# Survival and Growth of Small and Mid-Sized Firms: Evidence from Corporate Income Tax Cuts in China [*]

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September 19, 2023

**Abstract**

Our study examines China's notch-based corporate income tax cuts from 2014 to 2018 aimed at aiding small and medium-sized enterprises (SMEs). Analyzing tax data, we find that these cuts both encourage covered SMEs to boost production and prompt some above-notch firms to reduce production for tax arbitrage. Then we develop a structural model illustrating tax policy's substantial impact on firm output. Our counterfactual analysis assesses policy implications on economic output and SME expansion. Ultimately, we compare support policies, suggesting that kink-based tax cuts and size-based precision subsidies may achieve tax revenue goals more efficiently while stimulating SMEs like notch-based policies.

**Keywords:** corporate income tax, size-based policy, SME

[*]We express our gratitude to Kerem Cosar, Jonathan Eaton, Jingting Fan, Kala Krishna, Yue Liu, Chang Sun, Jim Tybout, Felix Tintelnot, Stephen Yeaple, and Shaoda Wang for their invaluable insights and comments. We are grateful to seminar participants at the Central University of Finance and Economics, Liaoning University, Renmin University of China, Shanghai University of Finance and Economics, Tsinghua University, RUC-Xiamen U Public Finance Forum, the Penn State Alumni Academic Conference, and the Asian Meeting of Econometric Society 2023 for constructive feedback. Any errors that appear are solely our responsibility.

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# 1 Introduction

Governments worldwide prioritize the stability and growth of small firms and have introduced various support programs for them. These programs encompass several measures, such as tax cuts, subsidies, simplified operational procedures, and credit support for firms below a size-based threshold. While these policies have gained popularity, they remain a subject of controversy. Advocates assert that small firms are vital for job creation and often face growth challenges due to market failures and capital market imperfections (Decker et al., 2014). However, opponents contend that preferential treatment for specific firms can lead to distortions. Size-based thresholds may incentivize firms to remain below the threshold and cause misallocation by crowding out larger firms (Guner et al., 2008; Garicano et al., 2016; Martin et al., 2017; David and Venkateswaran, 2019). Thus, understanding the overall economic impact of size-based support policies and identifying the most efficient policies to stimulate small firms and total economic output become crucial.

This study investigates the impacts of China's Halve-Levy program on its economic output and tax revenue. The program offers corporate income tax cuts for small-scale enterprises, effectively cutting the tax rate in half for those eligible. A critical requirement is that the annual taxable income of these small-scale enterprises must fall below a specified threshold. This, in turn, creates discontinuous jumps in the average tax rate at the threshold point. Notably, China has consistently raised the threshold for eligible production scales annually from 2014 to 2018. This ideal progression provides an optimal context for studying the effectiveness and efficiency of size-based policies.

Analyzing the effects of this program sheds light on its effectiveness for China and offers invaluable insights for other countries. As shown in Table 1, many countries, except those adhering to a linear corporate tax structure, provide preferential tax rates for small and medium-sized enterprises (SMEs). These countries can be categorized into two groups based on their tax reduction methods: notch-based and kink-based. The former reduces the average tax rate (similar to China's case), while the latter affects the marginal tax rate. Constructing a theoretical framework to capture how tax incentives affect firms' output will help comprehend the economic impacts of notch-based tax reductions in China and can be extended to analyze the effects of similar size-based support policies in other countries.

Using confidential administrative data extracted from corporate tax returns in Shanxi Province, which encompasses alterations in eligibility thresholds for the Halve-Levy program, we provide evidence of the reactions of Chinese small-scale firms to the program's incentives. Subsequently, we develop a structural model to capture firms' production behaviors, emphasizing the influence of tax incentives on their production output. Based on this model, we conduct counterfactual analyses to answer the following key questions: 1.

Table 1: Corporate Income Tax Cuts for Firms of Different Sizes by Country

| Linear tax (no cuts) | | Kink-based cuts | Notch-based cuts |
|---|---|---|---|
| Austria | Italy | Argentina | Australia |
| Czech Republic | Mexico | Brazil | Chile |
| Denmark | New Zealand | Belgium | China |
| Finland | Norway | Canada | India |
| Germany | Slovenia | France | Poland |
| Greece | Sweden | Japan | Slovakia |
| Hungary | Switzerland | South Korea | Spain |
| Ireland | Turkey | Luxembourg | |
| Israel | USA | Holland | |
| | | Portugal | |
| | | South Africa | |
| | | UK | |

Data Source: Wolters Kluwer Taxation Database.

How do firms make production-scale decisions? How do they respond to tax incentives? 2. What is the holistic impact of China's notch-based tax cuts on the overall economic output? How do different types of firms affected by the policy shift collectively contribute to the net aggregate change? 3. Comparing notch-based tax cuts, kink-based tax cuts, and size-based precision subsidies, which policy is more effective in achieving equivalent stimulus to economic output? To what extent does the more effective policy reduce the tax bill associated with the preferential program?

In Section 3, we commence our analysis by examining the impact of corporate tax cuts on fostering the growth of eligible firms. The Halve-Levy program, spanning 2014–2018, raised the threshold for eligibility annually. Consequently, a cohort of newly eligible firms began benefiting from the preferential tax rate of 10%, while the control group's tax rate remained at 25%. Given the frequent policy shocks, we employ a difference-in-differences (DID) design to identify the policy's impact. The estimation results reveal that halving the tax rate promotes the taxable income of eligible firms by approximately 10%.

Next, we investigate firms' bunching behaviors by applying the bunching estimates proposed by Kleven and Wassem (2013) to our data. These estimations indicate that a proportion of firms bunch just below the thresholds in response to sudden jumps in tax liability. We quantify the decrease in taxable income resulting from the tax notch using a bunching estimator. Our findings indicate that, on average, firms reduce their taxable income by approximately 5% within the exclusion region, leading to a loss in overall social welfare. Notably, this response is limited by the fact that a significant proportion of firms with taxable income close to the notch (ranging from 50% to 80%) do not reduce their production levels to align with the notch. Bunching frictions, such as misinformation about the tax policy, could explain the large proportion of non-bunchers (Kostøl and Myhre, 2021).

In Section 4, we present a structural model that examines a firm's adjustments to production decisions in response to changes in costs and tax incentives. Our model builds upon Arkolakis' trade entry model (2010) by incorporating the impact of tax incentives on firms' production decisions. Specifically, our model considers factors such as after-tax marginal revenue at a given production scale, the marginal opportunity cost faced by management in investing or forfeiting at that scale, and the influence of tax incentives. By incorporating China's corporate tax cuts into our model, we propose that a reduced corporate income tax rate can amplify after-tax returns, prompting policy-covered firms to expand production. Simultaneously, the mechanism of notch-based tax cuts encourages firms near the notch threshold to optimize their profits strategically by reducing production to qualify for a lower tax rate. Furthermore, our model introduces the concept of heterogeneous firms characterized by varying productivity levels, resulting in diverse production decisions. Under a linear tax regime, different firms have distinct production sizes. When considering the Halve-Levy program, we observe that the smallest firms may exit the market under a 25% linear tax system; however, they may survive under the current policy. Similarly, small firms that would have endured under a 25% tax system can now expand their output owing to the lower corporate income tax rate. Some firms positioned near the higher notch point experience tax-incentivized motivations to reduce their production, while specific larger firms remain relatively unaffected by the tax cuts policy designed for small and micro firms. In summary, our model adeptly captures the observed data patterns pertaining to firms' entry, production, and bunching behaviors, serving as a robust theoretical foundation and counterfactual analytical framework.

In Section 5, we describe our two-step parameter estimation process. First, we estimate supply- and demand-related parameters to reconstruct firms' production curves. This is accomplished by employing a non-linear least squares approach within a standard trade entry framework. In the second step, using a non-parametric estimation method and based on the retrieved production curve, we estimate the parameters associated with firms' bunching behavior. We focus on opportunity cost-related parameters to account for the varying levels of opportunity costs incurred by SMEs as they expand their production. These estimations contribute to understanding the influence of different corporate income tax rates on firms' production scales. The structural estimates of firms' bunching behavior reveal that, during the first five years of the Halve-Levy program, over 50% of the firms incentivized to reduce production to reach the notch did not profit from engaging in this activity. This underscores the presence of significant frictions in firms' comprehension of tax rate changes, tax information, and adaptation to the tax system. The validity of our model is further supported by its ability to match the output's data distribution closely. This alignment is strengthened by the observation that the estimated structural parameters closely correspond to those derived from parsimonious reduced-form evidence.

In Section 6, we initiate our first counterfactual analysis by examining the aggregate welfare effects of the policy. The results reveal that despite the fully progressive nature of the notch-based policy, which introduces inefficiencies due to firms' bunching behavior at the notch, the existing program elevates total economic output by 0.09–0.1% annually. Additionally, firms that benefited from the preferential tax rates experienced a substantial increase in economic output, ranging from 2.37% to 5.18%. This outcome remains evident while many firms fail to capitalize on the opportunity to bunch. If the policy persists, and informational frictions on firms' bunching behavior are reduced, the increase in economic output from the tax incentive should gradually diminish over time. Although existing policies contribute to the overall output boost, they also lead to lower overall tax revenues, ranging from 1.11% to 3.3%, because of the lower corporate income tax rates offered to beneficiary firms.

Subsequently, we delve into the role played by firms affected differently by existing policies in determining the ultimate aggregate economic outcome. Based on firms' reactions to existing incentives, we categorize them into four groups: new entrants under the influence of incentives, firms covered by the policy that expand production, firms strategically reducing production to align with the notch point for arbitrage, and firms not covered by the policy, abstaining from arbitrage activities. The counterfactual analysis reveals that the overall increase in economic output primarily stems from the expansion of production by already surviving firms. Conversely, output growth from new entrants and production reductions from the bunching behavior of the third group have minimal impact on the aggregate output shift within our sample year.

Additionally, we analyze the time trend of the policy effects. As the size threshold of preferential policy increases, newly covered firms become larger scales and experience a lesser degree of output boost from the incentives compared to smaller firms. Simultaneously, as firms become more adept at profiting from output reductions, the negative effect of bunching behavior around the notch point intensifies. As a result, the magnitude of the output increase rate, due to preferential policy shifts, tends to decrease annually. Our simulation results offer valuable policy insights for determining the optimal size thresholds to stimulate the overall economy effectively.

Furthermore, we evaluate the merits and effectiveness of different government support policies tailored to SMEs compared to the benchmark notch-based tax cuts. Specifically, we compare kink-based tax cuts and precise subsidies based on a firm's taxable income size. Our assessment revolves around their capacity to stimulate economic output while simultaneously safeguarding tax revenues, all within a consistent framework of tax rates and incentive size thresholds. The simulations demonstrate that if firms are well-informed about incentive changes and adapt accordingly, the notch policy increases total economic output by approximately 0.04–0.05% annually. Conversely, owing to the absence of policy distortions caused by bunching behaviors, the kink and precision subsidy policies propel a more substantial increase, ranging from 0.1 to 0.13%. Regarding tax revenue reduction minimization, all three types of policies promote economic growth while causing reduced tax revenues owing to incentives or subsidies for supporting firms. Among these support policies, the kink policy generally reduces annual tax revenues by approximately twice as much as the notch policy. This phenomenon arises from the tax breaks targeting the portion of all firms' incomes below the threshold. Contrarily, a size-based precision subsidy policy stimulates economic output and minimizes the reduction in tax revenues. This is because a subsidy based on the size of the business only needs to compensate for the opportunity cost of engaging in business activities to promote production expansion. Meanwhile, a tax incentive involving a lower tax rate would require the forfeiture of a significant proportion of tax revenues. However, implementing such an efficient subsidy policy requires establishing a precise mapping between the subsidy amount and the operational profit of each specific firm, necessitating a higher level of forecasting and modeling ability.

Finally, we compare notch-based tax cuts, kink-based tax cuts, and precision subsidy policies that achieve the same effect of stimulating economic output. Moreover, we assess the extent to which each policy type minimizes the reduction in tax revenues. Our counterfactual analysis demonstrates that if the government optimizes aggregate output, kink-based tax cuts achieve the same policy effect while causing a reduction in tax revenues only 1/8–1/3 of that caused by notch-based tax cuts. Furthermore, the reduction in tax revenue from a precision subsidy policy for small firms is merely one-tenth of that resulting from notch-based tax cuts.

We build a counterfactual framework to compare the merits and drawbacks of different SME support policies. Notably, while notch-based corporate tax cuts are widely adopted by various governments, including China, owing to their targeted support for SMEs and straightforward administration, they exhibit inefficiencies related to firms' production cuts near the notch point. Consequently, the policy effects are notably less efficient compared to kink-based tax cuts and precise subsidies to firms. Our counterfactual simulations are conducted with Chinese data. However, the structural framework we develop in this study holds potential for broad application and extension. It can be used to analyze different SME support policies across countries, compare different policy advantages and disadvantages, and identify the optimal support policy tailored for each country.

Our study contributes significantly to the existing literature in several ways. First, we contribute to the ongoing debate regarding the effectiveness of preferential tax policies in supporting small firms. While some research has found positive effects of tax cuts in stimulating small firms (Harju et al., 2020), others express concerns about policy distortions. Many studies have observed bunching around the cutoff of size-based policy threshold (Boonzaaier et al., 2017; Bachas and Soto, 2020; Devereux et al., 2014). Conversely, our comprehensive evaluation of size-dependent support policies considers the benefits from incentive effects on incumbent firms and new entrants, as well as the losses from bunching around bracket cutoffs and the potential crowding-out effects on large firms' businesses. By building a theoretical framework that incorporates both aspects of tax policies, we conduct counterfactual analysis and strive to identify the optimal policies to support SMEs.

Our study builds upon traditional trade entry models by incorporating tax incentives into firms' considerations. This family of trade entry models originated from Melitz (2003) and Chaney (2008), who introduced the concept of firms' heterogeneous productivity following Pareto distribution. Building upon this framework, Arkolakis (2010) expanded the Melitz-Chaney model by introducing market penetration costs to capture the performance of small and medium-sized exporters within the trade market. Subsequent research by Eaton, Kortum, and Kramarz (2011) honed in on the export performance of French firms on global stage. In our model setup, we integrate the incentive of corporate income tax for SMEs into the market expansion cost function of Arkolakis (2010) to analyze the impact of current policies on SMEs' production decisions. Our model extends these classic models without additional complexity and effectively aligns with SMEs' production decisions. Consequently, it seamlessly facilitates counterfactual analyses aimed at assessing the effects of different types of policies on SMEs and aggregate output.

This study contributes to the broader literature concerning the impact of corporate taxes on business behavior, particularly their impact on corporate investment and output expansion (Hassett and Hubbard, 2002). Extensive research has explored tax reforms that modify tax rates or introduce changes in tax burdens, often involving adjustments in depreciation incentives. Additionally, various studies have analyzed the elasticity of taxable income (ETI) in response to changes in corporate income tax rates (Devereux et al., 2014; Gruber and Rauh, 2007; Dwenger and Steiner, 2012; Patel et al., 2015; Baches and Soto, 2020). In line with this context, our analysis also reveals a positive effect of corporate income tax rate reductions on firm production. Our contribution to the existing body of literature lies in estimating the elasticity of taxable income using bunching and DID methods rooted in the Chinese dataset.

The subsequent sections of this paper are organized as follows. Section 2 provides a review of the policy background and describes the dataset, while Section 3 presents the empirical evidence. Subsequently, Sections 4 and 5 describe the model and its empirical implementation, and Section 6 introduces the counterfactual analysis. Finally, Section 7 outlines the conclusions.

# 2 Policy Background and Data

## 2.1 Tax Preference Program for Small-Sized Enterprises

Under China's corporate income tax law, which was enacted in 2008, regular firms are subject to a flat tax rate of 25%, while "small and micro-profit enterprises" (SMPEs) can benefit from a reduced flat rate of 20%. The definition of SMPEs hinges on three requirements: (1) an annual taxable income not exceeding 300,000 RMB (approximately USD 41,000); (2) workforce size not surpassing 100 employees for manufacturing firms (or 80 for other firms); (3) total assets valued at no more than 30 million RMB for manufacturing firms (or 10 million RMB for other firms).

In response to the Global Financial Crisis, the Chinese government introduced the Halve-Levy program in December 2009. Within the framework of this program, SMPEs earning less than RMB 30,000 of taxable income annually were only required to include half of their income when computing tax liability. Consequently, these firms effectively benefited from a 10% tax rate on their taxable income. Over the years, the taxable income threshold with the Halve-Levy rule underwent several increases: (i) raised to 60,000 RMB for 2012–2013; (ii) further increased to 100,000 RMB for 2014; (iii) raised to 200,000 RMB for the first three quarters of 2015; (iv) subsequently adjusted to 300,000 RMB for the 4th quarter of 2015 and 2016; (v) further raised to 500,000 RMB for 2017; (vi) ultimately raised to 1,000,000 RMB for 2018. Before 2016, the threshold for the Halve-Levy rule was lower than that of SMPEs. However, since 2016, both thresholds have been identical. Simultaneously, the requirements for the number of employees and total assets remained consistent throughout this period. Our sample covers 2014–2018, during which the income threshold was raised each year. For a comprehensive overview of the gradual elevation in SMPE and Halve-Levy rule thresholds, please refer to Table 2. Notably, as declared by the Chinese government, the SMPEs policy saved firms' tax payments of RMB 89.5 billion (approximately USD 12.3 billion) in 2018, accounting for 2.5% of total corporate income tax revenue [1].

Owing to the SMPEs and the Halve-Levy program, China's corporate income tax system demonstrates discontinuous jumps in the average tax rate at specific thresholds. This differs from the corporate tax systems observed in several other countries, as shown in Table 1. Take, for instance, the UK and France, where the marginal tax rate increases discretely at bracket cutoffs, creating kink points. [2]

[1] Please see https://baijiahao.baidu.com/s?id=1715565337748128786&wfr=spider&for=pc.

[2] According to OECD (2015) reports, among OECD countries, fourteen countries apply reduced tax rates to SME income based on taxable income levels and other eligibility criteria, including business turnover.

Table 2: SMPE Threshold and Halve-Levy Rule Threshold

| Requirement | SMPE Threshold | Halve-Levy Rule Threshold |
|---|---|---|
| 2010–11 | 300 | 30 |
| 2012–13 | 300 | 60 |
| 2014 | 300 | 100 |
| 2015 | 300 | 200 |
| 2016 | 300 | 300 |
| 2017 | 500 | 500 |
| 2018 | 1000 | 1000 |

Note: Unit: Thousands of RMB. The Halve-Levy rule threshold is 200,000 RMB for the first three quarters of 2015, and it increases to 300,000 RMB for the 4th quarter of the same year.

The tax rate for firms above the SMPE threshold remains the standard 25%. Firms under the SMPE threshold and above the Halve-Levy rule threshold are eligible for a flat 20% tax rate. Conversely, firms situated below the Halve-Levy rule threshold can effectively enjoy a flat 10% tax rate.

## 2.2 Data

We utilized confidential administrative data of corporate tax returns from Shanxi Province, spanning 2014–2018. This dataset was provided by the Shanxi Provincial Tax Bureau of the Chinese State Administration of Tax, an entity that handles tax collection and auditing for all registered firms within the province. [3] Shanxi Province, situated in northern China, boasts of a population of 31.8 million, ranking 18th among Mainland China's 31 provinces, equivalent to the populations of Canada, Malaysia, and Austria. In 2018, Shanxi's per capita GDP reached 45.5 thousand RMB (USD 6270), positioning it at the 25th spot among all provinces. Any firm that remits a positive amount of corporate income tax to the tax administration in Shanxi finds its place in our dataset.

The data we collected comprises detailed records of tax payments and other financial statement information, such as taxable income, profit, sales, and employment, used for tax-related calculations. A significant advantage of this dataset is its inclusion of firms of all sizes. This inclusiveness enables us to assess the impact of tax cuts on small firms. Conversely, the commonly used datasets for studying Chinese firms—the Annual Survey of Industrial Firms and the Tax Survey Data—only cover a few small firms. [4]

Our raw dataset comprises approximately 470,000 observations, with the observation count progressively increasing over time, ranging from 80,341 in 2014 to 116,572 in 2018 [5].

[3] Prior to 2018, China's tax administration comprised two entities: the National Taxation Bureau and the Local Taxation Bureau. The former handled corporate income tax revenue from firms established before 2002, while the latter managed revenue from those established afterward. In 2018, China merged these two, creating a unified tax system. Our dataset, acquired in 2019 post-merger, includes firms from both periods.

[4] For instance, Chen et al. (2022) and Liu and Mao (2019) employ these two datasets to investigate the effects of VAT reform on firm investment and productivity.

[5] refer to Column (1) of Table 3

Columns 2 and 3 further demonstrate that in 2014, 91.6% of firms has annual taxable income falling below the SMPE threshold, and 84% remain below the Halve-Levy rule threshold. As the Halve-Levy rule thresholds are raised from 2014 to 2018, the proportion of firms below the threshold increases. Moreover, Column 4 reveals that over 90% of firms situated below the taxable income threshold meet the employee number requirements, which stipulates not exceeding 100 for manufacturing firms (or 80 for other firms). While our data lack information on firms' total asset value, we utilize the Tax Survey Data and find that over 90% of firms below the Halve-Levy rule threshold also meet the total asset value requirements, which require not exceeding 30 million RMB for manufacturing firms. This implies that among the three requirements for the preferential tax rate, the taxable income threshold is the most crucial factor.

Table 3: Number of Firms in the Sample

| Number of firms | Original Sample | Firms below the SMPE threshold | Firms below the Halve-Levy threshold | Firms below the Halve-Levy threshold and are satisfied with the requirements of the number of employees |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| 2014 | 80,341 | 73,585<br>(91.6%) | 67,998<br>(84.6%) | 66,019<br>(97.1%) |
| 2015 | 80,205 | 73,701<br>(91.9%) | 71,891<br>(89.6%) | 69,481<br>(96.6%) |
| 2016 | 87,459 | 80,382<br>(91.9%) | 80,382<br>(91.9%) | 70,772<br>(88.0%) |
| 2017 | 100,355 | 94,333<br>(94.0%) | 94,333<br>(94.0%) | 86,677<br>(91.9%) |
| 2018 | 116,572 | 111,481<br>(95.6%) | 111,481<br>(95.6%) | 107,791<br>(96.7%) |
| ALL | 464,932 | 433,482<br>(93.2%) | 426,085<br>(91.6%) | 400,740<br>(94.1%) |

Note: The SMPE and Halve-Levy rule thresholds for each year are shown in Table 2. The value in parentheses in Columns 2–3 represents the number of firms as a ratio to the total firms in the original sample. The value in parenthesis in Column 4 is the ratio of the number in Column 4 to that in Column 3.

# 3 Empirical Evidence

We present preliminary evidence regarding the impact of tax cuts on small-scale firms, particularly those eligible for the Halve-Levy rule. First, we examine the effects of corporate income tax cuts in promoting the growth of eligible firms. Subsequently, we analyze firms' bunching behaviors through the application of bunching estimates.

## 3.1 Firms' Responses to Tax Cuts: DID results

We employ the DID method to examine the effects of tax cuts on promoting the growth of eligible firms. As the qualifying threshold is adjusted annually, we conduct separate DID regressions on subsamples for two consecutive years. For instance, in the 2014–2015 sample, the threshold increased from 100 thousand in 2014 to 200 thousand in 2015. Consequently, firms with taxable income ranging from 100 thousand to 200 thousand were ineligible in 2014 but eligible in 2015. Conversely, firms with taxable income above 200 thousand remained ineligible. Therefore, the treatment group comprises firms with initial taxable income ranging from 100 thousand to 200 thousand in 2014, and the control group includes firms with initial taxable income ranging from 200 thousand to 500 thousand in 2014. The bandwidth of the control group is set as three times larger than that of the treatment group to maintain a sufficient number of control group observations. To eliminate the confounding impact of bunching near the threshold, we drop observations in the excluded bunching region (see Subsection 3.2). For example, in the 2014–2015 sample, we exclude firms with taxable income ranging from 184 thousand to 250 thousand in 2015.

The DID specifications are as follows:

$$log(taxable\ income)_{it} = \beta Treat_i * Post_t + (Z_i * \lambda_t)'\Theta + \gamma_i + \rho_t + u_{it},$$

where the dependent variable is the logarithm of the taxable income for firm $i$ in year $t$. $Treat_i$ is a dummy variable, as previously defined.[6] $Post_t$ is defined as 1 in the year 2015 and 0 in 2014. We include the interaction term between firm-level initial characteristics $Z_i$ [7] and year dummies $\lambda_t$ in the regressions to control for the time effects of these characteristics on the outcome of interest. $\gamma_i$ and $\rho_t$ represent firm and year-fixed effects, respectively. The standard errors are clustered at the firm level. Notably, the corporate income tax rate for the treatment group decreased from 20% in 2014 to 10% in 2015, while the control group's tax rate remained unchanged. The coefficient $\beta$ is expected to demonstrate a sign, indicating

[6] The regression yields an intention-to-treat effect. Firms with initial taxable income ranging from 100 thousand to 200 thousand in 2014 may not necessarily experience treatment effects. If their taxable income grows beyond 200 thousand, they will no longer enjoy the preferential tax rate.

[7] Firm-level initial characteristics include factors such as age, number of employees, industry dummies and city dummies.

the impact of the reduced tax rate on the growth of firm income.

Similar DID specifications are conducted for the 2015–2016, 2016–2017, and 2017–2018 samples in Table 4. [8] In each case, the results show that tax cuts exert a positive effect on taxable income. This suggests that the reduced tax rates encourages newly eligible firms to expand their business size. For example, Column 1 demonstrates that after cutting the corporate income tax rate from 20% to 10%, firms increase their taxable income by 16.8%. Furthermore, the ETI concerning the net-of-marginal tax rate is estimated at 1.34. Notably, the final row of Table 4 illustrates a decrease in the estimated ETI over time.

Table 4: Firms' Responses to Tax Cuts: DID results

| | Dependent variable: logarithm of taxable income | | | |
|---|---|---|---|---|
| | 2014–15 sample | 2015–16 sample | 2016–17 sample | 2017–18 sample |
| | (1) | (2) | (3) | (4) |
| Tax Cuts | 0.168 | 0.110 | 0.152 | 0.113 |
| | (0.036) | (0.046) | (0.046) | (0.041) |
| Initial Characteristics * Year FE | YES | YES | YES | YES |
| Observations | 9018 | 4256 | 4038 | 4198 |
| $R^2$ | 0.126 | 0.150 | 0.178 | 0.133 |
| Elasticity of Taxable Income (ETI) | 1.34 | 0.88 | 0.75 | 0.57 |

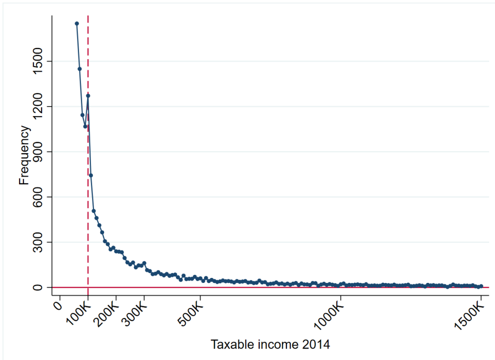
Note: The firm-level clustered standard errors are reported in parentheses. All regressions control for the interaction term of firm-level initial characteristics and year dummies. Firm-level initial characteristics include age, number of employees, industry dummies, and city dummies.

### 3.2 Bunching Response

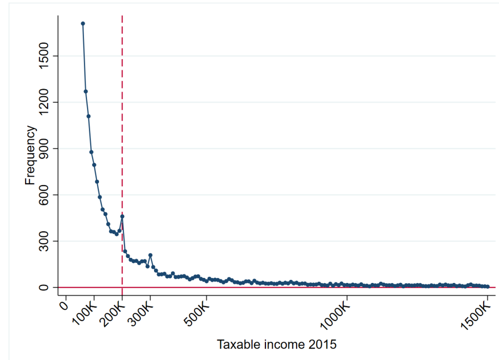
The Halve-Levy program creates significant discontinuous jumps in tax liability at program thresholds, inducing firms to bunch just below these thresholds to benefit from lower tax liability. Figure 1 illustrates the distribution of taxable income for different years. Panel A shows that, in 2014, a pronounced and sharp excess bunching was observed below 100 thousand RMB, the program threshold for that year, combined with missing mass above the threshold. Furthermore, we find no evidence of bunching at other points. Similarly, Panels B to E show evident bunching at 200 thousand, 300 thousand, 500 thousand, and one

[8] In the 2015–2016 sample, firms with initial taxable income in 2015 ranging [200 thousand, 300 thousand) and [300 thousand, 600 thousand) are defined as treated and control groups, respectively. The corporate tax rate of the treated group has fallen from 20% in 2015 to 10% in 2016, while the tax rate of the control group remains at 25%. In the 2016–2017 sample, firms with initial taxable income in 2016 ranging [300 thousand, 500 thousand) and [500 thousand, 1.1 million) are defined as treated and control groups, respectively. In the 2017–2018 sample, firms with initial taxable income in 2017 ranging [500 thousand, 1 million) and [1 million, 2.5 million) are defined as treated and control groups, respectively. For the 2016–2017 and 2017–2018 samples, the corporate tax rate of the treated group has fallen from 25% to 10%, while the tax rate of the control group stays at 25%.

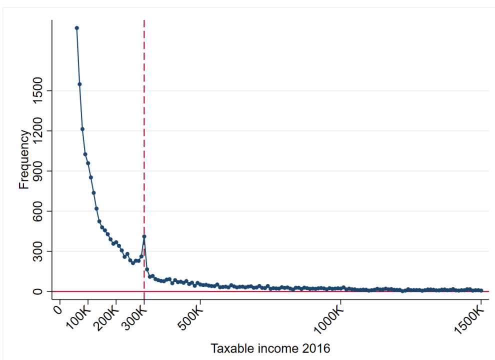
Figure 1: Bunching at Different Thresholds of Taxable Income



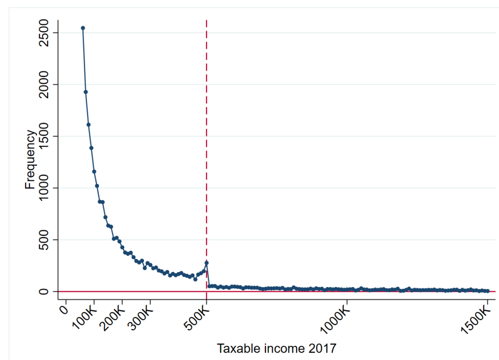

(a) Panel A



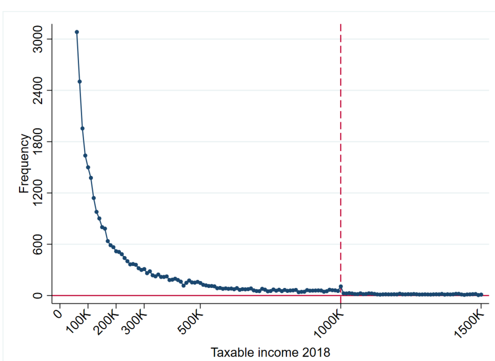

(b) Panel B




(c) Panel C




(d) Panel D




(e) Panel E

Note: This figure plots the empirical distribution of the taxable income for firms with taxable income between 50,000 RMB to 1.5 million RMB. Panels A, B, C, D, and E report the distribution for each year from 2014 to 2018, respectively. Notably, large fractions of firms bunch immediately below the thresholds (100,000 RMB in 2014, 200,000 RMB in 2015, 300,000 RMB in 2016, 500,000 RMB in 2017, and 1 million RMB in 2018) at which they can enjoy the reduced tax rate.
Source: Shanxi Administrative Tax Return Database.

million RMB for the years 2015, 2016, 2017, and 2018, respectively [9]. This corresponds to the varying program thresholds in different years. The figure indicates that, in response to the program, a substantial number of firms strategically position themselves at tax notches to reduce their tax burden.

To quantify the response in taxable income, we follow the approach of Kleven and Waseem (2013) and Chen, Liu, Serrato, and Xu (2021), which uses the observed distribution of taxable income $f_1(\cdot)$ to infer the counterfactual distribution in the absence of the tax cuts, denoted as $f_0(\cdot)$. This approach is based on the assumption that only firms within a specific exclusion region $[TI_l, TI_u]$ are responsive to the program. This approach uses $f_1(\cdot)$ outside this region to estimate $f_0(\cdot)$. We divide the data into small bins of taxable income denoted as $TI$. Further, we estimate the polynomial regression using the following equation:

$$c_j = \sum_{i=0}^{p} \beta_i \cdot (TI_j)^i + \sum_{s=TI_L}^{TI_U} \gamma_s \cdot \mathbf{1}(TI_j = s) + \varepsilon_j,$$

where $c_j$ represents the number of firms in the bin corresponding to taxable income $TI_j$; $p$ represents the order of the polynomials; $TI_l$ and $TI_u$ are the lower and upper bound of the exclusion region; the $\gamma_s$ values represent intercept shifters for each bin located within the exclusion regions. Subsequently, $\hat{c}_j = \sum_{i=0}^{p} \hat{\beta}_i \cdot (TI_j)^i$ is an estimate for $f_0(TI)$, which excludes the $\gamma_s$ shifters to ensure that the counterfactual density is smooth around the threshold.[10]

Comparing this counterfactual density with the observed distribution enables us to estimate the excess number of firms bunching to the left of the threshold, denoted as $\hat{B} = \sum_{j=TI_L}^{TI^*} (c_j - \hat{c}_j)$, in which $TI^*$ is the income threshold. Hence, we can obtain the standard bunching estimator $\hat{b} = \frac{\hat{B}}{\frac{1}{2}[\hat{f}_0(TI^*) + \hat{f}_0(TI_U)]}$, which is defined as the ratio of excess bunching mass to the average height of the counterfactual density at the threshold. This estimator measures the average bunching response, specifically considering the weighted average impact of the decreased taxable income for bunchers and the lack of reaction of non-bunchers within the bunching interval (Almunia and Lopez-Rodriguez, 2018). Following the approach of Kleven and Waseem (2013), we can further quantify the observed ETI with respect to the marginal tax rate. [11]

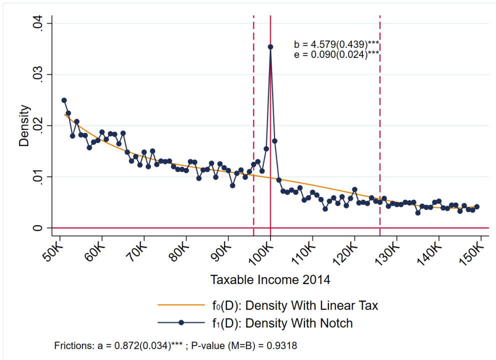
Figure 2 displays the results of this estimation. In each panel, the blue line with circle markers represents the observed distribution of taxable income, denoted as $f_1(\cdot)$. The orange line represents the estimated counterfactual density, denoted as $\hat{f}_0(\cdot)$, and the excluded

[9]Moreover, a tiny and insignificant bunching at 300 thousand in 2015 is observed. This pattern aligns with the fact that the threshold was raised from 200 thousand to 300 thousand in October 2015.

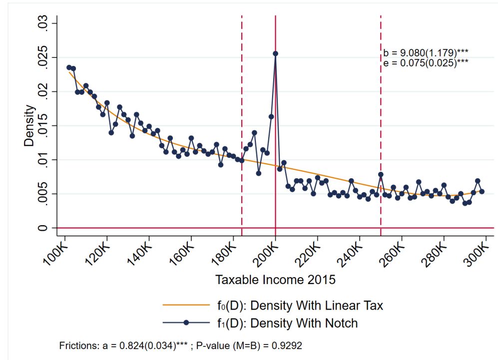
[10]Following Diamond and Persson (2016), $TI_l$ , $TI_u$, and $p$ are determined by a data-driven procedure that ensures that $\hat{f}_0(\cdot)$ has the same mass over the excluded region as $f_1(\cdot)$. See online Appendix Section 8.1.1 for details.

[11]Please refer to Appendix 8.1.2 for details.

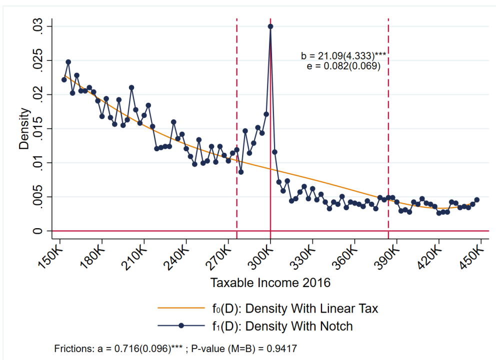
Figure 2: Estimated Counterfactual Densities of Taxable Income



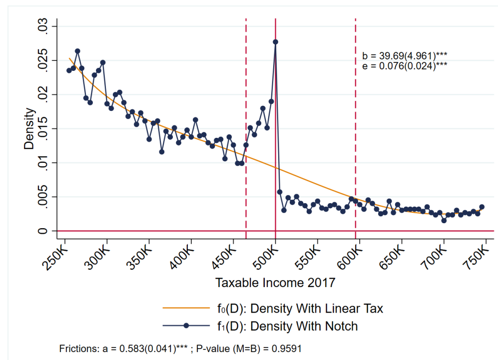

(a) Panel A. 2014



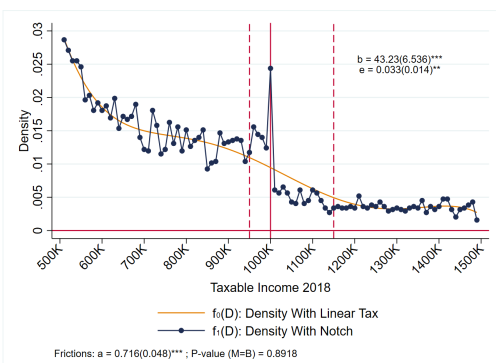

(b) Panel B. 2015




(c) Panel C. 2016




(d) Panel D. 2017




(e) Panel E. 2018

Note: This figure reports the results of bunching estimation for each year from 2014 to 2018. Within each panel, we plot the empirical density of taxable income in blue and the estimated counterfactual taxable income in orange. The lower bound $TI_l$ and upper bound $TI_u$ for the excluded region are indicated by vertical short-dashed lines. $\alpha^*$ represents the fraction of firms constrained from participating in the program. We provide the $p$-value of the test assessing the equality of the missing mass and the excess mass. $b$ represents the average decrease in taxable income in the exclusion regions, and $e$ denotes the estimated ETI with respect to the marginal tax rate. The horizontal coordinate is in thousands of RMB.
Source: Shanxi Administrative Tax Return Database.

region $[TI_l, TI_u]$ is demarcated by vertical short-dashed lines. The bunching estimator $\hat{b}$ and tax elasticity estimator $e$ are also shown in the graph. As shown in Panel A, the bunching estimator is 4.579 (s.e. 0.439) for the year 2014 and is statistically different from zero. This point estimate indicates that firms originally within the bunching interval reduce their reported taxable income by an average 4.58 thousand RMB, which is approximately 4.6% of the total taxable income, in response to the tax notch. The estimated ETI with respect to net-of-marginal-tax rate is 0.09 [12]. The magnitude of these bunching responses (as well as the elasticity) is constrained by a substantial number of firms within the bunching region that should logically respond to the notch but do not, owing to optimization frictions, such as neglect of the tax cuts program or adjustment costs. As shown in the figure, the proportion of firms situated in strictly dominated regions that fail to respond to the program is $\alpha^{*}$=0.87 in 2014. Panels B to E further show that firms in the exclusion region reduce their reported taxable income by 4.5%, 7.0%, 7.9%, and 4.3% for each year between 2015 and 2018, respectively, and the estimates of the proportion of non-responders fluctuate between 0.58 and 0.82 during the same period. [13]

The empirical analysis in this section provides essential insights into the production incentives of current policies for beneficiary firms and confirms the existence of firm bunching behavior at the notch points. However, to comprehensively understand how current policies impact economic output and tax revenues, a unified framework incorporating mechanisms that positively and negatively affect firms' production is crucial. In the subsequent section, we develop a structural model based on our empirical findings to analyze firms' production strategies in response to tax incentives and cost shocks. This model enables a more comprehensive welfare analysis of policies and facilitates a comparison of the outcomes of different potential SME support policies.

# 4 Model

In this section, we develop a theoretical framework to model firms' production and entry decisions, with a focus on understanding the influence of changes in tax incentives on firms' output. The construction of this model is motivated by empirical findings and provides model propositions and structural parameters that align with observed patterns in firm behaviors.

The fundamental structure of our model is based on a standard Melitz (2003) model. In this framework, each firm produces a differentiated product, and firms exhibit diversity in productivity. Under monopolistic competition, firms make decisions regarding market entry by assessing after-tax profits derived from their business activities, along with unamortizable

[12]The ETI obtained from bunching estimates is notably smaller than DID estimates (Table 4). He et al. (2021) also find that the elasticity of individual taxable income estimated from tax reform and bunching approach differs.

[13]Appendix 8.1.3 further shows that these bunching estimates are robust to a battery of specification tests.

pre-tax entry opportunity costs independent of their direct business operations.

To address the impact of corporate income tax incentives on changes in a firm's production scale, we introduce the Arkolakis (2010) fixed cost structure for market entry. Within our framework, the opportunity cost incurred in establishing a firm's business is a convex function of the firm's market penetration. This modeling approach ensures the alignment of our theoretical propositions with crucial empirical findings: (1) reduced corporate income tax rates prompt incentivized firms to expand their production levels; (2) the estimated elasticity of taxable income is decreasing over the Halve-Levy program's implementation years. Additionally, we incorporate incentives for firms' bunching behaviors to scale down production to the notch point, achieving a decreased tax rate in our theoretical model.

Consequently, our model captures the positive effect of tax incentives on economic output, reducing costs for beneficiary firms and promoting their growth, and the negative effect on economic output, prompting specific firms to scale down production to exploit the tax incentives. Equipped with this theoretical foundation, we can analyze the overall impact of existing notch tax policies on economic output and assess the effectiveness of different policies in supporting the development of SMEs.

We proceed by first addressing the demand side of the model and subsequently introduce the model setup pertaining to the supply side.

### 4.1 Demand

We utilize a standard Constant Elasticity of Substitution preference for aspect of the demand. In China, each firm produces a single and differentiated product, denoted as $j$. A representative Chinese consumer optimizes their utility by purchasing individual goods $j$ in quantities $q_j$ according to the utility function:

$$U = [\int_{j\in\Omega} f_j^{\frac{1}{\sigma}} q_j^{\frac{\sigma-1}{\sigma}} dj]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where $\sigma > 1$ represents the elasticity of substitution between goods, and $\Omega$ represents the set of all available products in the Chinese market. The parameter $f_j$ denotes the market penetration ratio of product $j$ in China, serving as a preference shifter within consumers' preferences. Higher market exposure of firm $j$'s products implies a higher likelihood that a representative consumer gains access to its product, resulting in increased utility from purchasing more of good $j$ for the representative consumer. Consumers optimize their consumption $q_j$ to maximize their utilities. We define the aggregate expenditure in China as $X_n$. Hence, the quantity demanded of good $j$ at price $p_j$ can be expressed as follows:

$$q_j = f_j \frac{p_j^{-\sigma}}{P_n^{1-\sigma}} X_n \tag{2}$$

where we define the price index in China as $P_n = [\int_{j\in\Omega} f_j p_j^{1-\sigma} dj]^{\frac{1}{1-\sigma}}$. The expenditure on good $j$ is then given by

$$r_j = f_j(\frac{p_j}{P_n})^{1-\sigma} X_n \tag{3}$$

### 4.2 Producer heterogeneity and unit cost

The firm producing goods labeled as $j$ in Shanxi utilizes resources and manufacturing inputs for its production activities. Each firm denoted as $j$ possesses a distinct productivity denoted as $\varphi_j$, and the cost of its bundle of resources and manufacturing inputs is denoted as $w_s$ in Shanxi. We assume a constant return to scale production function, and the marginal cost of good $j$ is represented as follows:

$$c_j = \frac{w_s}{\varphi_j} \tag{4}$$

Each firm $j$'s productivity $\varphi_j$ is drawn from a Pareto distribution [14] as

$$\mu(\varphi_j \geq \varphi) = T_s(\varphi)^{-\theta} \tag{5}$$

where $T_s$ represents the technology level of Shanxi firms, and $\theta$ controls the dispersion of firm productivity.

### 4.3 Opportunity cost

The firm manager initially observes the firm's productivity and subsequently makes a decision on whether to enter the market and compete to generate profits. This decision considers the firm's productivity level, market competition, market demand, and the opportunity cost of establishing a firm.

We consider the opportunity cost of establishing a business as an independent cost not directly related to the firm's primary business activities and not deductible in the calculation of corporate income tax. To account for the fact that larger product market penetration ratios and production scales require a larger management board and more time investment from managers, we define the opportunity cost $F_j$ incurred by firm $j$ for selling and penetrating a fraction $f_j$ of potential consumers in the Chinese market[15]. The specification is

[14] The distribution choice is often employed in influential papers such as those by Gabaix (1999), Luttmer (2007), Helpman, Melitz, and Yeaple (2004), Chaney (2008), Arkolakis (2010), and Eaton, Kortum, and Kramarz (2011), among others. The selection of the Pareto distribution of firm productivity enables us to obtain a solid alignment with the distribution of firms' sales, considerably simplifying our estimation procedure.

[15] A similar form of fixed costs is also present in studies by Arkolakis (2010) and Eaton, Kortum, and Kramarz (2011). Arkolakis (2010) interprets the fixed cost as marketing cost, while Eaton, Kortum, and Kramarz (2011) introduced a firm-specific fixed cost shock into the framework of Arkolakis (2010).

given by

$$F_j = F_s \frac{1-(1-f_j)^{1-\frac{1}{\lambda}}}{1-\frac{1}{\lambda}} \tag{6}$$

where $F_s$ represents the opportunity cost shock experienced by all firms in Shanxi, while the parameter $\lambda$ reflects the increasing cost of reaching a larger fraction of potential buyers. The variable $f_j$ assumes values between 0 and 1, measuring the exposure of firm $j$'s products to the total buyers in China. We assume that each consumer in China encounters each firm's product with an equal probability, and the impact of the penetration degree $f_j$ is already incorporated into the utility function of the representative consumer.

This functional form for the opportunity cost possesses desirable characteristics to approximate firms' opportunity costs and sales decisions. First, the fixed cost is 0 if the firm reaches $f = 0$ consumers, and it monotonically increases with the penetration ratio $f_j$. Second, as shown in the subsequent subsection, the convex function of penetration degree $f_j$ implies a negative relationship between the corporate income tax rate faced by firm $j$ and the production scale it decides upon. This property is crucial for our model to align with the evidence that reductions in corporate income tax result in production expansion for firms affected by this policy. Furthermore, we leverage this characteristic to analyze the impacts of tax policies on firm production in our counterfactual analysis.

This functional form for the opportunity cost is well-motivated, realistic, and intuitive while being consistent with our empirical findings. It facilitates the objectives of our counterfactual analyses and contributes to understanding the implications of tax policies on firm behavior and production decisions.

### 4.4 Entry and competition

Conditional on entry, firm $j$ characterized by a unit cost of $c_j$, pricing at $p_j$, and penetrating a fraction $f_j$ of consumers generates a net profit under its applicable corporate income tax rate $\tau_j$ as follows:

$$\pi_j(p_j, f_j) = (1-\tau_j) f_j (p_j - c_j) \frac{p_j^{-\sigma}}{P_n^{1-\sigma}} X_n - F_s \frac{1-(1-f_j)^{1-\frac{1}{\lambda}}}{1-\frac{1}{\lambda}} \tag{7}$$

For optimization, firm $j$ prices its product at the constant markup over unit cost, following the framework of Dixit and Stiglitz's (1977):

$$p_j = \frac{\sigma}{\sigma-1} c_j. \tag{8}$$

To simplify the notations, we define $\overline{m} = \frac{\sigma}{\sigma-1}$. By taking the F.O.C. of Equation (7) regarding the penetration ratio $f_j$, incorporating Equation (8), we obtain the optimal market penetration ratio for firm $j$:

$$f_j = max\{1 - [(1-\tau_j)\frac{X_n}{\sigma F_s}(\frac{\overline{m}c_j}{P_n})^{1-\sigma}]^{-\lambda}, 0\} \tag{9}$$

The maximum unit cost $\bar{c}$ incurred by a firm to earn a positive profit and exist on the market, making $f > 0$, is given by

$$\bar{c} = [(1-\bar{\tau})\frac{X_n}{\sigma F_s}]^{\frac{1}{\sigma-1}}\frac{P_n}{\overline{m}} \tag{10}$$

where $\bar{\tau}$ is the lowest level of corporate income tax rates for the smallest firms. Correspondingly, the productivity threshold for the least productive firm to survive in the market is

$$\bar{\varphi} = w_s[(1-\bar{\tau})\frac{X_n}{\sigma F_s}]^{\frac{1}{1-\sigma}}\frac{\overline{m}}{P_n} \tag{11}$$

Firm $j$ enters the market if and only if its productivity satisfies $\varphi_j \geq \bar{\varphi}$. With goods markets clearing, by substituting Equations (8), (9), and (11) into (3), we arrive at the functional representation of the taxable income of firm $j$ as follows:

$$\pi_j^{tax} = \frac{r_j}{\sigma} = \frac{X_n}{\sigma}(\frac{\overline{m}c_j}{P_n})^{1-\sigma}\{1-[\frac{1-\bar{\tau}}{1-\tau_j}(\frac{c_j}{\bar{c}})^{\sigma-1}]^{\lambda}\} = \frac{F_s}{1-\bar{\tau}}(\frac{\varphi_j}{\bar{\varphi}})^{\sigma-1}\{1-[\frac{1-\bar{\tau}}{1-\tau_j}(\frac{\varphi_j}{\bar{\varphi}})^{1-\sigma}]^{\lambda}\} \tag{12}$$

Taking the logarithm of both sides of the equation and incorporating time subscript $t$, we have

$$log(\pi_{jt}^{tax}) = log(F_{st}) - log(1-\bar{\tau}_t) + (\sigma-1)(log(\varphi_{jt}) - log(\bar{\varphi}_t)) + log\{1-[\frac{1-\bar{\tau}_t}{1-\tau_{jt}}(\frac{\varphi_{jt}}{\bar{\varphi}_t})^{1-\sigma}]^{\lambda}\} \tag{13}$$

Equations (10) and (11) govern entry, while Equations (9) and (12) govern taxable income conditional on entry. These equations link our theory on how exogenous economic shocks, including tax cuts, affect firms' production to the data.

These equations are crucial for our counterfactual analysis. They enable us to draw inferences consistent with our empirical findings. By merging Equations (9) and (3) and subsequently taking the first-order derivative of the corporate income tax rate $\tau_j$, we obtain the following result.

**Proposition 1:** If $\lambda > 0$, firms covered by a lower corporate income tax rate expand their production.

**Proof:**

$$\frac{\partial r_j}{\partial \tau_j} = \frac{\partial f_j}{\partial \tau_j} X_n P_n^{\sigma-1}(\bar{m}c_j)^{1-\sigma} = -\lambda(1-\bar{\tau})^{-\lambda-1}(\sigma F_s)^{\lambda}[X_n P_n^{\sigma-1}(\bar{m}c_j)^{1-\sigma}]^{1-\lambda} < 0.$$

In our model, a firm's taxable income is determined by a constant return to scale of the firm's market penetration. Simultaneously, the opportunity cost of establishment faced by the firm follows a convex function of the market penetration ratio. In this framework, the optimal market penetration ratio chosen by the firm depends on the marginal taxable income gain and the marginal opportunity cost from an additional unit of market penetration. When the corporate income tax is lower, the marginal benefit of penetrating the market is higher; hence, firms increase their market penetration and the final production output. This model proposition aligns with our empirical evidence discussed in Section 3.1. This proposition within our model ensures that it provides a mechanism for tax preferential policies to facilitate the expansion of covered firms' production scale. This aspect becomes crucial when testing the economic effects of existing policies. Furthermore, the following proposition demonstrates how our model is consistent with the decreasing elasticity of taxable income as estimated in Table 4.

**Proposition 2:** If $\lambda > 0$, smaller firms will expand their production size more substantially as a result of being exposed to lower tax rates than larger firms.

**Proof:**

$$\frac{\partial log(r_j)}{\partial \tau_j \partial \varphi_j} = \frac{1}{f_j}\frac{\partial f_j}{\partial \tau_j \partial \varphi_j} = \frac{1}{f_j}\lambda^2(\sigma-1)(1-\tau_j)^{-\lambda-1}\varphi_j^{-(\sigma-1)\lambda-1}[\frac{X_n}{\sigma F_s}(\frac{\bar{m}w_s}{P_n})^{1-\sigma}]^{-\lambda} > 0.$$

In our model, a firm's marginal benefits derived from its market penetration are also related to the firm's productivity and manufacturing costs. Larger and more productive firms demonstrate greater market expansion size in our model. In a setting where a firm's opportunity cost follows a convex function relative to the market penetration ratio, larger firms experience a steeper increase in the opportunity cost associated with further expansion than smaller firms. Thus, lower productivity and smaller firms expand more when being exposed to a lower tax rate. As a result, Proposition 2 predicts that the increasing size requirement threshold corresponds to the decreasing estimated elasticity of taxable income as we show in Table 4.

The aforementioned model propositions explore the impact of changes in the corporate income tax rate on a firm's production scale regarding the intensive margin. Similar to other studies built on Melitz's (2003) model[16], the following proposition analyzes the impact of lower corporate income tax rates on economic output regarding the extensive margin.

**Proposition 3:** A lower corporate income tax rate leads to more micro firms surviving in the market.

**Proof:**

$$\frac{\partial \bar{\varphi}}{\partial \bar{\tau}} = \frac{1}{\sigma-1}w_s\frac{\bar{m}}{P_n}(\frac{X_n}{\sigma F_s})^{\frac{1}{1-\sigma}}(1-\bar{\tau})^{\frac{\sigma}{1-\sigma}} > 0.$$ [17]

[16] For instance, Helpman, Melitz, and Yeaple (2004), Chaney (2008), Arkolakis (2010), and Eaton, Kortum, and Kramarz (2011), among others.

[17] In traditional trade entry models, lower trade costs resulting from trade liberalization lead to more entrants and market competition, and thus increase the productivity threshold for survival in the market. In our model, lower

A lower tax rate provides micro and small firms with a larger marginal gain in production and lowers the productivity threshold requirement for firms to survive in the market. This proposition aligns with the corollary of the extensive effect of tariffs and other economic shocks in the margin on economic output and trade volumes in most macro and trade models in recent years.

Our model setup for firm output is derived from existing literature, and the model's predictions of how corporate income tax rate policy affects firm production size are consistent with empirical findings from real data. To complete our analysis of tax incentives' impact on firms' production, we model firms' bunching responses to notch-based tax policies in the next subsection.

### 4.5 Notch and bunching behaviors

The corporate income tax in China's Halve-Levy program has the following structure:

$$\tau = \begin{cases} \tau_0, & \text{if } \pi_j^{tax} > \alpha \\ \bar{\tau}, & \text{if } \pi_j^{tax} \leq \alpha \end{cases}$$

Here, $\alpha$ represents the policy threshold, $\tau_0$ denotes the regular corporate income tax rate (25%) applied to all firms before the Halve-Levy program started, and $\bar{\tau}$ denotes the preferential tax rate for the small treated firms (10%) in the Halve-Levy program.

A firm decides whether to engage in bunching behavior by comparing its net profit from bunching, achieved by setting $f^{\alpha}$ to make $\pi^{tax} = \alpha$, to the net profit of the firm at its optimal production scale above the notch—$f_j$ from Equation (9). Specifically, firm $j$ decides to reduce its production to $\alpha$ if $\pi_j^{tax}(\tau_j = \bar{\tau}) > \alpha$ and $(1-\tau_0)\pi_j^{tax}(\tau_j = \tau_0) - F(f_j(\pi_j^{tax}(\tau_j = \tau_0))) < (1-\bar{\tau})\alpha - F(f_j(\pi_j^{tax} = \alpha))$.

Following our aforementioned theoretical framework, there is a point at which all firms with taxable income under the original tax structure before the incentive is issued decide to reduce production. However, in reality, many firms in this interval did not scale back. In our model, we interpret these firms' failure to bunch as a result of missing information about favorable tax rates or the inability to adjust production or financial management promptly. We treat these missed bunches as exogenous and stochastic, and we assume that the probability of exogenously missing a bunch is $\delta_t^m$ for each year $t$ for a firm with a potential

corporate taxes would also encourage firms enjoying lower tax rates to penetrate a larger share of the market, thus increasing market competition. However, it is crucial to note that the economic output of SMEs covered by the Halve-Levy program accounts for less than 3% of total output during our sample year. Therefore, it is unlikely that the increase in market competition triggered by the expansion of production by these firms poses a greater challenge to the survival of microenterprises than the incentive for expansion that a lower tax rate directly creates for microenterprises. Thus, unlike the conclusions drawn from the classic Melitz model, our model underscores that reduced corporate taxes lead to the survival of a greater number of firms.

bunch.

Additionally, not all firms that can enjoy a lower tax rate by reducing production can precisely reduce their taxable income to the notch point $\alpha$. We assume that if a firm attempts to reduce production to the notch point, the scale of production it eventually reduces to, $\pi^{\alpha}$, follows an exogenous probability distribution, $G^{b}(\alpha)$.

The introduction of firms' bunching behavior in our model is based on the bunching estimates in Section 3.2. This enables our theory to capture the distortions and inefficiencies brought to the economy by the existing notch-based tax cuts. By incorporating these elements, our model provides a comprehensive analysis of the impact of tax incentives on firms' production, accounting for firms' bunching responses to the policy.

### 4.6 Misreporting

The literature on the economic effects of taxation has sparked considerable interest among economists in distinguishing between real decisions made by firms and the decisions they report to tax authorities, which can be influenced by tax policies. Thus far, our discussion of the Halve-Levy program's impact has centered on firms' reported behaviors, specifically the reported amount of taxable income. Now, we assume that firms are rational and simultaneously determine their reported income and actual income in their production and operation. [18] Next, we explain why the Halve-Levy program is unlikely to induce additional misreporting behaviors among covered firms.

In a recent impactful study on China's tax policy, Chen, Liu, Serrato, and Xu (2021) have developed a mechanistic approach to uncover firms' real investment levels and reevaluate their behaviors under tax incentives. They introduce an expected penalty cost function, denoted as $h(evasion_i)$, to account for a firm's misreported behavior, enabling them to determine the firm's optimal real investment level, given their reported investment level. This function, $h(evasion_i)$, implies that firm $i$ faces an expected cost of tax evasion exceeding the actual amount of tax evasion, $evasion_i$. However, in some cases, considering other costs such as investment adjustment costs, firms may find it advantageous to invest below the incentive thresholds and misrepresent their reported levels, resulting in a disparity between actual and reported investment levels brought by the tax policy.

The environment discussed in this study is also situated in a similar tax regime, where the potential profit a firm gains from tax evasion is less than the expected penalty cost if caught by the government for such evasion. In reality, the Chinese tax authorities have a corresponding penalty mechanism in place to deter tax evasion. In this setup, if a firm

[18] It's worth noting that during the study period, tax-cut policies were announced several months prior to their implementation. This provides bunching firms with ample time to adjust their production and report tax income decisions following their rational strategies.

analyzed in our study does not engage in bunching—it does not report its taxable income as $\alpha$—it naturally lacks an incentive to misrepresent its taxable income because the potential benefits from such actions are outweighed by the expected penalty cost of getting caught. Similarly, if a firm $i$ decides to bunch and report at the notch point $\alpha$, it has no incentive to misreport. Suppose firm $i$ has already produced up to its reported taxable income of $\alpha$. In that case, if it chooses to produce at a higher level of $\pi_i$, surpassing $\alpha$, and then misreports its income to $\alpha$, the expected penalty cost $h(\pi_i - \alpha)$ incurred would exceed the profit $\pi_i - \alpha$ made from the additional production and misreporting. [19]

Even if we further relax the functional form to allow $h(evasion_i) < evasion_i$ for $evasion_i$ within a small interval $(0, \bar{evasion})$ where $\bar{evasion}$ represents the threshold at which the expected penalty equals the evasion value, indicating that firms may engage in a small level of misreporting. Under these conditions, optimizing firms would equate the marginal cost of sheltering \$1 of income from taxation with the net marginal cost of reducing real production by \$1, as suggested by Chetty (2009). Consequently, all firms in the economy engage in slight misreporting to enhance their profits. Importantly, the Halve-Levy program still does not introduce additional incentives for firms to engage in misreporting and even empowers covered firms to better regulate their evasion behaviors as shown in our analysis above. This is because, having decreased production below the policy threshold $\alpha$, the cost to firms of continuing production and then misreporting their income exceeds the cost of misreporting income for non-bunching firms—in addition to the expected penalties that every misreporting firm faces, the additional cost of being removed from the SME preferential tax rate exists. The new scenario would not change the results of our assessment of the economic impact of the Halve-Levy program and our comparison of alternative SME support policies in the following sections. Therefore, our analysis remains valid even when acknowledging a minor degree of misreporting among all firms as it is not induced by the SME support policy.

However, if firms were less rational and first made real production decisions before determining their reported income, the Halve-Levy program might potentially induce additional misreporting behaviors. To further bolster our findings, we conduct a robustness check by analyzing the number of employees of firms near the notch point. This analysis helps infer whether a discontinuity in the ratio of the number of employees to taxable income exists near the notch point. Our findings in Appendix 8.2 provide additional empirical evidence that the SME policies we study do not incentivize firms to misreport their income. This suggests that firms act rationally and simultaneously determine both real production and

[19] Our misreporting outcome differs from that of Chen et al. (2021) owing to differing policies. The policy for R&D tax cuts focused on in their study requires firms' R&D levels to exceed a specific threshold. Consequently, firms in their case may have incentives to misrepresent instead of paying a substantial amount of R&D costs to bunch. Conversely, the SME policies we study require firms to have taxable income up to a specific threshold. Firms have no additional costs to bunch but face stricter penalties for producing more than the threshold and then misreporting; hence, they have little motivation to misreport.

reporting decisions.

Overall, regarding the SME income tax incentives, firms demonstrating bunching behavior are more inclined to reduce production rather than engage in misreporting.

# 5 Estimation

In the preceding section, we construct a model to capture the empirical pattern of how firms respond to tax incentives. In this section, we present our estimation method for recovering the parameters of the structural model, which will enable us to perform our counterfactual analysis.

## 5.1 Estimation Procedure

The set of parameters to be calibrated and estimated includes the following:

$$\{\sigma, \theta, \lambda, F_{st}, \delta_t^m, G_t^b(\alpha_t), \eta\}.$$

We begin by calibrating the elasticity of substitution $\sigma$. Following previous literature (Melitz and Redding, 2015; Chen, Chen, Liu, Serrato, and Xu, 2021), we set $\sigma$ to 4.

Next, we employ the non-linear least square method to estimate $\theta$, $\lambda$, and $F_{st}$. Our estimation process follows the algorithm outlined below:

1. Given the value of $\theta$, we simulate $N_t$ firm heterogeneity draws $\frac{\hat{\varphi_{nt}}}{\overline{\varphi}_t}$, where $N_t$ denotes the number of firm observations for each year $t$ in the data. Under the assumption that firm productivity follows a Pareto distribution of dispersion $\theta$, conditional on a firm $j$ surviving on the market and being observed by the economist, the firm's productivity relative to the threshold productivity $\frac{\varphi_{jt}}{\overline{\varphi}_t}$ follows a Pareto distribution of scale 1 and dispersion $\theta$. [20]

2. With the heterogenous firm draws, we then simulate the taxable income of the $N_t$ artificial firms using Equation (13), along with the values of $\theta$, $\lambda$, and $F_{st}$.

3. Finally, we rank the artificial and actual taxable incomes from smallest to largest for each year and estimate the parameters $\theta$, $\lambda$, and $F_{st}$ by minimizing the objective function:

$$\min \sum_t \sum_r \|log(\pi_{rt}^{tax,\ arti}) - log(\pi_{rt}^{tax,\ real})\|^2$$

[20] For a detailed proof, see Appendix 8.3.

where $\pi_{rt}^{tax,\ arti}$ represents the rth value of the taxable income of the artificial firms, and $\pi_{rt}^{tax,\ real}$ represents the rth value of the taxable income in the actual data. Additionally, to mitigate estimation bias arising from firms' bunching behaviors, we exclude a significant range of observations close to the notch and their corresponding artificial firms.

Our estimation strategy is similar to the method of simulated moments employed in recent structural studies of Chinese policies (e.g., Chen, Liu, Serrato, and Xu, 2021; Chen, Chen, Liu, Serrato, and Xu, 2021). However, our estimation is akin to an SMM estimation that maps each firm's sales to its counterpart as a moment to fit the overall distribution shape rather than targeting several sets of moments to capture the distribution shape.

Subsequently, we identify the probability parameter $\delta_{mt}$ and the probability distribution $G_t^b(\alpha_t)$ associated with firms' bunching behavior. Using the demand and production-related parameters $\theta$, $\lambda$, and $F_{st}$ estimated in the previous steps, we can recover the distribution of firm production under the linear tax. Thus, we can determine the interval $[\alpha, bunchbound_t]$, where $bunchbound_t$ is the upper bound of the taxable income of firms that have an incentive to reduce production for higher returns. We then introduce into the model the number of firms falling within this interval. By comparing the model simulation with data observations, we can infer the exogenous probability $\delta_{mt}$ that a firm misses the opportunity to reduce production to the notch.

Similarly, we divide the interval $[0.9\alpha_t, \alpha_t]$ into ten small segments. Based on the distribution of corporate taxable income under linear tax rates that we recover, we examine the extent to which more of the data are observed within these ten small bands compared to what is simulated by the model. Employing this non-parametric approach, we estimate the distribution of the final reduction outcome $G_t^b(\alpha_t)$ for the firm.

## 5.2 Estimation Results

Table 5 presents the calibration and estimation results for our structural parameters related to production and demand. Tables 6–8 display the estimation of parameters related to bunching behavior.

We first examine the parameter $\lambda$ in the model, which is particularly relevant to the expansion of SMEs. Previous studies, such as those by Arkolakis (2010) and Eaton, Kortum, and Kramarz (2011), estimated coefficients around 1.093 and 0.91, respectively, using data for French exporters and fixed cost functions for market penetration. In our study, using data from manufacturing firms located in Shanxi Province, China, we estimate $\lambda$ to be 0.623, which is smaller than the coefficients reported in the previous literature. This suggests a significant increase in fixed costs for market expansion, indicating that Chinese SMEs may encounter more resistance when expanding.

We also analyze the estimated dispersion parameter $\theta$ of the firm productivity distribution. Our estimated $\theta$ is smaller compared to the estimates in the studies by Arkolakis (2010) and Eaton, Kortum, and Kramarz (2011) and even smaller than $\sigma - 1$. One possible explanation is that the firms in Shanxi Province exhibit substantial variation differences. Shanxi Province is a relatively backward province in China. However, the province is known for its unique natural resources, which have contributed to the emergence of many affluent firms and billionaires in China. The dataset used in our analysis encompasses all tax-administrative firms in Shanxi Province. If we were to incorporate data from all firms in China, we would derive a higher estimate for the parameter $\theta$.

Table 5: Estimated Parameters - Demand and Supply

| Parameters | Calibrated / Estimated Values | Target |
|---|---|---|
| $\sigma$ | 4 | Melitz and Redding (2015)<br>Chen, Chen, Liu, Serrato, and Xu (2021) |
| $\theta$ | 1.526 | dispersion shape of taxable income |
| $\lambda$ | 0.623 | dispersion shape of taxable income |
| $F_s(2014)$ | 3031.2 | production level in 2014 |
| $F_s(2015)$ | 2990.77 | production level in 2015 |
| $F_s(2016)$ | 3979.37 | production level in 2016 |
| $F_s(2017)$ | 5186.81 | production level in 2017 |
| $F_s(2018)$ | 6081.16 | production level in 2018 |
| Observation | 453,651 | |
| $R^2$ | 0.999 | |

Note: The $F_{st}$ is measured in units of Chinese RMB. We delete the top and last 0.5% of the sample in the estimation to alleviate the bias of the extreme observations.

Next, we focus on the estimated $F_{st}$. Our results show that the market penetration cost base increases annually, except for 2015. This trend is consistent with the growth rate of Shanxi's regional GDP, which experienced a small decrease in 2015 and then increased annually, especially in 2016–2017.[21] By integrating our estimated $\lambda$, we can infer the market penetration costs for firms within Shanxi Province under the context of the specific Halve-Levy program policy. For instance, in 2016, a firm penetrating 50% of the national market corresponds to a market penetration cost of 3,427 RMB, while penetrating 99% of the national market incurs a cost of 100,141 RMB. This range of opportunity costs implies that large firms undergo smaller changes in production scale before and after the tax policy change. However, small and medium-sized firms experience a significant tax impact, which

[21] According to statistics from the Shanxi Bureau of Statistics, the GDP growth rate of Shanxi Province was 4.9% in 2014, 3.0% in 2015, 4.1% in 2016, 6.8% in 2017, and 6.7% in 2018.

aligns with our empirical observations and model propositions.

Table 6: Bound of Potential Bunching Firms' Taxable Income

| Year | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Upper bound | 132.84 | 258.43 | 386.09 | 638.58 | 1259.13 |
| Lower bound (threshold, $\alpha_t$) | 100 | 200 | 300 | 500 | 1,000 |

Note: The values above are measured in units of thousands of Chinese RMB.

With the coefficients estimated above, in conjunction with the specific Halve-Levy program, we can deduce the taxable income interval $[\alpha_t, \text{bunchbound}_t]$ applicable to firms incentivized to profit by cutting production. Table 6 showcases our estimated values for $\text{bunchbound}_t$ for each year. Our finding reveals that the bunch bound for each year surpasses the intuitive bound $1.2\alpha_t$.[22] Under the current tax system, the accounting tax benefits of producing taxable income at both $\alpha_t$ and $1.2\alpha_t$ are the same.[23]. Nevertheless, achieving production at $1.2\alpha_t$ requires greater management efforts, management time, and additional opportunity costs that cannot be accounted for in the accounting profit, resulting in a net benefit lower than that of reducing production to the bunch point $\alpha_t$. Consequently, we establish an upper bound on the taxable income of firms with an incentive to reduce production, which also exceeds $1.2\alpha_t$ per year.

Table 7: Bunching Parameters - Miss Bunching Probability

| | Miss Bunching Probability $\delta_t^m$ (%) | | | | |
|---|---|---|---|---|---|
| Year | 2014 | 2015 | 2016 | 2017 | 2018 |
| Rate | 86.68 | 84.92 | 73.71 | 59.99 | 67.17 |

Table 7 presents our estimates of the probability $\delta_t^m$ that a firm misses the opportunity to profit from a production reduction each year. Our structural parameter estimates indicate that in the first year of the Halve-Levy program inception, up to 86.68% of firms miss the opportunity to achieve greater gains by cutting production. Subsequently, the probability of firms missing bunching decreases each year from 2014 to 2017. Possible reasons for this include increasing opportunities to learn about tax benefits and the fact that firms are more likely to respond to policies as they accumulate experience. Notably, our estimates reveal that over the five years of policy implementation observed in our data, more than 50% of the firms motivated to reduce production did not ultimately profit from the reduction.

[22]Intuitively, $(1-\tau_0)\pi > (1-\bar{\tau})\alpha_t \Rightarrow (1-25\%)\pi > (1-10\%)\alpha_t \Rightarrow \pi > 1.2\alpha_t$. Hence, $[\alpha_t, 1.2\alpha_t]$ represents the intuitive bunch bound.

[23]$1.2\alpha_t * (1-25\%) = \alpha_t * (1-10\%)$

Table 8: Bunching Parameters - Reduction Outcome Distribution

| | Over Bunching Hazard $h^o$ (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intervals from the bunching range edge to the notch | | | | | | | | | |
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2014 | -4.38 | 1.68 | 3.48 | 0.58 | 3.68 | 8.38 | 6.96 | 5.05 | 14.26 | 60.32 |
| 2015 | 0.54 | 0.60 | 5.54 | 7.63 | 12.57 | -2.04 | 5.74 | 5.80 | 19.60 | 44.02 |
| 2016 | 3.07 | 4.49 | -1.07 | 9.51 | 4.24 | 7.04 | 10.93 | 9.83 | 14.85 | 37.12 |
| 2017 | 1.49 | 1.70 | 5.47 | 9.01 | 7.88 | 10.11 | 13.21 | 9.63 | 14.96 | 26.54 |
| 2018 | 7.70 | 8.08 | 7.99 | 3.01 | 5.56 | 11.97 | 10.67 | 9.92 | 7.28 | 27.84 |

Table 8 illustrates the final production reduction results for firms that decide to reduce production to the notch point. The table displays how firms that cut production from the right end of the notch point to the left end of the notch point each year are distributed in ten equal intervals from $0.9\alpha_t$ to $\alpha_t$. The probability distribution of these small intervals sums to 100% for each row (per year). As our estimation results demonstrate, most firms tend to bunch into the 8th, 9th, and 10th intervals. Our non-parametric estimation results also show that although firms do not precisely bunch to the notch point, they have a higher probability of bunching to intervals closer to the notch point.

The structural parameter estimation results presented in this section are crucial for our counterfactual analyses. The parameter estimates for demand and supply will be utilized to predict how tax incentives affect the production size of firms. Moreover, the estimates of parameters related to bunching behavior will be used to predict the extent to which tax policies influence firms' production reductions and distortions. This will contribute to evaluating the expectation of firms' eventual production reduction outcomes.

### 5.3 Model Fit

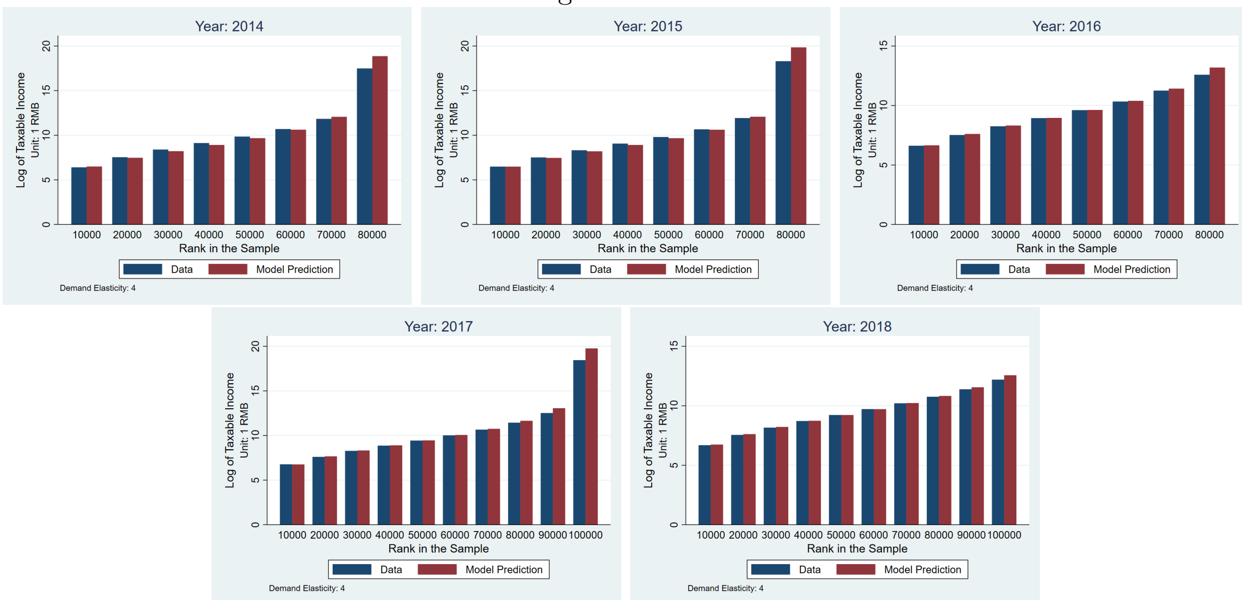
In this section, we assess the adequacy of the model's fit on firms' output using Figures 3 and 4.

Figure 3 examines whether the model aligns with the data on firms' production scale (taxable income). We begin by ranking the taxable income of each firm in each year from the real data and comparing it with the sales of each artificial firm in the model's prediction. Subsequently, we plot the log sales for each firm with the actual data against the model-predicted sales of the corresponding firm at the same rank for each year. Figure 3 reveals a close fit, although minor discrepancies are observed for some smaller firms on the scale's left end. These smaller firms exhibit constant low values in the data, while the model's predicted values gradually increase for their counterparts.

In Figure 4, we evaluate the model's fit for several non-targeted moments. Similar to the methodology in Figure 3, we rank the sales of each firm in each year from the actual data and compare them with the sales of each artificial firm in the model's prediction. We plot the log of taxable income for the 10,000th, 20,000th, 30,000th, 40,000th, 50,000th, 60,000th, 70,000th, 80,000th, 90,000th, and 100,000th firms in the actual data using the blue bars and in the model's prediction using the red bars. The bars demonstrate that our model exhibits a considerably close fit to the data. In particular, in the non-largest 10% of companies per year, the model predictions closely align with the actual data at each stage. For the fraction of the largest firms, our model's predictions are slightly higher than the actual data, primarily because of the excessive variation in Shanxi firms and our estimation of a smaller productivity dispersion parameter. Nonetheless, as our policy analysis focuses on the impact of policies on SMEs below this size, which are well-fitted in our model, the limited prediction bias for the largest firms does not significantly affect our final analysis.

Figure 3: Fit 1

Figure 4: Fit 2




# 6 Counterfactual Analysis

In this section, we leverage our model and estimation results to conduct three counterfactual analyses. First, we simulate the combined effect of the existing tax preferential policy on total output and tax revenue. Further, as illustrated in Table 9, we categorize potential market entrants into four distinct groups and analyze the contribution of each category to total output and tax revenue. Second, we compare the alternative policies of kink-based tax preferential policies and size-based precision subsidies to the current notch-based policy. Our comparison focuses on tax revenue while ensuring equivalent economic boost and stimulation for SMEs.

Table 9: Firms by Categories of Exposure to Policy Shocks

| Category | Firms |
|---|---|
| 1 | Exit the market under 25% tax but survive under the existing policy |
| 2 | Exist under 25% tax and enlarge their production under the existing policy |
| 3 | Have the motivation to reduce taxable income to the notch |
| 4 | Not covered by the lower tax rate and will not reduce production for profit |

To facilitate these analyses, we consider the adjustment of policy concerning input prices and labor employment. A counterfactual outcome in our model setup relies on the assumption that either input prices or employment are fixed and inelastic. Notably, the economic output of SMEs covered by the Halve-Levy program constitutes less than 3% of the total provincial output in our sample year. While preferential policies for micro and small enterprises prove highly effective in promoting growth and employment for such businesses, they have limited influence on market commodity prices because of their limited output share. Consequently, to close the model, we assume that the wages and input prices utilized by firms in the model are fixed and determined by the general exogenous economic environment. Moreover, we consider that the economy in Shanxi is not operating at its maximum employment capacity.

Therefore, for our counterfactual analysis, we maintain input prices and wage levels as constants. Additionally, we incentivize firms within Shanxi Province through policies to increase hiring and expand capital, aiming to facilitate economic growth and boost production among SMEs.

### 6.1 Welfare analysis of the existing policy

We analyze the impact of the existing notch-based corporate income tax incentives on overall economic output. The current policy motivates more firms to enter the market through the extensive margin. Moreover, it expands the production of firms covered by the preferential policy through the intensive margin. However, due to the notch property of the policy, some firms inefficiently curtail production. In the empirical findings section, we employ DID and bunching estimates to verify the effect of the policy on firms' expansionary production and bunching behavior independently. In this section, we utilize model simulations to quantify the collective effect of the policy on economic output. Furthermore, we determine the contributions of different types of firms, as shown in Table 9, to the overall change in output.

#### 6.1.1 Combined effect

Table 10 illustrates the combined effect of the Halve-Levy program on aggregate economic outcomes for each year. Our focus lies on the effects of the policies on aggregate output ($\Sigma_j r_j$), aggregate log output ($\Sigma_j log(r_j)$), and tax revenues ($\Sigma_j \tau_j \pi_j^{tax}$), respectively. Further, we consider the aggregate log output to provide substantial emphasis on SMEs in the economy, achieving a balanced distribution of economic output among firms. In the table, the 25% Tax column represents economic output and tax revenue under the original 25% linear tax system, while the Policy column displays the simulation of economic outcomes under the actual policy of the Halve-Levy program. The Effect column indicates the percentage change in the economic outcome resulting from the policy compared to the initial tax system.

The simulation results presented in Panel A show that the presence of tax incentives for undersized firms boosts total output by 0.09–0.1% per year.[24] Despite the inefficiencies and distortions around the notch point, the Halve-Levy program results in a positive impact on overall economic output.

Panel B indicates that the program drives an increase of 2.37–5.18% in the output for treated small firms. [25] The magnitude of the increase tends to decrease over the years, suggesting that as time passes and the policy threshold enhances, the size of new firms supported by the policy in later years becomes larger. Consequently, larger firms receive a smaller degree of growth in output boosts from the preferential policy compared to smaller firms.

Table 10: the Combined Impact of Halve-Levy program on Economic Outcomes

Panel A. Overall Economy

| Year | Aggregate Output ($\Sigma_j r_j$) Unit: Billions of Yuan | | | Aggregate Log Output ($\Sigma_j log(r_j)$) Unit: Thousands of Log Yuan | | | Tax Revenues ($\Sigma_j \tau_j \pi_j^{tax}$) Unit: Billions of Yuan | | |
|---|---|---|---|---|---|---|---|---|---|
| | 25% Tax | Policy | Effect (%) | 25% Tax | Policy | Effect (%) | 25% Tax | Policy | Effect (%) |
| 2014 | 45.64 | 45.68 | 0.09 | 679.79 | 731.89 | 7.66 | 11.41 | 11.28 | -1.11 |
| 2015 | 44.88 | 44.93 | 0.10 | 677.65 | 729.62 | 7.67 | 11.22 | 11.01 | -1.83 |
| 2016 | 65.17 | 65.23 | 0.09 | 761.59 | 820.46 | 7.73 | 16.29 | 15.97 | -2.00 |
| 2017 | 97.56 | 97.64 | 0.08 | 898.00 | 967.90 | 7.78 | 24.39 | 23.81 | -2.37 |
| 2018 | 132.88 | 133.00 | 0.09 | 1059.92 | 1142.81 | 7.82 | 33.22 | 32.12 | -3.30 |

Panel B. Treated SMEs

| Year | Aggregate Output ($\Sigma_j r_j$) Unit: Millions of Yuan | | | Aggregate Log Output ($\Sigma_j log(r_j)$) Unit: Thousands of Log Yuan | | | Tax Revenues ($\Sigma_j \tau_j \pi_j^{tax}$) Unit: Millions of Yuan | | |
|---|---|---|---|---|---|---|---|---|---|
| | 25% Tax | Policy | Effect (%) | 25% Tax | Policy | Effect (%) | 25% Tax | Policy | Effect (%) |
| 2014 | 869.11 | 914.09 | 5.18 | 506.68 | 558.81 | 10.29 | 217.28 | 91.41 | -57.93 |
| 2015 | 1392.39 | 1443.13 | 3.64 | 550.08 | 602.08 | 9.45 | 348.10 | 144.31 | -58.54 |
| 2016 | 2185.70 | 2260.82 | 3.44 | 626.98 | 685.89 | 9.40 | 546.43 | 226.08 | -58.63 |
| 2017 | 3829.82 | 3946.76 | 3.05 | 757.16 | 827.12 | 9.24 | 957.45 | 394.68 | -58.78 |
| 2018 | 7268.15 | 7440.49 | 2.37 | 930.82 | 1013.75 | 8.91 | 1817.04 | 744.05 | -59.05 |

Note: The "25% Tax" column represents economic output and tax revenue under the original 25% linear tax system, whereas the "Policy" column displays the simulated economic outcomes under the real policy of the Halve-Levy program. The "Effect" column indicates the percentage change in the economic outcome resulting from the policy compared to the initial tax system. The treated SMEs are specifically characterized as Type 1 and Type 2 firms, as referenced in Table 9.

Our counterfactual simulations demonstrate that existing policies boost total log output by 7.66–7.82% and the total log output of firms covered by preferential policy by 8.91–10.29%. The effect of existing policies on the total log output of the economy is larger relative to

[24] Our analysis excludes the top 0.5% of firms from the sample to prevent bias in the prediction of production for the largest firms because of the relatively small $\theta$ we estimated. Subsequent counterfactual analyses adhere to the same approach.

[25] In Table 10, the treated SMEs are specifically characterized as Type 1 and Type 2 firms, which are referenced in Table 9. These particular types of firms represent the Halve-Levy program's intended focus for support.

the boost in the economy's total output. Moreover, our results here closely align with the regression results in Section 3.1 of our empirical evidence, further confirming the accuracy of our model.

Finally, we analyze the impact of the existing policy on tax revenues. While the policy stimulates more firms to remain in the market and expand their output, it lowers overall tax revenues by anywhere from 1.11 to 3.3% due to the reduction in tax rates for covered firms.

### 6.1.2 Decomposition

Next, we categorize all firms into four distinct types, as displayed in Table 9, and examine the contributions of each category to the overall policy effects, as outlined in Table 11. We present the output and tax-related outcomes for different types of firms under the initial 25% linear tax rate and the existing preferential policies. The "Ratio" column indicates the proportion of the value added from each category of firms to the overall change in economic outcomes. Notably, the total ratio for all four categories equals 100% for each year. As shown in Table 11, the primary increase in economic output each year predominantly stems from the second category of firms, denoting the production expansion of existing firms. Conversely, the impact of new entrants and the reduction in production due to bunching behavior within the third category of firms demonstrate a relatively modest effect on the overall change in total output.

Furthermore, the influence of the bunching behavior of the third category of firms on economic output is more pronounced in the later years of the program than the earlier years. This is primarily because the lower corporate income tax rates provide less stimulus for the larger firms covered in the current years than in the earlier ones. As firms' miss-bunching probability decreases, the economic loss from bunching behavior increases. For example, in 2018, although the distorting effect of bunching behavior on economic output is only nearly one-third of the positive outcome from the expansion of Type 2 firms, the inefficiency of bunching behavior on the economy is already significant than it was in 2014.

When considering aggregate log output, the results in Table 11 indicate that Types 1 and 2 firms predominantly drive the impact, suggesting that the survival of new entrants significantly enhances the policy objectives of policymakers, particularly when they are focused on aggregate log output.

This analysis reveals the time-varying effect of the tax rate reduction policy on economic output. Over time, newly covered firms receive diminishing incentive boosts for output, while the negative effects of the notch-based policy increase as firms increasingly exploit policy rules to capitalize on bunching behavior. Our simulation results also underscore that even if the policymaker does not consider the reduction in tax revenue from tax incentives, providing wider coverage of incentives does not necessarily guarantee a substantial increase in the economy's output. Practically, Chinese policies have shown some iteration in selecting the threshold of preferential policies.

Table 11: Impact of Tax Cuts on the Economy by Firm Types

| Type | # of Firms | Aggregate Output Billions of Yuan | | | Aggregate Log Output Thousands of Log Yuan | | | Tax Revenue Millions of Yuan | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 25% Tax | Policy | Ratio | 25% Tax | Policy | Ratio | 25% Tax | Policy | Ratio |
| Year: 2014 | | | | | | | | | | |
| 1 | 7115 | 0 | 0.001 | 3.52 | 0.00 | 35.48 | 68.10 | 0.00 | 0.15 | -0.11 |
| 2 | 59846 | 0.869 | 0.913 | 105.28 | 506.68 | 523.34 | 31.96 | 217.28 | 91.26 | 99.28 |
| 3 | 1674 | 0.193 | 0.189 | -8.80 | 19.51 | 19.48 | -0.06 | 48.26 | 47.20 | 0.83 |
| 4 | 11705 | 44.580 | 44.580 | 0.00 | 153.60 | 153.60 | 0.00 | 11145.07 | 11145.07 | 0.00 |
| Year: 2015 | | | | | | | | | | |
| 1 | 7103 | 0 | 0.001 | 3.16 | 0.00 | 35.32 | 67.97 | 0.00 | 0.14 | -0.07 |
| 2 | 63552 | 1.392 | 1.442 | 108.43 | 550.08 | 566.75 | 32.08 | 348.10 | 144.17 | 99.20 |
| 3 | 1114 | 0.253 | 0.248 | -11.58 | 13.74 | 13.71 | -0.04 | 63.33 | 61.54 | 0.87 |
| 4 | 8435 | 43.236 | 43.236 | 0.00 | 113.83 | 113.83 | 0.00 | 10809.09 | 10809.09 | 0.00 |
| Year: 2016 | | | | | | | | | | |
| 1 | 7746 | 0 | 0.002 | 3.41 | 0.00 | 40.73 | 69.19 | 0.00 | 0.21 | -0.06 |
| 2 | 69885 | 2.186 | 2.259 | 119.69 | 626.98 | 645.16 | 30.88 | 546.43 | 225.87 | 98.44 |
| 3 | 1133 | 0.386 | 0.372 | -23.11 | 14.43 | 14.39 | -0.07 | 96.43 | 91.16 | 1.62 |
| 4 | 8694 | 62.594 | 62.594 | 0.00 | 120.18 | 120.18 | 0.00 | 15648.42 | 15648.42 | 0.00 |
| Year: 2017 | | | | | | | | | | |
| 1 | 8888 | 0 | 0.003 | 3.83 | 0.00 | 49.09 | 70.23 | 0.00 | 0.31 | -0.05 |
| 2 | 81458 | 3.830 | 3.944 | 139.91 | 757.16 | 778.03 | 29.86 | 957.45 | 394.36 | 97.38 |
| 3 | 1128 | 0.638 | 0.602 | -43.74 | 14.94 | 14.87 | -0.09 | 159.39 | 143.92 | 2.67 |
| 4 | 8880 | 93.093 | 93.093 | 0.00 | 125.90 | 125.90 | 0.00 | 23273.19 | 23273.19 | 0.00 |
| Year: 2018 | | | | | | | | | | |
| 1 | 10324 | 0 | 0.004 | 3.45 | 0.00 | 58.66 | 70.78 | 0.00 | 0.42 | -0.04 |
| 2 | 97300 | 7.268 | 7.436 | 136.86 | 930.82 | 955.09 | 29.28 | 1817.04 | 743.62 | 97.92 |
| 3 | 963 | 1.081 | 1.031 | -40.32 | 13.41 | 13.37 | -0.05 | 270.21 | 246.94 | 2.12 |
| 4 | 7984 | 124.526 | 124.526 | 0.00 | 115.69 | 115.69 | 0.00 | 31131.55 | 31131.55 | 0.00 |

Note: Column "25% Tax" presents the output and tax outcomes of different types of firms under the initial 25% linear tax rate, while the "Policy" column presents the output and tax outcomes of different types of firms under the existing preferential policies. The "Ratio" column indicates the proportion of the value added from each category of firms to the overall change in economic outcomes, with the total ratio for all four categories summing up to 100% for each year.

### 6.2 Alternative Support Policies

Next, we assess the effects of different government support policies on SMEs by comparing them to the benchmark of notch-based tax cuts. Specifically, we examine the efficiency of kink-based tax cuts and precise subsidies based on firm sales size in stimulating economic output and securing tax revenue.

Table 12 presents the four types of policies we use in our counterfactual analysis for comparison. First, the linear tax scenario represents the absence of any tax cuts, with all firms facing a 25% corporate tax rate on all taxable income. The Notch policy refers to the notch-based incentives similar to those implemented in the Halve-Levy program. Kink denotes kink-based tax cuts set at the same preferential tax rate level and preferential threshold position as the existing policy. Subsidy involves a subsidy policy where the opportunity cost of operating a firm's sales can be accurately estimated, and the opportunity cost for the portion of taxable income under the threshold is subsidized by 1/6 (the subsidy makes the actual opportunity cost base, $F_s^*$, of the firm subsidized to 5/6 of the original base, $F_s$). We set the subsidy ratio to 1/6 of the opportunity cost because, at this level of subsidy, the threshold of firm productivity that can survive in the market is similar for notch-based tax cuts, kink-based tax cuts, and scale-based subsidies. This policy setting enables us to ensure that the extensive margin of new entrants from different support policies remains the same. This also enables us to mitigate additional noise when comparing the advantages and disadvantages of different policies.

Table 12: Support Policies for Comparison

| Policy | Policy Threshold | Preferential Policy |
|---|---|---|
| Linear Tax | N.A. | N.A., 25% for all the taxable income |
| Notch | As real policy | 10% for all the taxable income if it is smaller than the threshold |
| Kink | As real policy | 10% for the part of taxable income under the threshold |
| Subsidy | As real policy | subsidy of 16.67%'s opportunity cost for the taxable income under the bar |

#### 6.2.1 Tax cuts and subsidies with the same threshold

Table 13 presents the impact of different support policies on total economic output, total log output, and tax revenue. These policies include versions of notch-based tax cuts, kink-based tax cuts, and scale-based subsidies, all set at identical policy threshold positions and with the equivalent extensive margin advantages.

Panels A and B illustrate the effects of different policies on the total economic output and the economic output of smaller firms covered by preferential policies.[26] Panel C provides

[26] In Table 13, the covered SMEs are precisely identified as Type 1, Type 2, and Type 3 firms, which can be cross-referenced in Table 9. These specific types of firms contribute to driving the overall changes in production and tax revenue within the Halve-Levy program.

further insights into the effects of different policies on tax revenues. For our counterfactual analysis, we consider the long-run impact of policies and assume that firms are fully informed about policy changes. Specifically, we assume that all firms with an incentive to reduce output profitably from notch-based preferences enact such reductions precisely to the point of the notch.

Table 13: Aggregate Impact of Different Support Policies on the Economy

Panel A. Aggregate Production

| | Total Economy | | | | Covered SMEs | | | |
|---|---|---|---|---|---|---|---|---|
| | Original | Change Rate | | | Original | Change Rate | | |
| Year | 25% Tax | Notch | Kink | Subsidy | 25% Tax | Notch | Kink | Subsidy |
| Unit: | Millions | | % | | Millions | | % | |
| 2014 | 45642.4 | 0.04 | 0.10 | 0.10 | 1062.2 | 1.83 | 4.24 | 4.10 |
| 2015 | 44882.1 | 0.05 | 0.11 | 0.11 | 1645.7 | 1.24 | 3.09 | 3.03 |
| 2016 | 65165.1 | 0.05 | 0.12 | 0.11 | 2571.4 | 1.15 | 2.93 | 2.88 |
| 2017 | 97560.1 | 0.05 | 0.12 | 0.12 | 4467.4 | 0.98 | 2.63 | 2.59 |
| 2018 | 132875.2 | 0.04 | 0.13 | 0.13 | 8349.0 | 0.66 | 2.07 | 2.05 |

Panel B. Aggregate Log Production

| | Total Economy | | | | Covered SMEs | | | |
|---|---|---|---|---|---|---|---|---|
| | Original | Change Rate | | | Original | Change Rate | | |
| Year | 25% Tax | Notch | Kink | Subsidy | 25% Tax | Notch | Kink | Subsidy |
| Unit: | Thousands | | % | | Thousands | | % | |
| 2014 | 679.8 | 7.63 | 7.67 | 7.67 | 526.2 | 9.86 | 9.91 | 9.90 |
| 2015 | 677.7 | 7.65 | 7.67 | 7.67 | 563.8 | 9.20 | 9.22 | 9.22 |
| 2016 | 761.6 | 7.72 | 7.74 | 7.73 | 641.4 | 9.16 | 9.18 | 9.18 |
| 2017 | 898.0 | 7.78 | 7.79 | 7.79 | 772.1 | 9.04 | 9.06 | 9.06 |
| 2018 | 1059.9 | 7.81 | 7.82 | 7.82 | 944.2 | 8.77 | 8.78 | 8.78 |

Panel C. Tax Revenue

| | Total Economy | | | | Covered SMEs | | | |
|---|---|---|---|---|---|---|---|---|
| | Original | Reduction | | | Original | Reduction | | |
| Year | 25% Tax | Notch | Kink | Subsidy | 25% Tax | Notch | Kink | Subsidy |
| Unit: | Millions | | | | Millions | | | |
| 2014 | 11410.6 | 157.38 | 320.53 | 30.17 | 265.5 | 157.38 | 150.97 | 30.17 |
| 2015 | 11220.5 | 244.82 | 478.21 | 37.95 | 411.4 | 244.82 | 237.19 | 37.95 |
| 2016 | 16291.3 | 382.75 | 742.86 | 57.13 | 642.9 | 382.75 | 371.30 | 57.13 |
| 2017 | 24390.0 | 665.71 | 1275.75 | 91.83 | 1116.8 | 665.71 | 647.33 | 91.83 |
| 2018 | 33218.8 | 1246.81 | 2327.65 | 143.96 | 2087.2 | 1246.81 | 1217.35 | 143.96 |

Note: The "Original 25% Tax" column represents economic output and tax revenue under the original 25% linear tax system. The "Notch," "Kink," and "Subsidy" columns display the percentage change in simulated economic outcomes under the actual notch-based tax cuts, counterfactual kink-based tax cuts, and counterfactual size-based precision subsidies to the 25% tax scenario. The covered SMEs are identified as Type 1, Type 2, and Type 3 firms, which can be cross-referenced in Table 9.

The results presented in Panel A demonstrate that the notch policy can increase total economic output by approximately 0.04–0.05% per year. Further, for firms coverred by preferential policies, the notch policy can lead to an output growth of 0.66–1.83%. Conversely, kink and subsidy policies can increase total economic output by approximately 0.1–0.13% per year while enabling SMEs coverred by the policy to achieve an output growth of 2.07–4.24%. Our simulation results indicate that kink and subsidy policies can significantly amplify the policy effect on economic output and SME production by 2–3 times more than notch-based tax incentives. This enhancement is primarily because of the absence of distortions caused by firms profiting from production cuts.

In Panel B, the results show that kink and subsidy policies do not increase the overall log of production much more than notch-based policies. As indicated by our previous results and analysis in Table 11, the effect of tax policy on overall log output is significantly driven by new entrants from the extensive margin. As the three types of policies are set to provide equivalent stimulus effects in the extensive margin for comparison, it is logical to arrive at these conclusions.

Finally, Panel C focuses on the impact of different policies on tax revenues. The panel first displays the corporate income tax revenues of the overall economy under the 25% linear tax scenario and those of the SMEs covered by the actual incentives. Subsequently, it reveals the ultimate reduction in tax revenues under the different tax incentives. Although the support policy leads to the growth of economic output, it also results in a reduction in tax revenue. Kink-based tax cuts notably mitigate the distortionary behavior of firms that reduce production and significantly promote output. However, the annual reduction in tax revenue is generally approximately twice as substantial as that resulting from the notch-based tax cuts. This is primarily due to the tax break for the part of income below the threshold for all firms. This highlights that while kink-based policy eases distortionary effects, it concurrently exerts greater pressure on fiscal balance.

Conversely, compared to notch and kink-based corporate income tax reductions, a subsidy policy based on the size of operating income stimulates economic output and minimizes the reduction in tax revenues. This is because lower-rate tax incentives require foregoing a significant percentage of taxable income, whereas a subsidy by size only requires compensating a portion of the opportunity cost of business operations. Nevertheless, implementing such an efficient subsidy policy presupposes the ability to find a one-to-one correspondence between the subsidy amount and the operational profit of a specific firm. Therefore, our exploration of this subsidy policy is framed within a more idealized context.

#### 6.2.2 Tax cuts and subsidies with the same stimulating effect

In this subsection, we compare notch-based tax cuts, kink-based tax cuts, and precisely subsidized policies, focusing on achieving the same stimulus effect on economic output but with varying extents of tax revenue reduction.

Our counterfactual analysis follows these steps:

1. We calculate the extent to which the existing notch-based tax incentive increases total output and total log output compared to a 25% linear tax rate in a scenario where all firms are rationally and optimally informed about the government's tax policies and make a bunching decision.

2. We adjust the kink-based tax incentives and precise subsidies based on the output scale introduced in the previous subsection. Maintaining the same tax rates and subsidy ratios, we move the threshold location for beneficiary firms to a point that enables the incentive to achieve the same stimulus effect on economic output as the notch-based tax cuts under the new location.

3. We compare the differences in the reduction of tax revenue across the different types of support policies to determine their efficiency.

Table 14 presents the four types of policies we compare, with flexible benefit thresholds for kink-based tax cuts and size-based subsidies to achieve the same stimulus effect.

Table 14: Alternative Support Policies to Achieve the Same Objective

| Policy | Policy Threshold | Preferential Policy |
|---|---|---|
| Linear Tax | N.A. | N.A., 25% for all the taxable income |
| Notch | As real policy | 10% for all the taxable income if it is smaller than the threshold |
| Kink | New threshold | 10% of the part of taxable income under the threshold |
| Subsidy | New threshold | subsidy of 16.67%'s opportunity cost for the taxable income under the bar |

The results of this analysis are presented in Table 15. The 25% Tax refers to the tax revenue under the initial 25% linear tax rate, and the "Aggregate Output" column displays the amount of tax revenue reduction required for Notch, Kink, and Subsidy policies to achieve the same effect as the existing Halve-Levy policies if the government's optimal goal is to optimize total output. The "Aggregate log output" column represents the scenario where the government treats total log output as the policy objective. As the actual policy is the notch-based tax cuts, the values in this column are similar to the ones in the previous table, serving as a benchmark for comparison.

Table 15: Effectiveness of Different Types of Support Policies

| Objective | | Aggregate Output | | | Aggregate Log Output | | |
|---|---|---|---|---|---|---|---|
| Year | Original Tax | Tax Reduction | | | Tax Reduction | | |
| | Unit: Millions of Yuan | | | | Thousands | | |
| | 25% Tax | Notch | Kink | Subsidy | Notch | Kink | Subsidy |
| 2014 | 11,411 | 157.4 | 53.8 | 9.4 | 157.4 | 148.6 | 19.5 |
| 2015 | 11,221 | 244.8 | 58.9 | 10.0 | 244.8 | 208.8 | 24.3 |
| 2016 | 16,291 | 382.8 | 85.6 | 14.6 | 382.8 | 320.7 | 36.6 |
| 2017 | 24,390 | 665.7 | 126.2 | 21.6 | 665.7 | 537.0 | 58.7 |
| 2018 | 33,219 | 1246.8 | 151.1 | 26.5 | 1246.8 | 921.4 | 91.8 |

Note: The "25% Tax" column presents tax revenue under the original 25% linear tax system. The "Notch," "Kink," and "Subsidy" columns display the amount of tax revenue reduction compared to the 25% linear tax scenario when the actual notch-based tax cuts, the counterfactual kink-based tax cuts, and the counterfactual size-based precision subsidies are applied. The "Aggregate Output" column displays the amount of tax revenue reduction required for Notch, Kink, and Subsidy policies to achieve the same effect as the existing Halve-Levy policies if the government's optimal goal is to optimize total output. The "Aggregate Log Output" column presents the scenario where the government treats total log output as the policy objective.

Our simulations demonstrate that if the government aims to optimize total output, kink-based tax cuts achieve the same policy effect with only 1/8–1/3 of the tax reduction required for notch-based tax cuts. As the government raises the threshold for preferential policies, notch-based tax cuts become more inefficient, and kink-based policies can save even more fiscal expenditure. If the government aims to optimize total log output, a kink-based policy remains more effective than a notch-based policy; nonetheless, the difference is not substantial. This is primarily because of the significant weight of all the promotion effects on the micro new entrants.

Furthermore, when comparing a policy of precise subsidies by size with a notch-based tax cut, the fiscal reduction of the subsidy policy can be even less, possibly up to as lower as 1/10 of that under the notch tax cuts.

Our simulations reveal that while notch-based tax incentives, a prevalent approach in many countries, including China, may not require precise prediction of firm costs or reduction of tax revenues for all firms (including large ones), the financial commitment associated with such policies is significant than other types of support policies. This discrepancy is due to the inefficiencies related to firm production reductions at the notch.

## 7 Conclusion

Governments place significant emphasis on fostering the growth and stability of SMEs. To shed light on the impact of China's cascading notch-based tax cuts for SMEs during 2014–2018, we employ a combination of parsimonious empirical tests and structural counterfactual analysis. Our empirical tests utilize established methods, such as DID estimation and bunching estimation. For the theoretical foundation and counterfactual framework, we integrate tax incentives into Arkolakis' trade entry model (2010). Our model shows that notch-based tax cuts motivate qualified SMEs to boost production while also prompting some above-notch firms to decrease production for arbitrage opportunities. This approach enables a comprehensive analysis of the effects of these policies, facilitating a comparison of the advantages and disadvantages of different policy types.

In our theoretical framework, firms' optimal output results from balancing post-tax marginal benefits with marginal costs due to expansion. Consequently, corporate income tax cuts stimulate economic output by enabling firms to achieve higher levels of marginal returns at lower corporate income tax rates, ultimately leading to increased production. Owing to the model's simplicity and low data requirements for more detailed information, our theoretical mechanism can be broadly applied and extended to study size-based preferential policies. Meanwhile, in the real economy, lower corporate income tax rates also boost firms' output through various mechanisms, including increased R&D activity and export investment under higher budget constraints. While our model focuses on macro-level impact mechanisms, there is potential for further development by incorporating more detailed data to analyze how firms expand their financing budget constraints through reduced corporate income tax incentives and dynamically grow through R&D and export activities. This avenue of research offers opportunities to refine the model and better understand how changes in tax incentives affect firms' production decisions through specific mechanisms of action. Hence, this topic has significant potential for exploration in conjunction with fiscal and tax policy.

In conclusion, our study employs rigorous empirical tests and a solid theoretical framework to analyze the impacts of China's notch-based tax cuts on SMEs, facilitating a comprehensive comparison of different policy types. Our findings suggest that utilizing kink-based tax cuts and size-based precision subsidies may prove more effective than notch-based policies in achieving the goal of stimulating SMEs. The findings contribute valuable insights to the field and open avenues for further research into the nuanced effects of tax incentives on firms' production decisions and economic output.

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# 8 Appendix (For Online Publication)

## 8.1 Bunching Estimates

### 8.1.1 Cross-Validation of $p$ and $[TI_l, TI_u]$ in Bunching Analysis

We follow Diamond and Persson (2016) and Chen, Liu, Serrato, and Xu (2021) and use a data-based approach to select the width of the exclusion region (i.e., $[TI_l, TI_u]$) and the order of the polynomial, $p$. In particular, we use K-fold (K = 5) cross-validation to search over a triple $(p,\ TI_l, TI_u)$ that determines the excluded region. We first test the hypothesis that $f_0(\cdot)$ and $f_1(\cdot)$ have equal mass over the exclusion restriction and keep the combination of parameters that do not reject the test of equality at the 10% level. Subsequently, we compute the sum of squared errors across the test subsamples and select a triple $(p,\ TI_l, TI_u)$ that minimizes the sum of squared errors. Finally, we bootstrap the entire procedure to calculate standard errors.

### 8.1.2 Estimates of the elasticity of taxable income with respect to tax rate

Following the approach of Kleven and Waseem (2013), we can estimate the proportion of firms ($\alpha^*$) that should have incentives to bunch but do not react because of optimization frictions. Relying on the assumption that the proportion of nonbunchers, $\alpha^*$ , is constant in the bunching range, we can construct the estimator

$$\hat{\alpha}^* = \frac{\int_{TI^*}^{TI_D} f_1(TI)d(TI)}{\int_{TI^*}^{TI_D} \widehat{f}_0(TI)d(TI)}$$

Here, $TI_D$ is the indifference point of firms under the two tax systems—the tax liability at $TI_D$ is the same as that at the threshold $TI^*$. In a frictionless world, the range $(TI^*, TI_D)$ will be dominated by the notch, and there would be zero mass in this range. Thus, we call $(TI^*, TI_D)$ as the strictly dominated region.

Using the estimate of $\alpha^*$, we reweight the average bunching estimator $b$ to obtain the adjusted bunching estimator $brc$. The explicit formula for the estimator is given by

$$\widehat{brc} = \frac{\hat{B}}{\frac{1}{2}(1-\hat{\alpha}^*)\cdot[\hat{f}_0(TI^*)+\hat{f}_0(TI_U)]} = \frac{\hat{b}}{(1-\hat{\alpha}^*)}$$

which measures the structural response of firms' taxable income (i.e., the response that we would observe in a frictionless world).

Subsequently, we can adapt the reduced-form approach proposed by Kleven and Waseem (2013) to calculate the elasticity of corporate taxable income. As the behavior response is driven by a jump in the average tax rate rather than a jump in the marginal tax rate, we must first calculate the implicit marginal tax rate change created by notch and then calculate the tax elasticity. The calculation formula is specifically given by

$$\begin{aligned}\tau^* \equiv \frac{T(TI_U) - T(TI^*)}{TI_U - TI^*} &= \frac{(\tau + \Delta\tau)\cdot TI_U - \tau \cdot TI^*}{\Delta TI^*} \\ &= \frac{(\tau + \Delta\tau)\cdot (TI^* + \Delta TI^*) - \tau \cdot TI^*}{\Delta TI^*} \\ &= \tau + \frac{\Delta\tau \cdot (TI^* + \Delta TI^*)}{\Delta TI^*} \\ &= \tau + \Delta\tau + \frac{\Delta\tau \cdot TI^*}{\Delta TI^*}\end{aligned}$$

where $T(TI^*)$ and $T(TI_U)$ are the tax liability when firm's taxable income is at the notch, and at the upper bound of the bunching region, $\tau$ is the preferential tax rate, while $\tau + \Delta\tau$ is the original tax rate, implying that $\Delta\tau$ is a nominal change in the tax rate. $\Delta TI^*$ is response of taxable income of firms in the bunching region, while $\Delta\tau^* \equiv \tau^* - \tau$ is approximately marginal tax rate change created by notch.

Notably, in the above equation, the response of taxable income of firms in the bunching region $\Delta TI^*$ should be the structural response of firms' taxable income, which is estimated by *brc*. The formula for the implicit marginal tax rate change is given by

$$\Delta\tau^* \equiv \tau^* - \tau = \Delta\tau + \frac{\Delta\tau \cdot TI^*}{\Delta TI^*} = \Delta\tau + \frac{\Delta\tau \cdot TI^*}{brc}$$

Thus, we can calculate the observed tax elasticity. The formula for the estimator of observed tax elasticity is given by [27]

$$\hat{e} = \frac{\hat{b}/TI^*}{\Delta\tau^*/(1-\tau)} = \frac{\hat{b}/TI^*}{\Delta\tau \cdot (\frac{TI^*}{\widehat{brc}} + 1)/(1-\tau)}$$

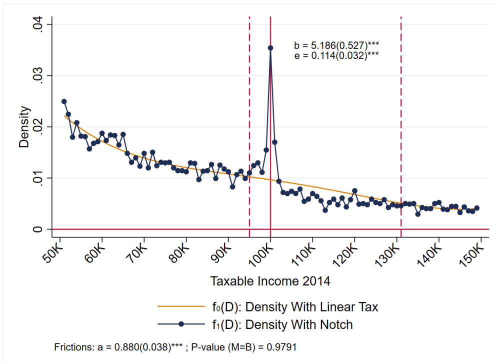
### 8.1.3 Robustness of Bunching Estimates

This section explores the robustness of our bunching estimates. First, Figure 5 shows that restricting ($p$, $TI_l, TI_u$) to the second-best estimate results in extremely similar estimates with the baseline estimates.

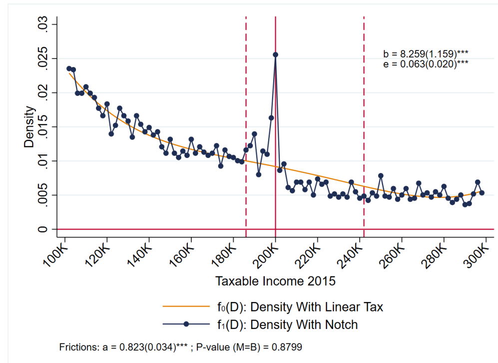
Second, as our sample data contains information on the number of employees reported by enterprises, we can conduct further research on firms that meet the requirements of the number of employees—fewer than 100 employees for industrial sector and 80 employees for other sectors. Figure 6 displays the estimates of the counterfactual density of taxable income, which are qualitatively and quantitatively similar with baseline estimates.

[27] This is smaller than the structural elasticity obtained in a frictionless world.

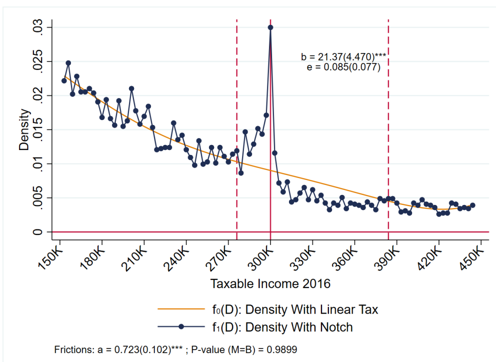
Figure 5: Robustness of Bunching Estimates to Specification of Counterfactual Density



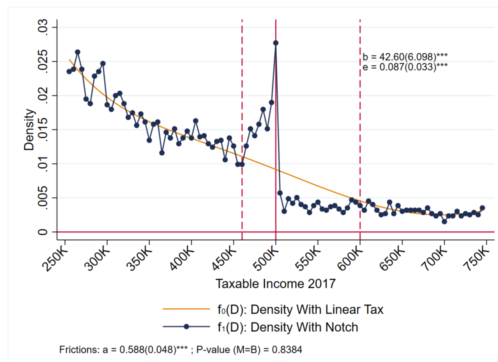

(a) Panel A. 2014



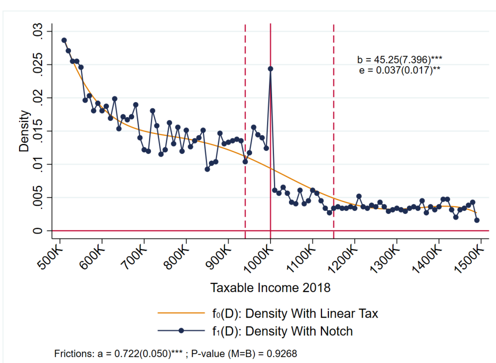

(b) Panel B. 2015




(c) Panel C. 2016



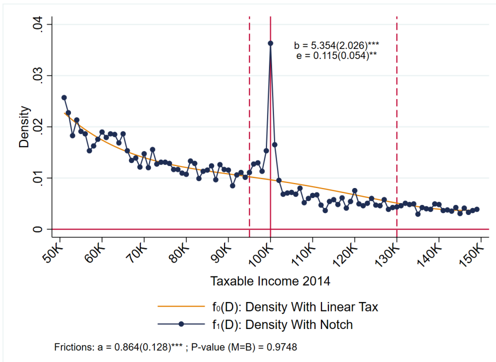

(d) Panel D. 2017



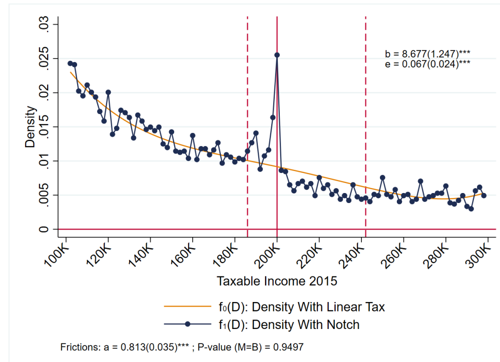

(e) Panel E. 2018

Note: This figure conducts a robustness check of the benchmark bunching analysis in figure 2. As discussed in Appendix, we select ($p$, $TI_l, TI_u$) via cross-validation. We use the second-best choice for the specification of ($p$, $TI_l, TI_u$), and the graphs in Figure 5 show that our benchmark results are robust to how we specify ($p$, $TI_l, TI_u$).
Source: Shanxi Administrative Tax Return Database.

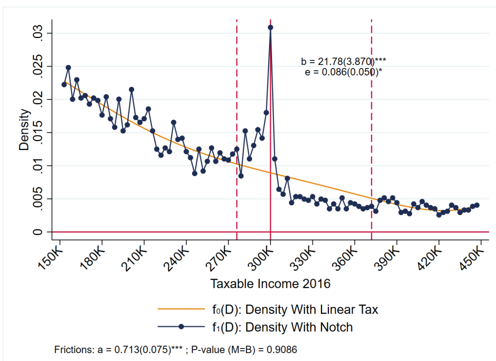
Figure 6: Robustness check: Requirements of the Number of Employees



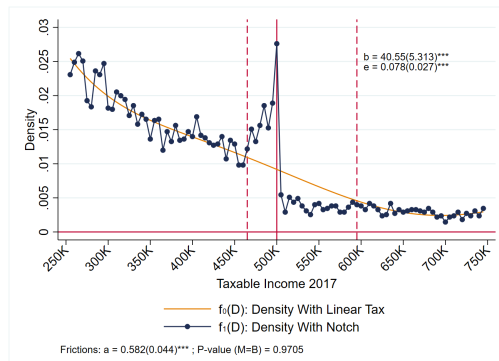

(a) Panel A. 2014



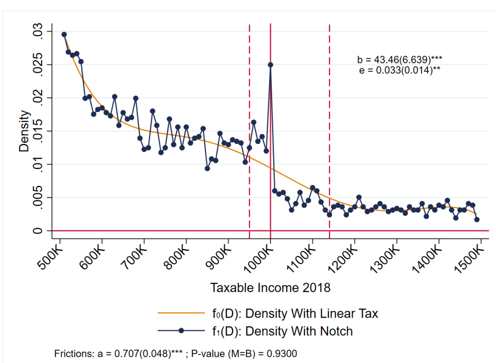

(b) Panel B. 2015




(c) Panel C. 2016




(d) Panel D. 2017




(e) Panel E. 2018

Note: This figure presents a robustness check of the benchmark bunching analysis in Figure 2. We conduct further sample screening to meet the other specific employees' requirements of the Halve-Levy program in addition to the taxable income requirements.
Source: Shanxi Administrative Tax Return Database.

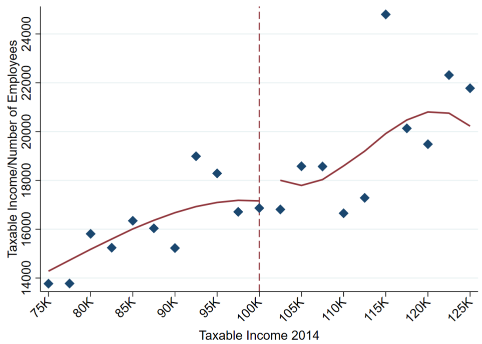
## 8.2 Misreporting Evidence

Figure 7 illustrates the ratio of taxable income to the number of employees for different size groups. The figure groups firms into bins of taxable income and plots the mean of this ratio for each bin. Additionally, we provide an estimated cubic regression on the ratio of taxable income with heterogeneous coefficients above and below the notches.

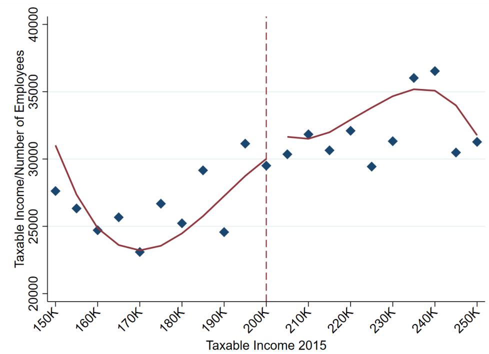
If a substantial number of firms underreport their taxable income by manipulating their tax returns, we would expect to observe a clear and discontinuous jump upward at the notch. This is because while bunchers may underreport their taxable income, they would not have incentives to underreport the number of employees. Consequently, bunchers (immediately below the notch) would demonstrate a lower ratio of taxable income to the number of employees than non-bunchers (immediately above the notch).

However, Figure 7 indicates that no evident discontinuous jump upward at the notch is observed, which suggests that most bunchers may not manipulate their tax returns but opt to reduce their real output. This evidence indicates that the focus of manipulation, if any, is likely on reducing production rather than underreporting taxable income.

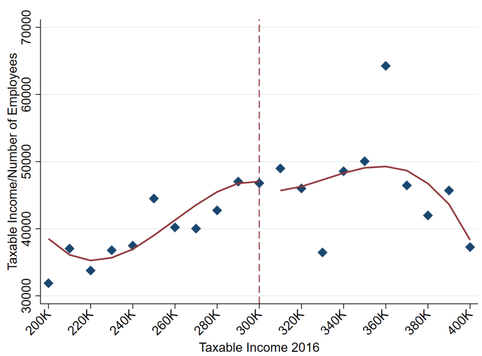
Figure 7: Alternative Measure of Firm Production at the Notch



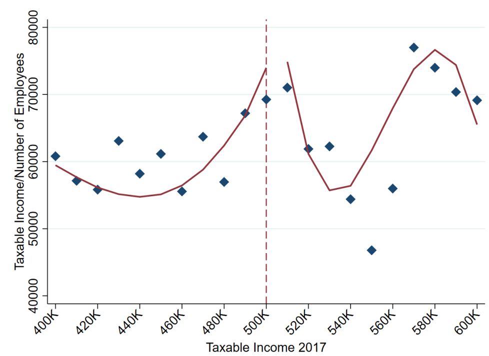

(a) Panel A. 2014



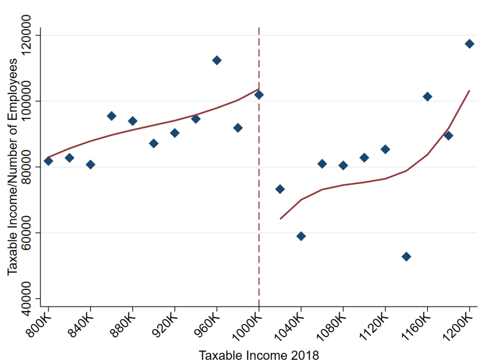

(b) Panel B. 2015




(c) Panel C. 2016




(d) Panel D. 2017




(e) Panel E. 2018

Note: This figure plots the ratio of taxable income to the number of employees at each size category, along with an estimated cubic regression of the ratio of taxable income with heterogeneous coefficients above and below the notches.

Source: Shanxi Administrative Tax Return Database.

### 8.3 Firm Heterogeneity Distribution

According to the properties of Pareto distribution, the portion of the distribution $\frac{\varphi_{jt}}{\overline{\varphi}_t}$ that maps to the observed data (market entrants) follows a Pareto distribution with a scale parameter of 1 and shape dispersion of $\theta$.

**Proof:** According to our Pareto distribution setting of firm productivities, the distribution of each firm $j$'s relative productivity to the cutoff productivity, denoted as $\frac{\varphi_{jt}}{\overline{\varphi}_t}$, has a distribution as

$$Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \leq y) = Pr(\varphi_{jt} \leq \overline{\varphi}_t \times y) = 1 - T_t(\overline{\varphi}_t y)^{-\theta}.$$

Consequently, the productivity distribution of market entrants observed in the data is the conditional distribution $Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \leq y|\varphi_{jt} \geq \overline{\varphi}_t)$ and we have

$$\begin{aligned}
Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \leq y|\varphi_{jt} \geq \overline{\varphi}_t) &= Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \leq y|\frac{\varphi_{jt}}{\overline{\varphi}_t} \geq 1) \\
&= Pr(1 \leq \frac{\varphi_{jt}}{\overline{\varphi}_t} \leq y)/Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \geq 1) \\
&= [Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \leq y) - Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \leq 1)]/Pr(\frac{\varphi_{jt}}{\overline{\varphi}_t} \geq 1) \\
&= [T_t(\overline{\varphi}_t)^{-\theta} - T_t(\overline{\varphi}_t y)^{-\theta}]/[T_t(\overline{\varphi}_t)^{-\theta}] \\
&= 1 - y^{-\theta}
\end{aligned}$$

Consequently, the relative productivities of the firms we observe from the data follows a Pareto distribution of scale 1 and shape dispersion $\theta$.