirectly diminish their income taxes by reducing their taxable income through these deductions.¹⁶ Hence, the book taxes paid by a firm can be expressed as,

$$T_p = \tau \cdot [Af(L) - \gamma wL],$$

where $Af(L)$ is the total output ($f(\cdot)$ is a production function, A is a productivity measure and for simplicity output price is normalized to 1) and τ stands for the statutory income tax rate, while the correct (true) taxes that a firm should pay are given by,

$$T_R = \tau \cdot [Af(L) - (1 - \lambda)\gamma wL].$$

The difference between the true and book taxes is the additional income tax evasion that results from avoiding social security payments,

¹⁶ The basic social insurance premium (pension fund, medical, unemployment, work-related injury, and maternity) can be fully deducted from the taxable income, while insurance premiums for supplementary endowments and medical treatments (e.g., annuities, supplementary medical insurance) can only be partially deducted.

$$b_L = T_R - T_p = \tau\lambda\gamma wL. \quad (1)$$

Equation (1) shows that the extent of tax evasion from not paying social security premiums is naturally increasing in the income tax rate (τ) and the proportion of employees the firm opts to not pay their corresponding social security premiums (λ).

Considering that a firm may also directly underreport revenues for taxing purposes, the firm jointly decides their level of social security avoidance and income tax evasion to maximize the following profit function,

$$\pi = \underbrace{(1 - \tau)[Af(L) - \gamma wL - e]}_{\text{after-tax income}} + \underbrace{e - c(e, \alpha)}_{\text{income from revenue tax evasion}} + \underbrace{b_L - g(\lambda, \beta)wL - c_L}_{\text{income from social security avoidance - labor costs}}, \quad (2)$$

where e represents the amount of revenue that a firm does not report for tax purposes, $c(\cdot)$ and $g(\cdot)$ are the costs of avoiding corporate income taxes and social security contributions, and α and β measure the government's degree of tax and social security supervision and enforcement.

In equation (2), we implicitly assume that the tax authority cannot detect the avoidance of social security contribution of a firm. This setup is generally consistent with the Chinese institutional regulations during the period of analysis, where firms' basic social security contributions were in most locations collected by the social security department (as indicated earlier), while corporate income taxes were collected by tax bureaus.¹⁷ As a result, the deduction of the social security premium is always calculated over a firm's overall payroll wL times the statutory social security contribution rate γ . For the same reason, we assume that α and β are

¹⁷ Even if firms evade their social security payments, the tax bureau did not have the right to inspect and punish them.

uncorrelated, so the enforcement of tax supervision does not affect the cost of avoiding social security.

The costs of avoiding taxes are assumed to increase with the amount or scale of tax evasion, and the larger the extent of evasion the higher the marginal cost of avoiding taxes (see, e.g., Keen and Slemrod, 2017; Basri et al., 2021). Hence, $c(\cdot)$ is a convex function in e such that $\partial c/\partial e > 0$ and $\partial^2 c/\partial e^2 > 0$. Similarly, more stringent government tax supervision and enforcement are expected to increase the difficulties for firms to evade a larger amount of taxes, i.e., $\partial^2 c/\partial e \partial \alpha > 0$. The costs of avoiding social security payments $g(\cdot)$ are, in turn, assumed to be convex in the proportion λ of workers for which the firm does not pay social security premiums, such that $\partial g/\partial \lambda > 0$ and $\partial^2 g/\partial \lambda^2 > 0$.

3.2 Tax enforcement and firms' social security participation

If tax supervision and collection is strengthened, firms will reduce their social security participation to transfer part of the tax burden to workers as well as benefit from a higher income tax evasion. Taking the partial derivative of the profit function defined in equation (2) with respect to the social security avoidance ratio λ and revenue tax avoidance e , we obtain,

$$\frac{\partial \pi}{\partial \lambda} = \tau \gamma wL + \gamma wL - g'_\lambda(\lambda, \beta) wL = 0 \Rightarrow (\tau + 1)\gamma - g'_\lambda(\lambda, \beta) = 0 \quad (3)$$

$$\frac{\partial \pi}{\partial e} = -(1 - \tau) - c'_e(e, \alpha) + 1 = 0 \Rightarrow \tau - c'_e(e, \alpha) = 0. \quad (4)$$

Substituting (4) into (3), we can define,

$$y \equiv [c'_e(e, \alpha) + 1]\gamma - g'_\lambda(\lambda, \beta) = 0.$$

Based on the implicit function theorem,

$$\frac{d\lambda}{d\alpha} = -\frac{\partial y/\partial \alpha}{\partial y/\partial \lambda} = \gamma \frac{c''_{e,\alpha}(e,\alpha)}{g''_{\lambda\lambda}(\lambda,\beta)} > 0. \quad (5)$$

Equation (5) shows that as the degree of government's income tax supervision and enforcement increases, the extent of a firm's social security evasion increases. We can thus establish the following testable proposition,

Proposition 1: More stringent government tax supervision and enforcement will reduce firms' social security participation.

3.3 Tax enforcement and employment

While firms may face the same nominal tax rate, the effective tax rate may vary depending on their scale of operation and production.¹⁸ According to Basri et al. (2021), large-scale firms as larger taxpayers are more closely monitored by centralized tax bureaus and thus face more stringent tax supervision and enforcement than small-scale firms. At the same time, however, local governments tend to protect large-scale firms or offer them tax breaks to promote local economic development, suggesting that local tax bureaus may perform less strict or more flexible tax supervision on large-scale firms.

Given that the tax reform switched income tax collection from local to state tax bureaus, we can assume that the reform further strengthened the tax supervision and enforcement of large-scale firms relative to small-scale firms, i.e., $\alpha'(L) \geq 0$ and $\alpha''(L) \geq 0$. Taking the partial derivative of equation (2) with respect to the number of workers L , we obtain,

$$\frac{\partial \pi}{\partial L} = (1 - \tau)[Af'(L) - \gamma w] + \tau \lambda \gamma w - (1 + \gamma - \lambda \gamma)w - g(\lambda, \beta)w - c'_\alpha(e, \alpha) \cdot \alpha'(L) = 0$$

We can rewrite the above equation as the following function,

¹⁸ See Slemrod (2019) for an extensive review of studies in tax compliance and enforcement.

$$y \equiv (1 - \tau)Af'(L) + [\tau\lambda\gamma - (1 - \tau)\gamma - (1 + \gamma - \lambda\gamma) - g(\lambda, \beta)]w - c'_\alpha(e, \alpha) \cdot \alpha'(L) = 0.$$

According to the implicit function theorem, we can determine the influence of income tax regulatory intensity α on firms' labor demand L^D as,

$$\frac{dL^D}{d\alpha} = -\frac{\frac{\partial y}{\partial \alpha}}{\frac{\partial y}{\partial L}} = \frac{c''_{\alpha, \alpha}(e, \alpha) \cdot \alpha'(L)}{\underbrace{(1-\tau)Af''(L)}_{-} - \underbrace{c''_{\alpha, \alpha}(e, \alpha)[\alpha'(L)]^2}_{+} - \underbrace{c'_{\alpha}(e, \alpha)\alpha''(L)}_{+}} < 0. \quad (6)$$

Equation (6) shows that firm's labor demand is a decreasing function of the degree of corporate income tax supervision, and we can establish the second testable proposition,

Proposition 2: More stringent government tax supervision and enforcement will reduce the number of firm workers.

3.4 Tax enforcement and average wage

Finally, we can assess the relationship between the intensity of income tax regulation and average wages. Following Gruber (1997), we can additionally model labor supply as,

$$L^S = S(w + \theta(1 - \lambda)w\gamma) \quad (7)$$

where $\theta > 0$ captures the extent to which workers care about receiving social security relative to the wage. Equating labor supply and demand and taking the total derivative of both equations we get,

$$dL^S = \frac{dL^S}{dw} dw + \frac{dL^S}{d\alpha} d\alpha = dL^D = \frac{dL^D}{dw} dw + \frac{dL^D}{d\alpha} d\alpha.$$

Letting $\epsilon^S = \frac{dL^S}{dw}$ and $\epsilon^D = \frac{dL^D}{dw}$, we obtain,

$$\epsilon^S \frac{w}{L} \frac{dw}{d\alpha} + \frac{\frac{dL^S}{d\alpha}}{=0} - \epsilon^D \frac{w}{L} \frac{dw}{d\alpha} - \frac{dL^D}{d\alpha} = 0 \Rightarrow \frac{d \ln w}{d\alpha} = \frac{L}{w} \frac{\frac{dL^D}{d\alpha}}{\epsilon^S - \epsilon^D}.$$

Combined with equation (6), we can establish that,

$$\frac{d \ln w}{d\alpha} = \frac{L}{w} \frac{\frac{dL^D}{d\alpha}}{\epsilon^S - \epsilon^D} < 0, \quad (8)$$

which indicates that the stricter the income tax supervision, the lower the equilibrium wage. We can then derive the third testable proposition,

Proposition 3: More stringent government tax supervision and enforcement will lower firm average wages.

Overall, we expect that stricter tax supervision and enforcement from the 2002 tax reform encouraged firms to pass on part of the burden to workers. In particular, a higher tax burden from more severe enforcement induces firms to cut their social security participation to both directly reduce their labor costs and indirectly reduce their taxable income; decrease their number of workers; and lower their wages due to a lower labor demand. We empirically test these propositions in the next section.

4. Empirical approach

4.1 Data

The data used in the study are obtained from the National Tax Survey (NTS) database maintained

by the Ministry of Finance and State Taxation Administration of China, which is a unique and comprehensive dataset designed to better monitor tax base information across the country. The database contains annual survey data from a stratified sample of tax-paying firms across various industries in 22 provinces, four autonomous regions, and four municipalities directly under the central government.¹⁹ The stratification is by industry, total sales, and type of taxpayers.²⁰

The NTS database comprises information on firm's characteristics (including number of employees and financial indicators), performance, wages, tax payments, and social security contributions. Compared to the widely used Chinese Annual Survey of Manufacturing Firms collected by the central government (National Bureau of Statistics), the NTS records more detailed taxes and contributions paid by enterprises, particularly more comprehensive social security contributions that are central to our analysis. As the NTS is supervised by local tax agencies, including potential verification of the data filled in by firms with the information in their tax return files and financial accounts, the NTS can additionally be regarded as less prone to measurement error and misreporting (Liu and Mao, 2019).²¹

We work with annual firm survey data that cover the period 2008 through 2011, as data from previous years are not publicly available.²² The raw dataset comprises 2,845,932 firm-year observations across the four survey waves.²³ We perform several data cleaning procedures for the analysis. First, we exclude foreign and centrally owned firms since they were not covered by the tax reform as their taxes were already being collected by the state tax bureau. Second, we exclude firms from several tertiary industries given the particularity of their activities such as

¹⁹ Taiwan and Tibet are excluded from the survey as well as the two special administrative regions (Hong Kong and Macao).

²⁰ The database includes firms that pay business and value-added taxes and excludes self-employed industrial and commercial households.

²¹ Other studies that have recently used the NTS include Fan and Liu (2020), Chen et al. (2021), and Chen et al. (2021).

²² The data are publicly available from 2007 until 2011, but we exclude 2007 as it lacks relevant tax information for our analysis.

²³ It is worth noting that the NTS does not follow a panel sampling strategy, but a portion of these observations may correspond to the same firm observed in more than one wave although several of the firms are only observed once. We accordingly implement, as discussed later, a repeated cross-section approach with industry, city, and year fixed effects.

social organizations, construction, electricity, gas, and water services, financial services, and public administration. Third, we drop enterprises classified as small-scale taxpayers in the NTS database who are not much supervised by the tax bureau and were extensively benefited by other tax policies (e.g., value-added tax (VAT) exemptions and preferential income taxes) to support the development of small and micro enterprises during the period of study.²⁴ Fourth, we drop firms that do not report key variables such as ownership type, financial indicators, and taxes. Fifth, we limit the analysis to firms that started their operations within four years before and after the implementation of the tax reform (i.e., between 1998 and 2006) to assure a reasonable (and symmetric) window of time for firm entry around the policy reform.²⁵ Lastly, to account for likely outlier values we trim the data by removing observations with financial indicator values on the top and bottom 2% of their respective distributions.²⁶ Our final working sample comprises 615,340 observations.

The outcome variables of interest include an indicator variable for basic social security contributions greater than zero (if social security contributions); social security compliance rate equivalent to the basic social security contribution rate over the statutory contribution rate in the corresponding province (compliance rate);²⁷ an indicator variable for supplementary social security contributions greater than zero (if supplementary contributions); annual average number of employees (labor), and annual average wages (wage).

The other key variable is the effective income tax rate defined following Cai and Liu (2009) as the corporate income tax paid to profit ratio (effective tax rate) and is set to zero for loss-

²⁴ We obtain similar results, however, if we do not drop these enterprises.

²⁵ We alternatively considered a window of two and six years around the reform (i.e., firms that started operations, respectively, between 2000 and 2004 and between 1996 and 2008) and find qualitatively similar results.

²⁶ The results are not sensitive to alternatively removing observations from the top and bottom 1% or 3% of the distributions.

²⁷ The statutory contribution rate is typically regulated by the provincial government. While the mandatory retirement contribution rate may vary across provinces (between 14% and 20% in 2008), the legal contribution rates for the other basic insurance programs is generally standard and equal to 8-10% for medical treatment, 1-2.5% for unemployment, 1-3.3% for work-related injury, and 0.8-2% for maternity.

making firms.²⁸ We focus on corporate income taxes as their collection changed from local to state tax bureaus with the reform. The profit in the denominator corresponds to the reported total profit equal to operating profit plus non-operating revenue minus non-operating expenditures. We similarly considered using an alternative imputed profit measure proposed by Cai and Liu (2009), defined as total revenue minus wages, intermediate inputs, financial charges, amount of currency depreciation, and value added taxes, but the correlation between this measure and reported profits is close to 0.7 (both before and after the tax reform) and the estimation results are not sensitive to using the imputed measure. The high correlation between the measures also points to relatively accurate firm reporting given the nature of the survey (as noted earlier), although we still discuss below whether the tax reform affected firms' profit reporting.

Regarding the financial indicators used as control variables, these include total fixed assets; debt to asset ratio defined as total debts over total assets (leverage ratio) that capture the level of financial constraint; operating margin defined as the ratio of operating profit to revenue (profit rate);²⁹ and current assets, such as cash and inventories, over total assets (current asset ratio) that measure the degree of asset liquidity.

Table 1 reports summary statistics of the key variables used in the analysis distinguishing by firms established before and after the tax reform. Roughly two of every three observations in our working sample correspond to firms established in January 2002 or later. The average social security participation rate is 69% and the compliance rate is 36%, which reveals a generally low level of compliance. We observe differences across firms established before and after the reform, both in the extensive margin (participation in social security contributions) and intensive margin (extent of contributions). The participation and compliance rates are 73% and 41% among firms established earlier versus 66% and 33% among those established later. The differences persist regarding participation in supplementary social security contributions (31% versus 25%). Firms

²⁸ Roughly 5% of our sample report negative profits and the results are not affected if these cases are not imputed a zero effective tax rate.

²⁹ For instances where revenue is not reported (4% of cases), we use instead total output value.

established after the tax reform similarly exhibit a smaller number of employees and the average wages are marginally lower. The average effective income tax rate is equal to 15.8% and firms established after the reform show a higher effective tax rate (16.2%) than firms established before the reform (15.2%).

As mentioned earlier, the large evasion of social security contributions could be explained by several reasons, including the high contribution burden and less efficient monitoring and enforcement mechanisms of the social security department (compared to the tax authorities) who directly collected these contributions in several provinces during our period of study.³⁰ The observed income tax rate, however, is also below China's statutory rate of 25%, which deserves some discussion. While this points to some degree of tax evasion (at the risk of being punished by tax authorities), there are other explanations such as specific tax preferential policies enjoyed by certain firms, policy misunderstanding, and 'reasonable tax avoidance' where firms take advantage of loopholes and ambiguities in tax laws together with unclear accounting regulations. Firms can additionally self-correct and pay back the taxes owed prior to a tax audit, which are typically performed with a lag of one to two years after tax payment and are not necessarily performed across all firms suspected of tax evasion.³¹

Regarding the financial measures, we do not observe major differences across most indicators between firms established before or after the tax reform. Our sample is composed of firms with fixed assets of around 5.7 million RMB (0.9 million US dollars). The average debt to asset ratio is 0.67, while the current over total assets ratio is 0.77, which reveal a relatively high level of financial constraint combined with a high degree of asset liquidity. The operating margin is, in turn, slightly negative, equal to -0.03.

Similarly, more than half of the observations in our sample correspond to manufacturing firms, 12% to exporter firms, and over 96% to privately owned firms and limited liability

³⁰ In Section 5, we explore varying firm behavior by type of collection agency based on firms' location.

³¹ The penalties imposed by tax authorities could also be reduced due to political or economic considerations.

companies.³² In China, privately owned firms are profit-making businesses owned (and controlled) by natural persons, while limited liability companies are businesses funded by less than 50 private shareholders where each shareholder bears limited liability to the company based on their contributions. The other two ownership types in our working sample are collective enterprises (2.1%) that are nominally owned by people residing in the area where the enterprise is located but controlled by the local government, and state-owned enterprises (1.5%).

4.2 Methodology

Considering that the tax reform resulted in more stringent tax enforcement for firms established after January 2002, we can use a regression discontinuity (RD) design to assess whether a higher tax burden encourages firms to pass on part of the burden to workers. The key underlying assumption is that firms established around the tax reform (before versus after) should only differ, on average, on the corporate tax rate faced while remaining comparable across other potential determinants of labor costs. Setting January 2002 as the cutoff point, we can define the following indicator variable,

$$D_i = \begin{cases} 1 & Z_i \geq 0 \\ 0 & Z_i < 0 \end{cases} \quad (9)$$

where Z_i is the assignment variable that captures firm's i birth month normalized to zero at January 2002; e.g., $Z_i = 14$ for a firm established in March 2003 and $Z_i = -10$ for a firm established in March 2001. The indicator variable D_i thus takes the value of one for firms established after the tax reform, and zero otherwise.

We follow a fuzzy RD estimation as the tax reform did not necessarily cover all targeted firms. As shown in Figure 1, there is an important jump at the cutoff point in the share of sample

³² It is worth noting that while China became a member of the World Trade Organization (WTO) in late 2001, the share of observations in our data corresponding to exporting firms is similar for enterprises established before and after 2002.

observations where the income tax is collected by the state tax bureau but there is not necessarily full compliance (i.e., the assignment rule is not deterministic). We observe state income tax collection in more than 87% of the cases among firms established after the reform versus 13% among firms established prior to the reform. The imperfect post-reform compliance is mainly explained by firms' mergers as well as firms restructuring and splits that resulted in the establishment of new enterprises while the income tax remained collected by the local tax bureau; we cannot, however, disentangle all these cases in our dataset due to lack of more detailed information. Likewise, income taxes of certain firms, especially limited liability companies enrolled in special government programs, were already being collected by the state tax bureau prior to the reform.

The discontinuity in the probability of income tax collection and enforcement by the state tax bureau can be used as an instrumental variable to identify the impact of corporate taxes on firms' labor cost decisions. In particular, we estimate the following two-stage least squares (2SLS) regression,

$$Taxrate_{ihct} = \beta_0 + \beta_1 D_i + f(Z_i, D_i) + \beta_2 X_{ihct} + \delta_h + \theta_c + \tau_t + \mu_{ihct} \quad (10)$$

$$y_{ihct} = \alpha_0 + \alpha_1 \widehat{Taxrate}_{ihct} + f(Z_i, D_i) + \alpha_3 X_{ihct} + \delta_h + \theta_c + \tau_t + \mu_{ihct} \quad (11)$$

where $Taxrate_{ihct}$ is the effective income tax rate of firm i in industry h located in city c at time t , which is instrumented by indicator variable D_i that identifies firms established after the reform; $f(Z_i, D_i)$ is the polynomial function of the assignment or running variable Z_i (birth month) and indicator variable D_i ; X_{ihct} is a vector of firm control variables including fixed assets, debt to asset ratio, operating margin, ratio of current to fixed assets, if the firm exports, and type of firm ownership; δ_h , θ_c , and τ_t denote industry, city, and time fixed effects, respectively; and μ_{ihct} is a white noise error term.³³ In equation (11), the outcome variable

³³ The regressions also include city and time interactions terms.

y_{ihtc} measures firm labor cost decisions, including basic social security contributions (participation and contribution rate), supplementary contributions, employment, and average wages; and $\widehat{Taxrate}_{ihtc}$ is the fitted value of the income tax rate that result from estimating equation (10) in the first stage.

4.2.1 Identification

A central aspect to the validity of the proposed RD approach (in identifying the effect of a higher tax burden on firms' labor cost decisions) consists in first assessing whether there is a discontinuity in the tax rate among firms established before versus after the tax reform; that is, whether the policy effectively changed firms' income tax rate. Figure 2 plots the effective tax rate paid by firms established before and after 2002 where the firm birth month is normalized to zero at January 2002. We observe a significant jump in the tax rate around the policy cutoff of about 1.7 percentage points (equivalent to a 11.2% increase in the tax rate as the average tax rate before the reform was 15.2%), providing evidence of a positive impact of the tax collection reform on corporate income taxes.³⁴ In contrast, we do not find a similar jump among foreign and centrally owned firms (as depicted in Appendix Figure A.1) who were not supposed to be affected by the tax reform, which offers additional support that the observed discontinuity in the tax rate among firms in our sample is driven by the tax reform and not by other policy.³⁵

In the same vein, Table 2 reports the estimation results of equation (10) that quantifies the impact of the tax reform on firms' income tax burden. We consider windows of 20, 30, and 40 months for firms established before and after the reform as well as window of 14 months derived following the Calonico et al. (2014a, 2014b) procedure. The first four columns present the results

³⁴ Note that there is not a clear relationship between firm age and the effective tax rate. We observe a sort of inverted-u relationship among firms established prior to 2002 and a positive correlation among firms established after 2002 (i.e., older firms pay similar or higher taxes than younger firms). This helps to discard the possibility that the results reported below could be simply driven by firm age (in the sense that older firms have more experience dealing with tax authorities and generally pay less taxes), instead of the tax reform.

³⁵ The point estimate for foreign and centrally owned firms is 0.6 percentage points and it is not statistically significant at conventional levels.

assuming a quadratic polynomial function for the assignment and indicator variable $f(Z_i, D_i)$,³⁶ while the last four columns present bias-corrected estimates assuming a fully nonparametric polynomial function (Calonico et al., 2019). All standard errors are clustered to firm birth month. The robust bias-corrected estimates (our preferred specification) for the different bandwidths considered, indicate a 1.6-1.7 percentage points (pp) higher tax rate among firms established after January 2002 versus those established earlier (equivalent to a 10.5-11.2% increase in the effective tax rate). Overall, this positive and non-negligible increase in the tax rate after the reform supports our identification strategy and is consistent with the findings of several previous studies (discussed earlier) that use an alternative data source.

A second identifying assumption in the proposed RD design is that firms should not be able to precisely manipulate the assignment (running) variable Z_i (McCrary, 2008; Lee and Lemieux, 2010). This implies checking that firms did not anticipate the policy change and selectively advanced their registration date, which could bias our estimation results. In principle, as indicated earlier, we should not expect major anticipatory behavior as the time passed between the promulgation of the tax reform and the implementation was very tight. Similarly, around the time of the reform it took about 46 business days to start up a business in China (The World Bank, 2004), so even enterprises with information advantages (if any) would have needed to incur in very high adjustment costs to start their operations about one to two months in advance (Xu et al., 2019).

In practice, we formally test for the continuity of the density of the firm birth month following Cattaneo et al. (2018, 2020). The local-polynomial density plot reported in the upper panel of Appendix Figure A.2 indicates no discontinuity in the running variable at the breakpoint of the policy implementation (the resulting T statistic for the optimal bandwidth of 24 is -0.14 with a p-value of 0.89). While this result supports no specific manipulation in firm entry around the tax reform (January 2002), the lower panel of the figure shows that the number of firm

³⁶ The results using a linear polynomial function are though very similar to assuming a quadratic function.

startups typically decreases at the beginning of each year, as New Year's holidays and Spring Festival (between late January and mid-February) generally encourage firms to avoid starting operations at the beginning of the year to prevent likely labor shortages (Li et al., 2018). We still implement in the next section an alternative interval estimation approach that accounts for the potential endogeneity of the running variable.

Another underlying assumption is that firms that started operations close to the tax reform should be roughly comparable to those that started after, i.e., there should not be discontinuities in the covariates used in our setup to model the impact of the shift in the tax rate on labor cost decisions (Lee and Lemieux, 2010). It is thus relevant to assess the continuity (smoothness) of the control variables used in our setup around the policy cutoff. Appendix Figure A.3 plots the firms' fixed assets (in natural logarithm), leverage ratio, operating margin, and current to total asset ratio by firm birth month. Except for fixed assets, we do not observe major discontinuities around the tax reform cutoff in the other three covariates included in the regression analysis.³⁷ We evaluate below the sensitivity of our main results to not controlling for covariates.

Additionally, since the denominator in the tax rate measure is reported profits and changes in tax enforcement may also affect profit misreporting (if any), we checked whether the profits' reporting pattern changed after the tax reform. If, for example, a stronger tax enforcement encourages firms to report less profits, the observed positive variation in the effective tax rate could be driven by lower profits reported rather than a higher tax burden that is central to our analysis. However, as shown in Appendix Figure A.4 and Table A.2, we observe that firms established after the reform report rather higher profits compared to firms established earlier, although the difference is not statistically significant at conventional levels. We find similar results using both reported profits as well as the alternative imputed profit measure derived in

³⁷ Appendix Table A.1 reports the corresponding breakpoint estimates and confirms that the discontinuity in fixed assets is statistically significant; there is similarly a marginal discontinuity in the current to total asset ratio although it is not always statistically significant for the modeled bandwidths. Appendix Figure A.3 also points to a seemingly positive correlation between firm age and firm size (as proxied by fixed assets) that could be worrisome if the effective tax rate is similarly negatively associated with firm age, which is not the case as noted earlier.

Cai and Liu (2009). Hence, the reform does not appear to have changed firms' profit reporting behavior and even if it did, the effect operates opposite to the observed change in the tax burden.

We similarly recognize that using 2008-2011 firm survey data to compare the behavior of alike firms established before versus after the 2002 tax reform certainly has some implications for the interpretation of the results that are worth remarking on. The most obvious implication is that our estimates are capturing mid- and long-term behaviors (effects), as opposed to short-term effects, of a higher tax burden on firms' pass through decisions on their workers. In the same line, the analysis is based on data from enterprises operating several years after the reform such that we are excluding potential impacts on firms that closed during the initial years after the reform. Despite we do not observe major differences in the number of startups before and after the reform in our data, it is reasonable to believe that firms that eventually closed faced different kinds of economic or financial difficulties prior to closing and were potentially more prone to adjust their social security compliance and labor decisions with a higher effective tax rate (all else equal); hence, our estimates could be underestimating the pass through effects of a higher tax burden. We return to this discussion later using an alternative, although less detailed, dataset.

Relatedly, our results could be affected by other tax policies that occurred after the 2002 reform. We are unaware, however, of other major subsequent policies that could have differentially affected firms established before versus after the reform in our working sample. The only relevant policy we were able to identify is the value-added tax (VAT) relief program that started in 2004 in a few provinces and was later extended nationwide, but this program targeted all firms regardless of their starting date. We nonetheless examine in the next section the robustness of our results to excluding the provinces of the pilot VAT program, as the period when this pilot was implemented is part of the four-year window for the start of firms' operations (around the tax reform) that we are considering for the analysis.

5. Results

We now turn to our estimation results. We first present and discuss our base results regarding the association between a higher income tax burden and firms' labor cost decisions, including social security compliance, employment, and wages. We then assess the sensitivity of our results and perform several robustness checks and additional estimations. Finally, we examine heterogeneous behaviors by firm ownership type and size and by the type of agency collecting social security contributions.

5.1 Income tax burden and labor cost decisions

Figure 3 provides graphical evidence on the association between the tax reform and labor cost decisions. The figure shows the RD plots of firms' participation in basic social security contributions, compliance rate, participation in supplementary contributions, number of employees (in natural logarithm), and wages (in natural logarithm) against firm birth month. We observe a discrete decrease across all five outcomes at the time of the tax reform, which mirrors the increase in the effective tax rate reported in Figure 2. These findings offer preliminary support that the policy reform, which resulted in a higher tax burden, encouraged firms to reduce their labor costs by cutting their social security participation and contributions, downsize, and lower wages.

Table 3 reports the corresponding 2SLS estimation results of equation (11), where we formally assess the impact of the tax reform on the five outcomes of interest. Panel A reports conventional (robust) estimates assuming a quadratic polynomial function for the assignment and indicator variable $f(Z_i, D_i)$ and using the resulting optimal bandwidth for each modeled outcome, while Panels B through D report bias-corrected estimates assuming a fully nonparametric polynomial function and using the optimal and nearby bandwidths. We find that the negative impact of the effective tax rate on the five outcomes is generally statistically significant across all specifications and bandwidths. Based on the bias-corrected estimates reported in Panel B, an increase in the tax rate by one percentage point (0.01) is associated with a

0.8% decrease in the probability of making basic social security contributions, 1.4 percentage points lower compliance rate, and 0.6% decrease in the probability of making supplementary contributions. Similarly, a one percentage point increase in the tax rate is correlated with a 4.4% decrease in the number of employees and 0.7% decrease in wages. Considering that a one percentage point increase in the tax rate is on average equivalent to a 6.3% rate increase, the resulting pass through tax elasticities are -0.13 for performing basic social security contributions, -0.61 for complying with all basic contributions, -0.09 for performing supplementary contributions, -0.7 for number of workers, and -0.11 for wages. The estimates for wages and employment are roughly in the range of those estimated in earlier studies, which have been extensively documented across different settings (e.g., Arulampalam et al., 2012; Liu and Altshuler, 2013; Azemar and Hubbard, 2015; Suarez Serrato and Zidar, 2016; Chen et al., 2018; Fuest et al., 2018).

The results are not very sensitive to restricting nor to expanding the window around the optimal window width, as reported in Panels C and D of Table 3. Based on these alternative windows, the probability of providing basic social security contributions is estimated to decrease by 0.8-0.9% after a one percentage point increase in the tax rate; the compliance rate by 1.1-1.3 percentage points; the probability of providing supplementary contributions by 0.5%; the number of workers by 3.1-3.8%; and wages by 0.7-0.8%. In sum, these findings provide support for Propositions 1, 2, and 3 above in that a higher tax enforcement (burden) will push firms to pass on the burden to workers by reducing their social security contributions, downsizing, and lowering wages.

5.2 Robustness checks

Next, we perform several robustness checks and additional estimations to assess the sensitivity and validity of our results in identifying the impacts of a higher tax burden on firms' labor cost decisions. These include performing standard placebo tests; excluding covariates; evaluating the

possible influence of other tax programs during the period of analysis; implementing an alternative (bound) estimation to account for the possible endogeneity (manipulation) of the running variable; and using another dataset to explore potentially more immediate impacts of the reform.

5.2.1 Placebo tests

We implement two standard placebo tests to evaluate the robustness of our estimations. First, we estimate the impact of the tax reform among a pseudo treatment group composed of foreign and centrally owned firms who should not have been affected by the reform since their taxes were already being collected by the State Taxation Administration. As shown earlier, we do not observe a break in the effective tax rate of these firms around the tax reform (see Appendix Figure A.1) and we should similarly do not expect a change in their labor cost decisions. Panel A of Appendix Table A.3 reports the pseudo treatment effects of the reform on the five outcomes of interest that result from estimating equation (11) for foreign and centrally owned firms. We do not find statistically significant effects on social security contributions, number of workers, and wages, which provide additional support to our empirical approach.³⁸

Second, we consider pseudo treatment periods by assuming that the tax reform was implemented in October 2001, July 2001, and January 2001 (instead of January 2002), such that we should expect no impacts in our working sample. Panels B through D of Appendix Table A.3 show that the corresponding pseudo treatment effects across the five outcomes of interest are generally not statistically significant, which point to no anticipatory reform effects neither seasonal effects or other temporal factors affecting our results.

³⁸ We alternatively estimated a simple differences-in-differences (DID) model comparing the outcomes of all firms included in our working sample (treatment group) versus foreign and centrally owned firms (control group), born before and after 2002. Appendix Table A.4 reports the corresponding DID estimators for each modeled outcome that show a statistically significant decline in social security contributions, number of workers, and wages among the treated firms with respect to the control group. The estimated impacts (declines) are 2.8 percentage points on making basic contributions, 3.1 percentage points on the compliance rate, 1.5 percentage points on making supplementary contributions, 5.6% on number of workers, and 1.9% on wages.

5.2.2 Excluding covariates

We assess the sensitivity of our results to excluding covariates from the estimation as these controls are measured after the tax reform and not all the covariates included in the analysis are necessarily continuous at the policy cutoff, which could potentially invalidate their use if the higher effective tax rate affected them directly. Appendix Table A.5 reports the estimation results without controlling for firms' fixed assets, leverage ratio, operating margin, and current to total asset ratio. We find that the results are all in the same direction as our base estimations. An increase in the tax rate by one percentage point is correlated with a 0.8% decrease in the probability of making basic social security contributions, 1.7 percentage points lower compliance rate, 1% decrease in the probability of making supplementary contributions, 7% decrease in the number of employees, and 1.3% decrease in wages.

5.2.3 Potential influence of value-added tax (VAT) relief program

Given that after the national tax collection reform the government implemented in 2004 a pilot relief reform for value-added taxes (VAT) that covered three provinces in the Northeast of China, it is worth exploring whether this additional tax program could be affecting our results.³⁹

Appendix Table A.6 shows the estimation results after excluding all firms located in the pilot provinces that were affected by the VAT reform. In this case, we find that a one percentage point increase in the effective tax rate is associated with a 0.8% decrease in the likelihood of making basic social security contributions, 1.6 percentage points lower compliance rate, 0.7% decrease in the likelihood of making supplementary contributions, 5% decrease in the number of

³⁹ The 2004 pilot was implemented in the provinces of Heilong Jiang, Jilin, and Liaoning and is known as *the Several Opinions on the Implementation of the Revitalization Strategy of Northeast China and Other Old Industrial Bases*. In 2007, a wide range of additional VAT adjustments were implemented known as the *Several Opinions of the CPC Central Committee and the State Council on Promoting the Rise of the Central Region*; this latter reform, however, occurred beyond our time window considered for the establishment of firms (i.e., up to 48 months after the 2002 reform) and was implemented across the whole country. In 2008, the Enterprise Income Tax Law (EITL) also became effective nationwide to level the tax rate between foreign-owned and domestic enterprises; for foreign firms, which are not part of our working sample, the new rate was phased over a five-year period.

employees, and 0.8% decrease in wages. The estimated magnitudes are close to our base results.

5.2.4 Interval estimation accounting for potential endogeneity of running variable

While we do not find evidence of manipulation of firm entry around the tax reform, we implement an alternative interval estimation method that relaxes the continuity assumption of the driving variable at the breakpoint and estimates an upper and lower bound of the estimated effect of the tax reform on firms' labor cost decisions. According to Gerard et al. (2020), we can fit density functions $f_Z(0^-)$ and $f_Z(0^+)$ of the driving variable on both sides of the breakpoint to approximate a manipulated degree $\tau = 1 - \frac{f_Z(0^+)}{f_Z(0^-)}$ of the driving variable, i.e., a probability that enterprises manipulate their entry point (prior to the reform). Based on this estimated coefficient τ , which is equal to 0.167 in our working sample, we can then derive an upper (Γ^U) and lower (Γ^L) bound of the average tax reform effect at the breakpoint on the different outcomes of interest (y) as follows,

$$\begin{aligned}\Gamma^U &\equiv \int y dF_1^U(y) - \int y dF_0^L(y) \\ \Gamma^L &\equiv \int y dF_1^L(y) - \int y dF_0^U(y)\end{aligned}$$

where the upper $F_d^U(y)$ and lower bound $F_d^L(y)$ of the distribution function of outcome variable y in the treatment ($d=1$) and comparison ($d=0$) group can be obtained by fitting the density functions on both sides of the breakpoint.

Appendix Table A.7 presents the interval estimation results following this approach as well as the point estimation effect assuming no enterprise startup manipulation (i.e., $\tau=0$). The results relying on this alternative estimation method support the negative association between the income tax burden faced by firms and their social security contributions, labor size, and wages. A one percentage point increase in the effective tax rate results in a 0.9-5% decrease in the probability of making basic social security contributions, lower compliance rate of 0.7-3.8 percentage points, 0.7-2.3% decrease in the probability of making supplementary contributions, 3.9-7.2% decrease in labor size, and 2.1-7.3%% decrease in wages. The point estimates suggest

larger effects than our base estimates for participation in basic and supplementary social security contributions and wages and rather similar effects for the compliance rate and number of employees. The estimations are though not necessarily directly comparable as the interval estimation method requires selecting multiple bandwidths for the density estimation, local polynomial estimation of conditional means, and discontinuity, as well as establishing a range of values to evaluate the estimated cumulative distribution functions.

5.2.5 Using an alternative dataset

Lastly, we examine effects of the tax reform on workers using the Chinese Annual Survey of Manufacturing Firms for the period 2002-2007. Although this dataset permits us to explore more immediate (short-term) reform impacts, it only provides self-reports for certain basic social security contributions (pension fund, medical, and unemployment) and presents several missing values, as opposed to the NTS database that is much more complete on this regard. With these caveats in mind, Appendix Table A.8 shows the corresponding estimation results for these modeled contributions as well as for number of employees and wages. A one percentage point increase in the effective tax rate is associated with a 6% decrease in the likelihood of making pension fund, medical or unemployment contributions, 2.9 percentage points lower compliance rate (defined in this case as the sum of pension fund, medical, and unemployment reported contributions over firms' total wages), 33.5% decrease in labor size, and 3.9% decrease in wages. These magnitudes are considerably larger than our base results using the NTS for the period 2008-2011 (including when restricting our working sample to only manufacturing firms),⁴⁰ and could be regarded in line with the argument discussed above that our base estimates could be an underestimate of the overall pass through effects, but we still should interpret these findings with caution given the limitations of

⁴⁰ When limiting our sample to manufacturing enterprises, we find a bit higher effects than those reported in Table 3 (Panel B) for most outcomes. A one percentage point increase in the effective tax rate is correlated with a 0.8% decrease in the probability of making basic social security contributions, 1.5 percentage points lower compliance rate, 1% decrease in the probability of making supplementary contributions, 6.6% decrease in the number of employees, and 1.2% decrease in wages.

these alternative data.

5.3. Heterogeneity analysis

In this section, we examine heterogeneous effects of the higher tax burden on social security participation, labor size, and wages by type of firm ownership and size and by type of agency collecting basic social security contributions.

5.3.1 Firm ownership

Table 4 reports the estimation results when distinguishing by type of firm ownership: privately owned firm (Panel A), limited liability company (Panel B), collective enterprise (Panel C), and state-owned enterprise (Panel D). The results show that limited liability companies are, in general, more able to adjust their social security contributions, workforce, and wages with a higher tax burden, followed by privately owned firms. Among the former group of firms, a one percentage point increase in the effective tax rate is correlated with a 0.6% decrease in the probability of making basic social security contributions, 1.6 percentage points lower compliance rate, 0.6% decrease in the probability of making supplementary contributions, 4.4% decrease in the number of employees, and 0.8% decrease in wages, while among the latter group of firms the corresponding figures are 0.7%, one percentage point, 0.2%, 5%, and 0.2%, although not all estimates are statistically significant. Collective and state-owned enterprises, in turn, do not show any significant adjustments; for these enterprises, particularly state-owned enterprises, with a more rigid workforce allocation and less flexible payrolls and labor benefits (Liu and Song, 2001; Xue and Bai, 2008), it is certainly more difficult to pass on the burden to workers through lower social security contributions, layoffs, and wages, although we recognize that the precision of the estimates (and very high standard errors) for these firms could be affected by their much fewer observations in our sample.

5.3.2 Firm size

Table 5 reports the estimation results when distinguishing by firm size. We divide the sample into two groups: firms with total assets of less than or equal to 8.2 million RMB (equivalent to the median value of total assets in our working sample) that we label as small firms (Panel A) and firms of more than 8.2 million RMB in total assets that we label as large firms (Panel B). We find differentiated results by firm size. While smaller firms seem to only adjust their social security contributions when faced with a higher tax burden, larger firms both adjust their social security contributions (except their participation in basic contributions) as well as their number of workers and wages. The adjustment in the compliance rate and supplementary contributions is also higher among larger than smaller firms (1.4 percentage points and 0.6% decrease, respectively, after a one percentage point increase in the effective tax rate versus one percentage point and 0.5% decrease). A one percentage point increase in the tax rate is similarly associated with a 4.2% workforce decrease and 1.2% lower wages among larger firms.

Despite smaller firms are probably less scrutinized and monitored by government authorities, which could explain why then can effectively adjust their participation in basic social security contributions, larger firms have a more flexible workforce structure and production process that could allow them to more easily adjust their number of employees and wages and part of their contributions (including supplementary contributions) to cope with the higher tax burden. The results, however, may also be affected by the fact that our analysis excludes firms that closed in the initial years after the reform and if smaller firms are more likely to close than larger firms, we are not capturing potentially more drastic adjustments on workforce and wages among a larger share of smaller firms that eventually closed.

5.3.3 Type of agency collecting social security contributions

In Table 6, we distinguish between provinces where basic social security contributions are directly collected by the social security department (Panel A), which roughly represent two thirds

of the observations in our sample, and by the tax bureau (Panel B).⁴¹ While the social security department may have more comprehensive knowledge about firms' expected contributions, the tax bureau has more detailed information about enterprises and their required tax payments and wages, combined with a more efficient collection system, likely making it more difficult for firms to avoid their social security contributions (Liu, 2011; Shen et al., 2020; Tang and Feng, 2021). In addition, contributions directly collected by tax authorities are treated as a mandatory 'quasi-tax' making them less prone to evasion. We effectively observe that firms located in provinces where social security contributions are collected by the tax bureau will only pass on part of the higher tax burden through a lower basic social security compliance rate, while firms in provinces where the contributions are directly collected by the social security department will significantly adjust all their social security contributions plus their workforce and wages.

6. Concluding Remarks

Corporate taxes are an important revenue source for governments in many developing regions but may also influence firms' labor decisions, including not only workforce allocation and wages but social security contributions that provide valuable social insurance protection for workers and are the foundation of retirement income. This paper pays special attention to this additional impact channel of a higher corporate tax burden on social security contributions that has been less documented in the literature. We develop a theoretical framework and exploit the 2002 national tax reform in China, which provided an exogenous change in the corporate tax burden, to examine the extent to which firms pass through income taxes to workers in terms of extensive and intensive participation in the social security system as well as number of employees and wages. The results show that an increase in the effective tax rate is associated with a lower probability of making basic and supplementary social security contributions, compliance rate,

⁴¹ By the end of the sample year (2011), there were eleven provinces where the tax bureau collected social security contributions (Guangdong, Gansu, Shaanxi, Liaoning, Heilongjiang, Hainan, Qinghai, Fujian, Hunan, Hebei, and Ningxia).

labor size, and wages. The pass-through effects are stronger among firms privately owned and controlled, large businesses, and in locations where social security contributions are directly collected by the social security administration.

Overall, the results indicate that workers not only bear part of the higher corporate taxes faced by firms in terms of employment and wages as found in several previous studies, but an increase in the tax burden contributes to social security evasion in the extensive and intensive margin. These findings have important policy implications in a context of already high labor market irregularities and informality, which is the case of several developing countries besides China. Eventual tax reform policies should consider these additional and nonnegligible welfare effects on workers when evaluating modifying the tax rate or strengthening the enforcement to increase the tax revenue. Since 2008, for example, China's income tax preferential policies for small and micro enterprises (excluded from this study) have played a positive role in promoting employment, stimulating wages, protecting workers' rights, and improving social security participation without much sacrificing tax revenues, which could be evaluated to be expanded to larger firms.

Finally, we acknowledge that since the study relies on a quasi-experimental approach, we cannot fully discard potential unobservable factors not accounted for that could be influencing our results, although we are not aware of other major policies, programs, or confounding factors during the period of analysis that could be affecting our estimates. Using firm data for several years after the tax reform to compare the behavior of similar firms established before versus after the reform, as detailed earlier data is unfortunately limited, certainly requires interpreting the results accordingly and with some caution. Future work should attempt to formally quantify the total costs and benefits of having more stringent versus flexible corporate tax policies, including aggregate revenue and welfare effects, that could be complex in a setting of high informality such as the Chinese economy.

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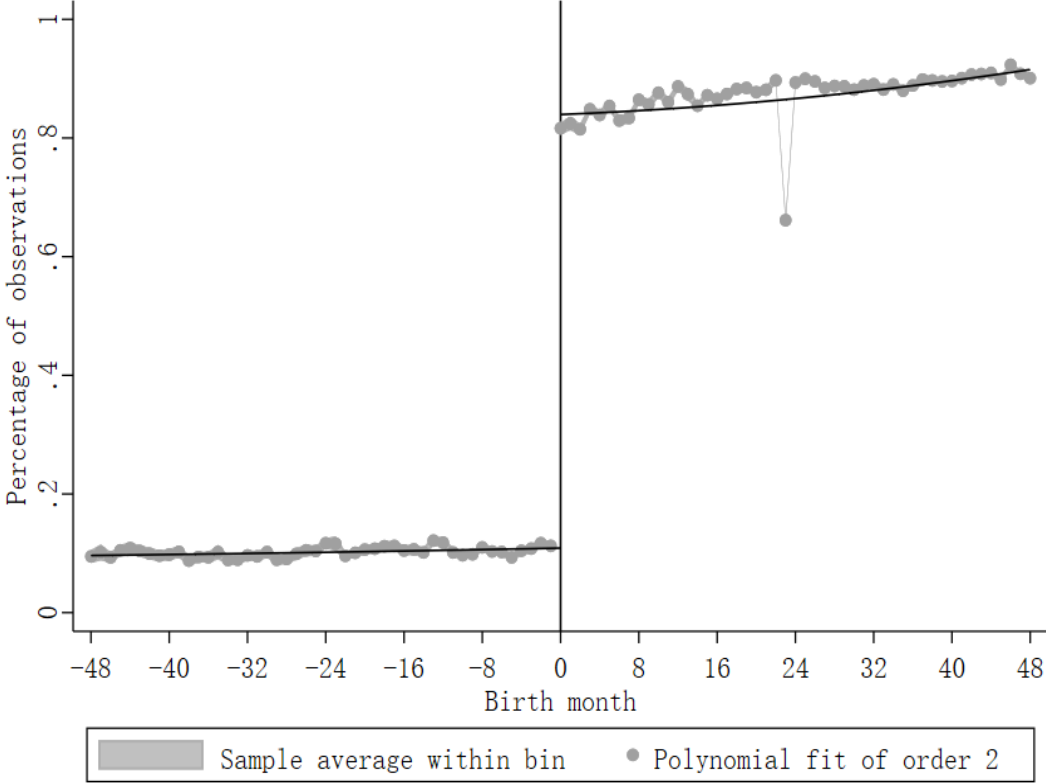
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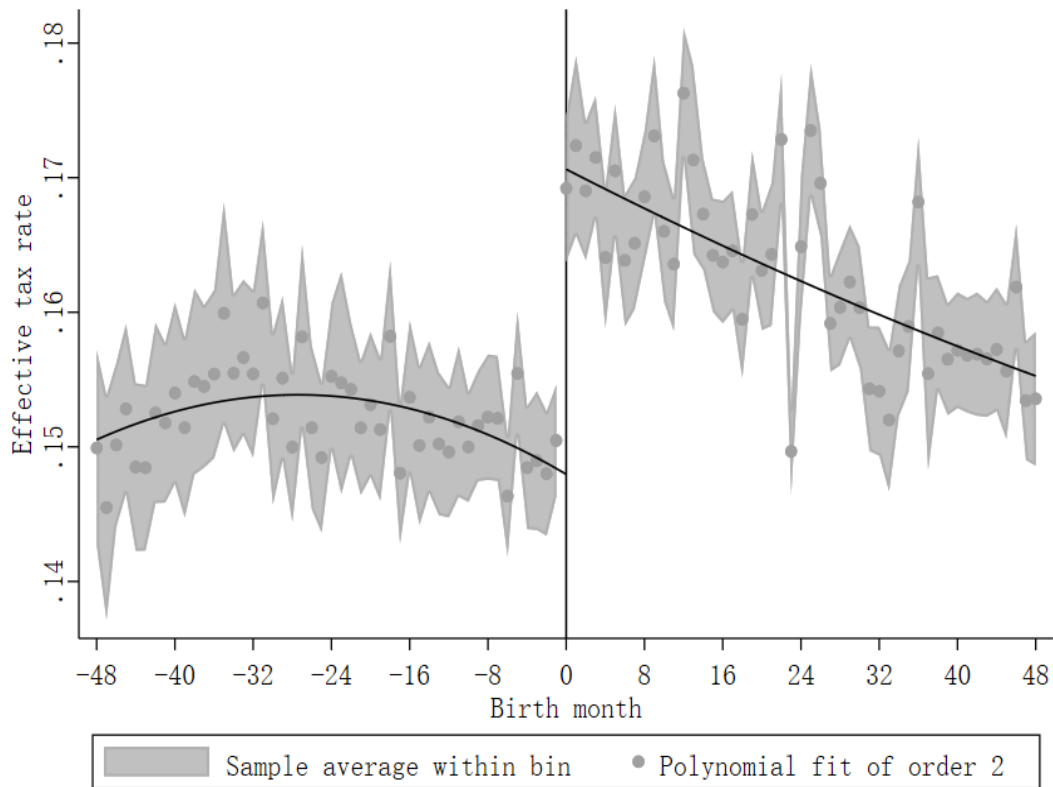
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Figure 1. State tax bureau income tax collection by firm birth month



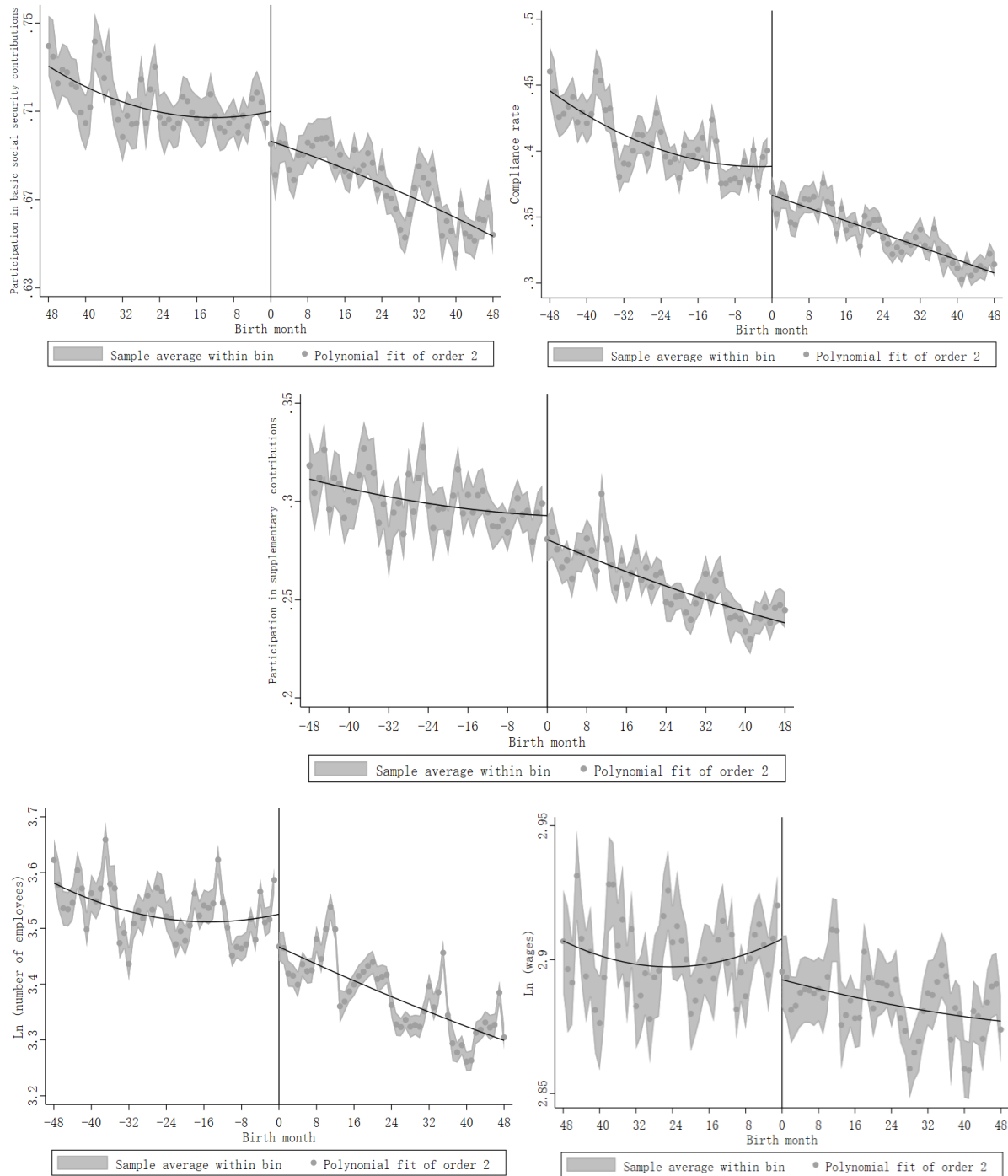
Note: The data-driven regression discontinuity plot is derived following Calonico et al. (2014b, 2015). The fitting line is a quadratic polynomial fitting, and the vertical line represents the cutoff point when the income tax reform was implemented. The birth month is normalized to zero at January 2002. Number of observations = 615,340.

Figure 2. Effective income tax rate by firm birth month



Note: The data-driven regression discontinuity plot is derived following Calonico et al. (2014b, 2015). The fitting line is a quadratic polynomial fitting, and the vertical line represents the cutoff point when the income tax reform was implemented. The grey area represents the 95% confidence interval. The birth month is normalized to zero at January 2002. Number of observations = 615,340.

Figure 3. Social security participation, number of employees, and wages by firm birth month



Note: The data-driven regression discontinuity plot is derived following Calonico et al. (2014b, 2015). The fitting line is a quadratic polynomial fitting, and the vertical line represents the cutoff point when the income tax reform was implemented. The grey area represents the 95% confidence interval. The birth month is normalized to zero at January 2002. Number of observations = 615,340.

Table 1. Summary statistics of key variables

Variable	Description	Established	Established	Total
		before Jan 2002	after Jan 2002	
		Mean (SD)	Mean (SD)	Mean (SD)
If social security contributions	If basic social security contributions greater than zero (1=yes; 0=no)	0.730 (0.444)	0.661 (0.473)	0.688 (0.463)
Compliance rate	Basic social security contribution rate over statutory contribution rate	0.412 (0.492)	0.331 (0.446)	0.361 (0.465)
If supplementary contributions	If supplementary social security contributions greater than 0 (1=yes; 0=no)	0.313 (0.464)	0.248 (0.432)	0.273 (0.445)
Labor	Annual average number of employees	75.347 (107.398)	57.854 (89.079)	64.498 (96.820)
Wage (thousand RMB)	Annual average wages	21.326 (12.535)	20.979 (12.081)	21.111 (12.257)
Fixed assets (million RMB)	Total fixed assets	6.551 (17.205)	5.229 (65.661)	5.732 (52.772)
Leverage ratio	Total debts over total assets	0.669 (0.828)	0.666 (1.049)	0.667 (0.971)
Operating margin	Operating profit over revenue	-0.026 (0.913)	-0.028 (0.843)	-0.027 (0.870)
Current to total asset ratio	Current assets over total assets	0.755 (0.239)	0.783 (0.245)	0.773 (0.243)
If manufacturing firm	1=manufacturing firm; 0=otherwise	0.589 (0.492)	0.523 (0.499)	0.548 (0.498)
If firm exports	1=export; 0=otherwise	0.125 (0.331)	0.122 (0.327)	0.123 (0.328)
If privately owned firm	1=privately owned firm; 0=otherwise	0.455 (0.498)	0.519 (0.500)	0.495 (0.500)
If limited liability company	1=limited liability company; 0=otherwise	0.484 (0.500)	0.461 (0.498)	0.469 (0.499)
If collective enterprise	1=collective enterprise; 0=otherwise	0.037 (0.189)	0.011 (0.106)	0.021 (0.144)
If state-owned enterprise	1=state-owned enterprise; 0=otherwise	0.024 (0.154)	0.009 (0.093)	0.015 (0.120)
Effective tax rate	Corporate income tax over gross profit	0.152 (0.197)	0.162 (0.210)	0.158 (0.206)
Observations		233,710	381,630	615,340

Note: The table reports the corresponding sample averages and standard deviations (SD) in parentheses.

Table 2. Effect of the tax reform on income tax rate

Coefficient	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Quadratic polynomial $f(Z,D)$				Nonparametric polynomial $f(Z,D)$			
	$h=\pm 20$	$h=\pm 30$	$h=\pm 40$	$h^*=\pm 14$	$h=\pm 20$	$h=\pm 30$	$h=\pm 40$	$h^*=\pm 14$
	Dependent variable: Effective income tax rate							
If established after January 2002	0.016***	0.017***	0.017***	0.018***	0.016***	0.016***	0.016***	0.017***
	[0.002]	[0.002]	[0.002]	[0.003]	[0.002]	[0.002]	[0.002]	[0.003]
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	268,983	405,292	515,937	188,195	268,983	405,292	515,937	188,195

Note: h is the window of months considered before and after the tax reform (± 20 , ± 30 , and ± 40 months) and $h^*=\pm 14$ is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Columns (1) through (4) report conventional estimates and columns (5) through (8) report bias-corrected estimates following Calonico et al. (2019). Standard errors (reported in brackets) are clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table 3. Effect of the tax reform on social security participation, number of employees, and wages

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
Panel A: Quadratic polynomial $f(Z,D)$, optimal bandwidth					
	$h^*=\pm 24$	$h^*=\pm 18$	$h^*=\pm 24$	$h^*=\pm 18$	$h^*=\pm 22$
Effective tax rate	-0.669 [0.487]	-1.980*** [0.536]	-0.845*** [0.384]	-6.544*** [1.994]	-1.552*** [0.480]
Observations	323,701	242,195	323,701	242,195	299,267
Panel B: Nonparametric polynomial $f(Z,D)$, optimal bandwidth					
	$h^*=\pm 24$	$h^*=\pm 18$	$h^*=\pm 24$	$h^*=\pm 18$	$h^*=\pm 22$
Effective tax rate	-0.847** [0.415]	-1.384*** [0.266]	-0.577** [0.286]	-4.428*** [1.124]	-0.748*** [0.281]
Observations	323,701	242,195	323,701	242,195	299,267
Panel C: Nonparametric polynomial $f(Z,D)$, optimal bandwidth + 5 months					
	$h=\pm 29$	$h=\pm 23$	$h=\pm 29$	$h=\pm 23$	$h=\pm 27$
Effective tax rate	-0.822** [0.368]	-1.260*** [0.351]	-0.546** [0.244]	-3.838*** [1.244]	-0.817*** [0.261]
Observations	399,930	317,018	399,930	317,018	373,142
Panel D: Nonparametric polynomial $f(Z,D)$, optimal bandwidth - 5 months					
	$h=\pm 19$	$h=\pm 13$	$h=\pm 19$	$h=\pm 13$	$h=\pm 17$
Effective tax rate	-0.887** [0.430]	-1.138*** [0.236]	-0.491* [0.266]	-3.132*** [1.157]	-0.708** [0.273]
Observations	259,805	176,556	259,805	176,556	232,620
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: h is the window of months considered before and after the tax reform, where h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies

if firm exports and ownership type. Panel A reports conventional estimates for the optimal bandwidth and Panels B through D report bias-corrected estimates following Calonico et al. (2019) for the optimal and nearby bandwidths. Standard errors (reported in brackets) are clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table 4. Effect of the tax reform on social security participation, number of employees, and wages, by firm ownership type

Coefficient	(1)	(2)	(3)	(4)	(5)
Nonparametric polynomial $f(Z,D)$					
Dependent variable:					
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
Panel A: Privately owned firms					
Effective tax rate	$h^*=\pm 18$ -0.717* [0.415]	$h^*=\pm 17$ -0.984** [0.415]	$h^*=\pm 14$ -0.217 [0.390]	$h^*=\pm 12$ -4.970*** [1.108]	$h^*=\pm 11$ -0.221 [0.439]
Observations	120,601	114,014	93,619	82,010	75,436
Panel B: Limited liability companies					
Effective tax rate	$h^*=\pm 16$ -0.555* [0.286]	$h^*=\pm 13$ -1.550*** [0.422]	$h^*=\pm 13$ -0.596** [0.301]	$h^*=\pm 12$ -4.426*** [1.657]	$h^*=\pm 12$ -0.820*** [0.321]
Observations	103,931	84,104	84,104	79,640	79,640
Panel C: Collective enterprises					
Effective tax rate	$h^*=\pm 14$ 0.765 [16.701]	$h^*=\pm 16$ 16.775 [74.465]	$h^*=\pm 18$ -20.066 [117.220]	$h^*=\pm 15$ -0.952 [98.036]	$h^*=\pm 15$ -13.026 [143.670]
Observations	4,006	4,528	5,017	4,293	4,293
Panel D: State-owned enterprises					
Effective tax rate	$h^*=\pm 14$ 3.439 [22.383]	$h^*=\pm 12$ 5.145 [19.163]	$h^*=\pm 13$ -0.854 [4.450]	$h^*=\pm 16$ 8.636 [29.895]	$h^*=\pm 18$ 9.178 [41.715]
Observations	2,647	2,298	2,465	2,971	3,319
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: The results reported in Panels A through D are based on privately owned firms, limited liability companies, collective enterprises, and state-owned enterprises, respectively. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month)

and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio plus a dummy if firm exports. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table 5. Effect of the tax reform on social security participation, number of employees, and wages, by firm size

Coefficient	(1)	(2)	(3)	(4)	(5)
	Nonparametric polynomial $f(Z,D)$				
Dependent variable:					
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
Panel A: Small firms					
	$h^*=\pm 17$	$h^*=\pm 16$	$h^*=\pm 15$	$h^*=\pm 15$	$h^*=\pm 13$
Effective tax rate	-0.869*	-1.009*	-0.463**	-1.329	0.930
	[0.507]	[0.550]	[0.210]	[1.672]	[0.590]
Observations	112,011	105,090	98,859	98,859	84,471
Panel B: Large firms					
	$h^*=\pm 13$	$h^*=\pm 13$	$h^*=\pm 15$	$h^*=\pm 13$	$h^*=\pm 11$
Effective tax rate	-0.124	-1.416***	-0.588**	-4.184***	-1.210***
	[0.355]	[0.466]	[0.227]	[1.284]	[0.386]
Observations	92,085	92,085	106,716	92,085	80,127
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: The results reported in Panels A and B are based on small and large firms, respectively. A firm is regarded as small if its total assets are less than or equal to the median value of total assets (8.2 million RMB) in our working sample and is considered large if its total assets are larger than the median value. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

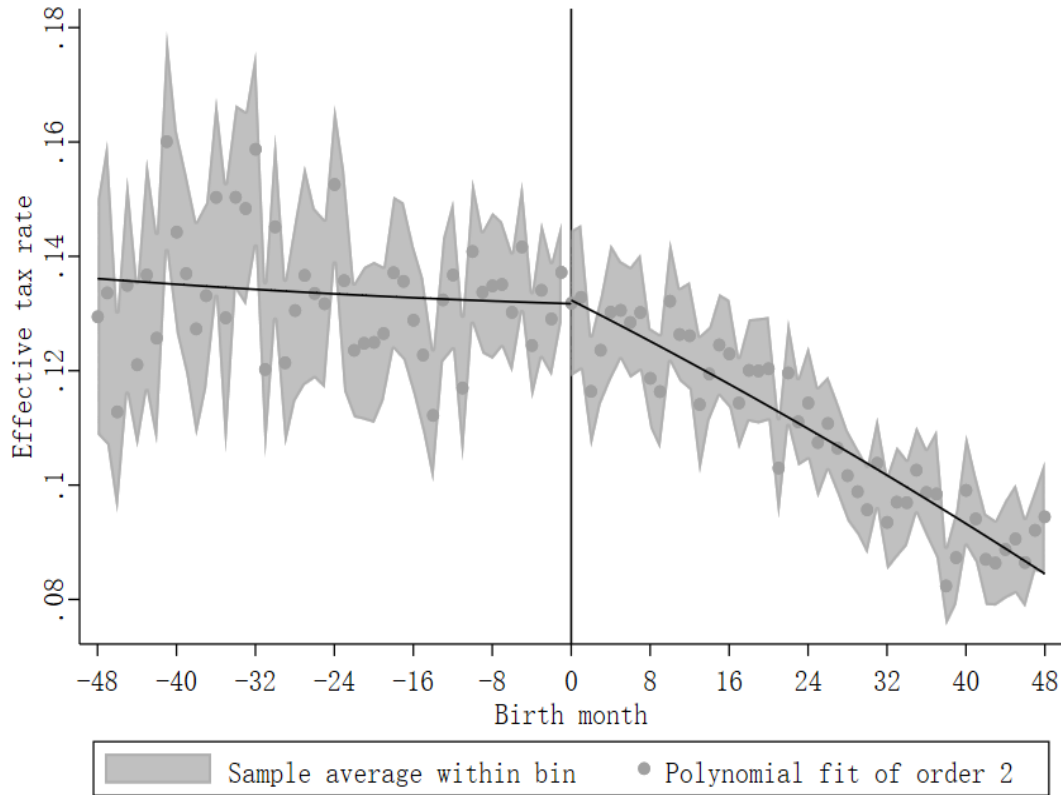
Table 6. Effect of the tax reform on social security participation, number of employees, and wages, by type of agency collecting social security contributions

Coefficient	(1)	(2)	(3)	(4)	(5)
	Nonparametric polynomial $f(Z,D)$				
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
	Panel A: Provinces where contributions are collected by social security department				
	$h^*=\pm 15$	$h^*=\pm 12$	$h^*=\pm 12$	$h^*=\pm 12$	$h^*=\pm 12$
Effective tax rate	-0.782**	-1.381***	-0.694**	-4.486***	-0.872**
	[0.377]	[0.368]	[0.311]	[1.117]	[0.398]
Observations	121,988	99,189	99,189	99,189	99,189
	Panel B: Provinces where contributions are collected by tax bureau				
	$h^*=\pm 18$	$h^*=\pm 14$	$h^*=\pm 16$	$h^*=\pm 18$	$h^*=\pm 18$
Effective tax rate	-0.553	-1.656**	-0.234	-2.930	-0.342
	[0.679]	[0.738]	[0.388]	[2.125]	[0.538]
Observations	99,541	77,807	88,770	99,541	99,541
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: The results reported in Panel A are based on firms located in provinces where social security contributions are directly collected by social security department, while the results in Panel B are based on firms located in provinces where the contributions are collected by the tax bureau. The latter provinces include Guangdong, Gansu, Shaanxi, Liaoning, Heilongjiang, Hainan, Qinghai, Fujian, Hunan, Hebei, and Ningxia. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

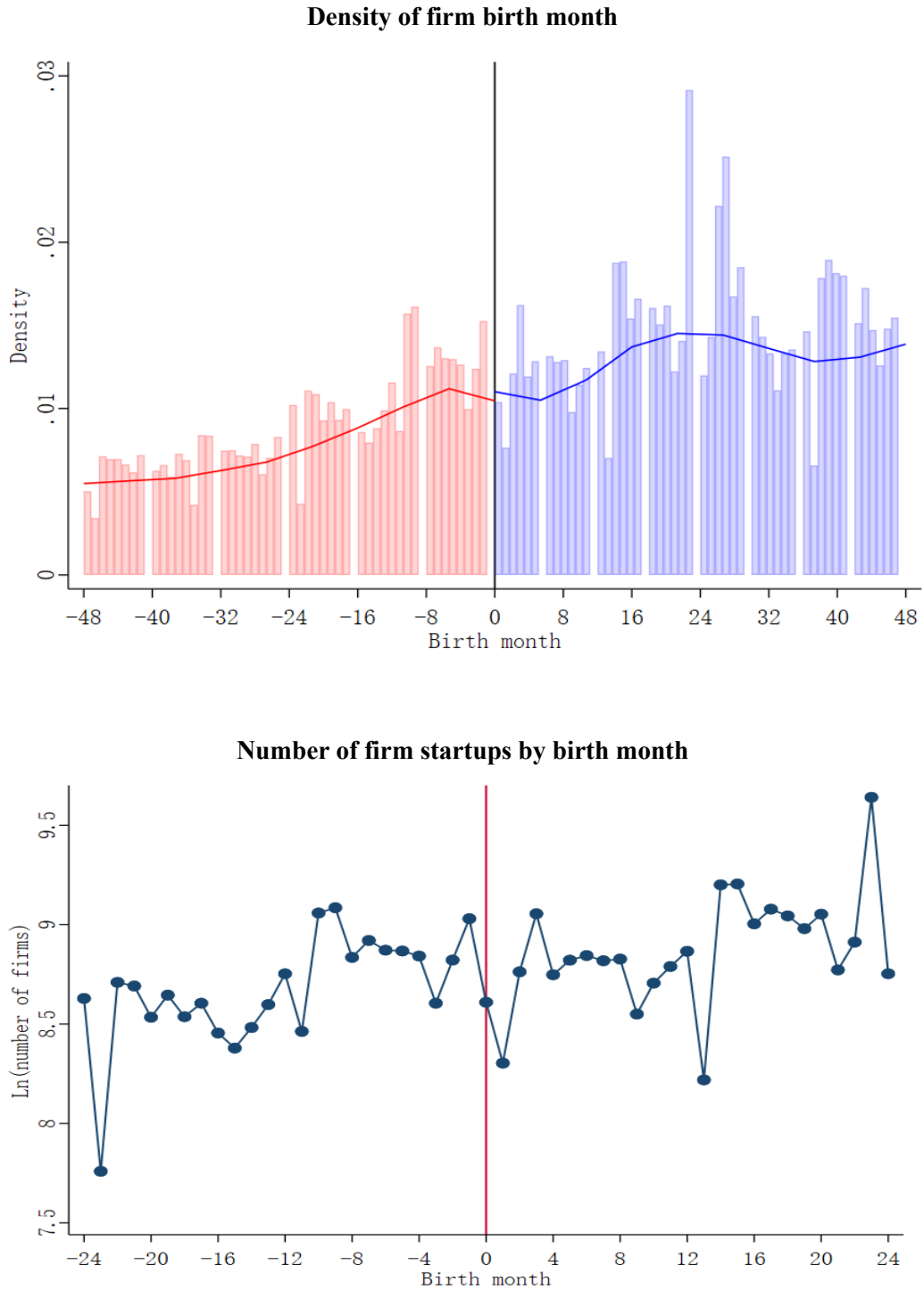
Appendix. Supplementary Figures and Tables

Figure A.1 Effective income tax rate by firm birth month, foreign and centrally owned firms



Note: The data-driven regression discontinuity plot is derived following Calonico et al. (2014b, 2015). The fitting line is a quadratic polynomial fitting, and the vertical line represents the cutoff point when the income tax reform was implemented. The grey area represents the 95% confidence interval. The birth month is normalized to zero at January 2002. Number of observations = 91,857.

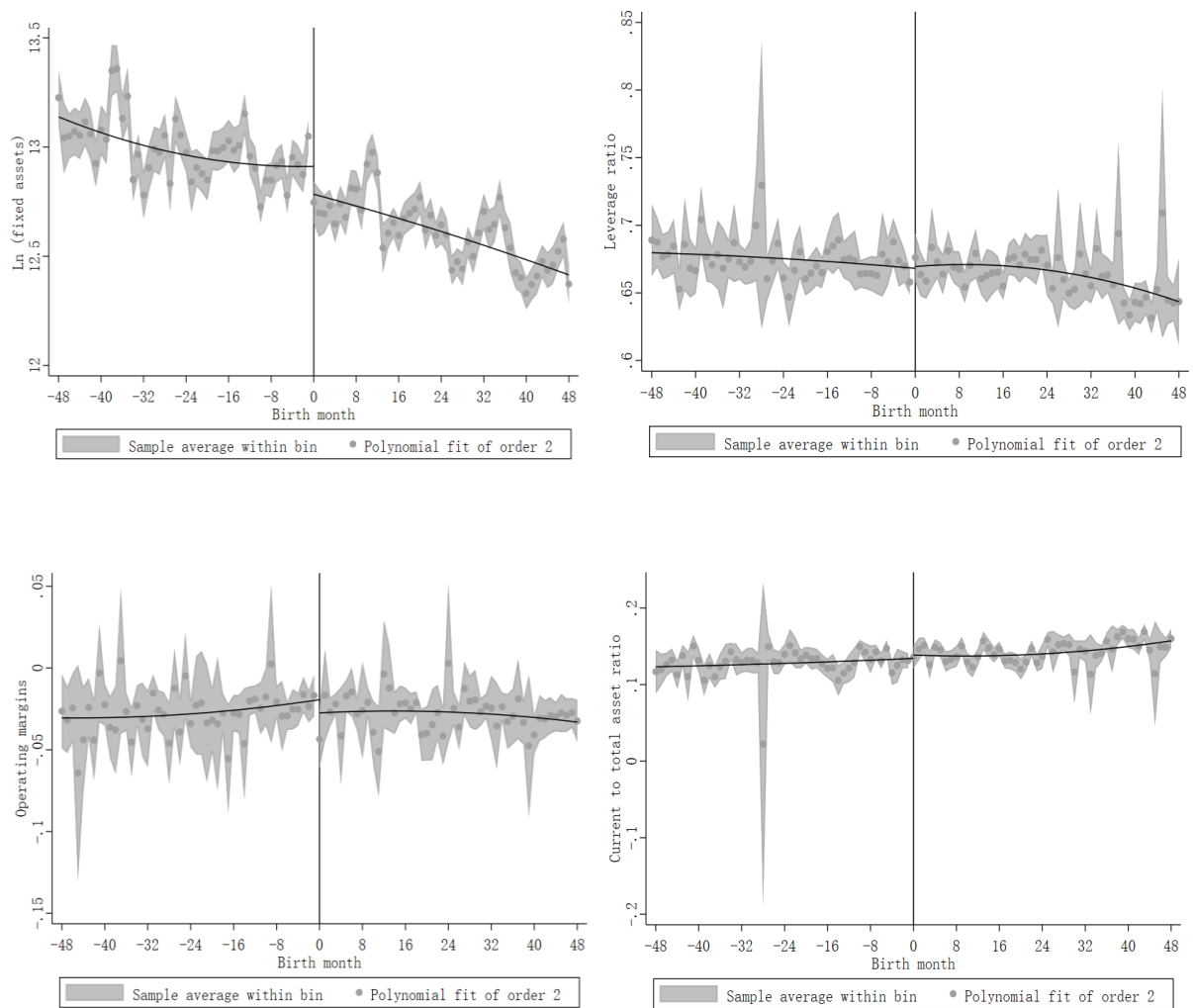
Figure A.2. Distribution and number of firm startups by birth month



Note: The top figure presents the local-polynomial density plot of firm birth month following Cattaneo et al. (2018, 2020) assuming an Epanechnikov kernel function and polynomial of order 3. The resulting T statistic is -0.14 with a

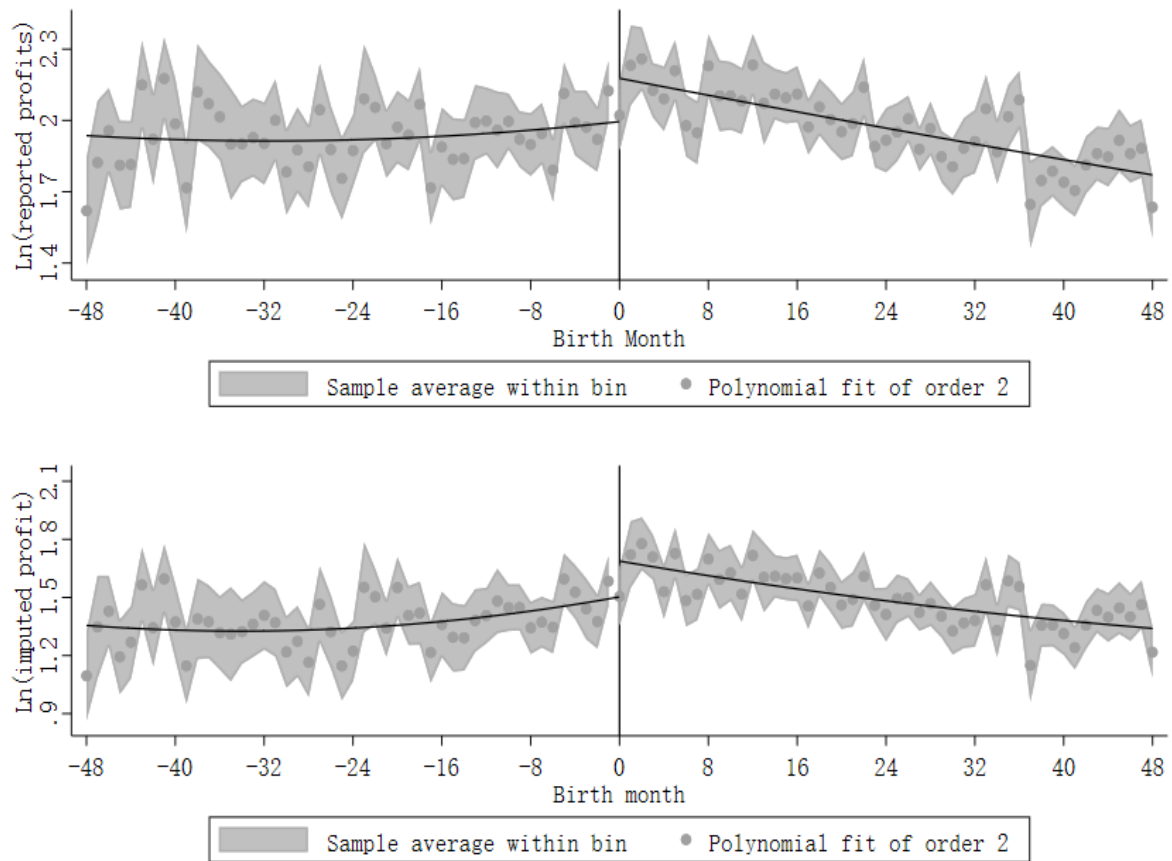
p-value of 0.89 (based on an optimal bandwidth of +/- 24 months and asymptotic plug-in standard errors). The bottom figure presents the number of firm startups (in natural logarithms) by birth month for the optimal bandwidth. In both figures, the birth month is normalized to zero at January 2002 and the vertical line represents the cutoff point when the income tax reform was implemented. Total number of observations considered to construct each figure = 615,340.

Figure A.3. Covariates by firm birth month



Note: The data-driven regression discontinuity plots are derived following Calonico et al. (2014b, 2015). The fitting line is a quadratic polynomial fitting, and the vertical line represents the cutoff point when the income tax reform was implemented. The grey area represents the 95% confidence interval. The birth month is normalized to zero at January 2002. Number of observations = 615,340.

Figure A.4. Reported and imputed profits by firm birth month



Note: The data-driven regression discontinuity plot is derived following Calonico et al. (2014b, 2015). The top figure corresponds to reported profits (in natural logarithm) and the bottom figure to imputed profits following Cai and Liu (2009). The fitting line is a quadratic polynomial fitting, and the vertical line represents the cutoff point when the income tax reform was implemented. The grey area represents the 95% confidence interval. The birth month is normalized to zero at January 2002. Number of observations = 615,340.

Table A.1. Continuity of covariates

Coefficient	(1)	(2)	(3)
	Nonparametric polynomial $f(Z,D)$		
	$h=\pm 18$	$h=\pm 22$	$h=\pm 24$
Panel A: Ln (fixed assets)			
If established after January 2002	-0.384*** [0.068]	-0.322*** [0.072]	-0.291*** [0.073]
Panel B: Leverage ratio			
If established after January 2002	0.005 [0.010]	0.007 [0.009]	0.008 [0.008]
Panel C: Operating margin			
If established after January 2002	-0.009 [0.009]	-0.009 [0.008]	-0.010 [0.007]
Panel D: Current to total asset ratio			
If established after January 2002	0.020** [0.008]	0.012* [0.007]	0.010 [0.007]
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes
Observations	242,195	299,267	323,701

Note: The three bandwidths (h) considered correspond to the optimal bandwidths for the five outcomes of interest analyzed in the study, following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.2. Effect of the tax reform on reported and imputed profits

Coefficient	(1)	(2)
	Nonparametric polynomial $f(Z,D)$	
	$h^*=\pm 21$	$h^*=\pm 22$
	Dependent variable:	
	Ln (reported profits)	Ln (imputed profits)
If established after January 2002	0.116	0.130
	[0.080]	[0.090]
Control variables	Yes	Yes
Industry fixed effects	Yes	Yes
City fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
City \times year fixed effects	Yes	Yes
Observations	285,826	299,304

Note: h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.3. Placebo tests

Coefficient	(1)	(2)	(3)	(4)	(5)
	Nonparametric polynomial $f(Z,D)$				
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
	Panel A: Pseudo treatment group (foreign and centrally owned enterprises)				
	$h^*=\pm 15$	$h^*=\pm 16$	$h^*=\pm 13$	$h^*=\pm 13$	$h^*=\pm 14$
Effective tax rate	1.531 [2.644]	3.560 [4.331]	-3.084 [2.673]	-0.850 [18.577]	-3.349 [4.565]
Observations	33,322	35,285	28,911	28,911	31,137
	Panel B: Pseudo treatment year (tax reform implemented in October 2001)				
	$h^*=\pm 14$	$h^*=\pm 14$	$h^*=\pm 12$	$h^*=\pm 14$	$h^*=\pm 15$
Effective tax rate	-27.329 [25.096]	6.654 [18.268]	-1.411 [3.194]	-5.733 [3.840]	-10.021 [10.790]
Observations	191,282	191,282	167,429	191,282	205,575
	Panel C: Pseudo treatment year (tax reform implemented in July 2001)				
	$h^*=\pm 12$	$h^*=\pm 13$	$h^*=\pm 14$	$h^*=\pm 13$	$h^*=\pm 13$
Effective tax rate	-2.012 [1.174]	-2.838* [1.639]	-0.899 [1.013]	-2.982 [22.718]	-0.777 [1.302]
Observations	167,429	176,556	191,282	176,556	176,556
	Panel D: Pseudo treatment year (tax reform implemented in January 2001)				
	$h^*=\pm 9$	$h^*=\pm 10$	$h^*=\pm 20$	$h^*=\pm 13$	$h^*=\pm 8$
Effective tax rate	-0.929 [4.541]	2.578 [11.371]	-0.801 [3.616]	-2.861 [24.109]	-3.822 [4.797]
Observations	128,093	142,719	273,427	176,556	114,107
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: Panel A results are based on foreign and centrally owned firms. Panels B through D results are based on our full working sample assuming that the tax reform occurred in October 2001, July 2001, and January 2001, respectively. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after

January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.4. Differences-in-differences estimations comparing firms in working sample versus foreign and centrally owned firms, born before and after 2002

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
DID estimator	-0.028*** [0.004]	-0.031*** [0.005]	-0.015*** [0.005]	-0.056*** [0.011]	-0.019*** [0.005]
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City × year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	707,197	707,197	707,197	707,197	707,197

Note: The estimated differences-in-differences (DID) model compares the corresponding outcomes of all firms included in our working sample (treatment group) versus foreign and centrally owned firms (comparison group), born before and after 2002. The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Robust standard errors reported in brackets clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.5. Excluding covariates

Coefficient	(1)	(2)	(3)	(4)	(5)
	Nonparametric polynomial $f(Z,D)$				
	$h^*_{\pm 15}$	$h^*_{\pm 11}$	$h^*_{\pm 15}$	$h^*_{\pm 11}$	$h^*_{\pm 11}$
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
Effective tax rate	-0.847** [0.397]	-1.700*** [0.298]	-0.961*** [0.320]	-6.950*** [1.656]	-1.256*** [0.362]
Observations	205,575	154,017	205,575	154,017	154,017
Control variables	No	No	No	No	No
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: The results reported are based on excluding firms' fixed assets, leverage ratio, operating margin, and current to total asset ratio from the regression analysis. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.6. Accounting for potential influence of value-added tax (VAT) relief program

Coefficient	(1)	(2)	(3)	(4)	(5)
	Nonparametric polynomial $f(Z,D)$				
	$h^*=\pm 12$	$h^*=\pm 11$	$h^*=\pm 17$	$h^*=\pm 11$	$h^*=\pm 13$
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
Effective tax rate	-0.787** [0.399]	-1.630*** [0.315]	-0.664** [0.327]	-4.989*** [1.125]	-0.772*** [0.260]
Observations	156,886	144,285	217,586	144,285	165,345
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: Estimation results excluding firms affected by pilot reform of value-added taxes in 2004. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.7. Using interval estimation approach

Coefficient	(1)	(2)	(3)	(4)	(5)
	Nonparametric polynomial $f(Z,D)$				
	Dependent variable:				
	If social security contributions	Compliance rate	If supplementary contributions	Ln (number of employees)	Ln (wages)
Probability of manipulation (τ)			$\tau=0.167$		
Interval effect of Effective tax rate	[-4.981, -0.864]	[-3.838, -0.734]	[-2.278, -0.734]	[-7.192, -3.851]	[-7.277, -2.056]
Point effect of Effective tax rate ($\tau=0$)	-1.661	-1.246	-0.959	-4.845	-3.616
Observations	323,701	242,195	323,701	242,195	299,267
Control variables	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes	Yes

Note: Estimation results based on Gerard et al. (2020) interval estimation approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio, plus dummies if firm exports and ownership type. Robust standard errors reported in brackets. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Table A.8. Using alternative dataset for period 2002-2007

Coefficient	(1)	(2)	(3)	(4)
	Nonparametric polynomial $f(Z,D)$			
	$h^*=\pm 15$	$h^*=\pm 17$	$h^*=\pm 18$	$h^*=\pm 13$
	Dependent variable:			
	If pension fund medical or unemployment contributions	Pension fund, medical, and unemployment contribution rate	Ln (number of employees)	Ln (wages) (wages)
Effective tax rate	-5.9743* [3.962]	-2.944** [1.2823]	-33.459** [14.001]	-3.851*** [2.183]
Observations	178,685	203,865	217,404	156,797
Control variables	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
City \times year fixed effects	Yes	Yes	Yes	Yes

Note: Estimation results using Chinese Annual Survey of Manufacturing Firms for the period 2002-2007. Pension fund, medical, and unemployment contributions are part of the five basic social security contributions in China. The contribution rate is simply calculated as the sum of the three reported contributions over total firm wages. h^* is the optimal bandwidth following Calonico et al. (2014a, 2014b) robust approach. $f(Z,D)$ is the polynomial function for assignment variable Z (firm birth month) and indicator variable D (if firm established after January 2002). The control variables include total fixed assets in natural logarithm, leverage ratio, operating margin, and current to total asset ratio plus dummies if firm exports and ownership type. Bias-corrected estimates following Calonico et al. (2019) reported with robust standard errors (in brackets) clustered to firm birth month. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

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