Business Income Taxes, Firm Dynamics, and Heterogeneous Policy Impacts*

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Abstract

This paper studies how business income taxes affect firm entry and exit across industries that differ in capital intensity. Using the German IAB Establishment Panel and district-level variation in local trade tax rates, I find that a one-percentage-point tax increase is associated with a 1.1-percentage-point rise in the annual exit probability of capital-intensive establishments, close to 40 percent of the average exit rate and more than twice the 0.5-point effect in the full sample. To interpret this evidence, I develop a two-sector general equilibrium model with heterogeneous productivity, capital accumulation, and endogenous entry and exit, in which incomplete capital-cost deductibility makes capital-intensive firms more sensitive to taxes. In the calibrated model, a one-percentage-point tax increase reduces the mass of capital-intensive firms by 2.3 percent, compared with 0.7 percent for other firms, and shifts employment toward the less capital-intensive sector. Aggregate employment and consumption fall by 0.14 and 0.36 percent, leaving an economy with fewer, larger, and less productive firms. A channel decomposition reconciles the model with the data: holding prices fixed, higher taxes raise exit, as observed empirically, but in the long run higher output prices more than offset this direct effect, so both entry and exit rates fall. An additional counterfactual, motivated by wider adoption of generative AI, shows that lowering entry costs raises firm mass, output, and average productivity. These results show how capital intensity and equilibrium adjustments shape the effects of business income taxation.

JEL classification: D21, E22, E24, H25, L11

Keywords: business income taxes, firm dynamics, firm heterogeneity

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1 Introduction

Business income taxes apply to net profits, but their effects can differ across industries because capital and labor costs receive different tax treatment. While labor expenses are generally deductible when incurred, deductions for capital investment are often spread over time, reducing their present value. This incomplete deductibility of capital costs may make capital-intensive firms more sensitive to changes in business income taxes.

This paper studies how capital intensity shapes firm entry and exit responses to business income taxation and how these responses affect employment, the firm distribution, and productivity. Specifically, how do changes in business income taxes disproportionately affect the entry and exit decisions of capital-intensive firms? How do these differences translate into aggregate impacts on firm distribution, total employment, and aggregate productivity? With the model calibrated to real-world data, the paper aims to quantify the disproportionate impact arising from differences in capital intensity across firms and tries to explain the potential mechanism.

Capital intensity in this paper refers to the reliance on capital to labor for production. Recent investment in semiconductor fabrication, clean-energy infrastructure, and AI data centers highlights the importance of capital-intensive production, which requires substantial investment in equipment, machinery, and structures. When capital costs are not fully deductible, these differences can generate heterogeneous responses to a common tax change. Through entry, exit, investment, and hiring decisions, such responses can alter both aggregate economic activity and its allocation across sectors. Therefore, understanding how policy affects firm entry and exit for different types of firms is central to evaluating the long-run impact on the economy.

Empirically, the analysis uses German establishment-level survey data. This dataset is used for the following reasons. First, changes in business income tax at the federal level, which is corporate income tax, are rare, and that makes it hard to investigate their impacts. By contrast, local business income tax exhibits greater spatial and temporal variation, creating a natural setting to study how local tax differences shape business entry, survival, and hiring decisions. In Germany, for instance, trade tax is a local tax on business profits levied by individual municipalities. If a firm operates in multiple municipalities, the trade tax is paid separately by each establishment to the local government. Second, aggregate-level datasets have their limitations in capturing important business characteristics, such as legal form and industry classification. Furthermore, this dataset covers both public and private establishments and is not restricted to large businesses. Including private business entities is crucial for examining long-run business dynamics, especially entry and exit.

Using a fixed-effects specification that exploits variation in local trade tax rates across locations and over time, I find a larger estimated exit response in the capital-intensive

subsample than in the full sample. Specifically, a one-percentage-point increase in the trade tax rate is associated with a 1.1-percentage-point increase in annual exit probability among capital-intensive establishments, more than twice the 0.5-point effect in the full sample and close to 40% of the average exit rate. Estimated entry responses are negative but statistically insignificant. A key concern is that municipalities may change tax rates in response to local economic conditions that also affect exit. District fixed effects absorb persistent local differences, year or sector-by-year fixed effects absorb aggregate and industry-wide shocks, and the results hold when controlling for local population, GDP growth, and property tax changes. Leads of tax changes do not significantly predict current exit, suggesting that tax increases do not systematically follow local downturns. The results are also robust to excluding sectors exempt from the trade tax. I therefore interpret the estimates as conditional associations rather than causal effects.

Guided by the empirical evidence, I develop a two-sector general equilibrium model to evaluate the long-run effects of income taxation on business dynamics. Building on Hopenhayn (1992) and subsequent extensions, the model features firms with different production technologies (C for capital-intensive firms and NC for non-capital-intensive firms) facing a common business income tax. Differences in capital intensity, combined with incomplete capital-cost deductibility, allow the model to examine how firms respond differently to changes in business income taxes and how these responses shape firm dynamics and aggregate outcomes. Note that while the empirical analysis uses local trade tax variation and establishment-level data for identification, the model considers a stylized corporate income tax and firm-level decisions to illustrate the underlying economic mechanism.

Quantitatively, I calibrate the model to match empirical moments and conduct two counterfactual exercises. The first considers a one-percentage-point increase in the corporate income tax rate. The tax increase dampens firm dynamism, with disproportionately larger effects on capital-intensive firms. The mass of firms declines by 2.3% in the C sector, compared with 0.7% in the NC sector, which is the combined impact of larger reductions in the masses of entrants and exiters in the C sector. This differential response reflects the interaction between capital intensity and the tax treatment of investment. Because capital expenditures are not fully deductible, an increase in the tax rate raises the effective user cost of capital, placing a greater burden on firms with larger capital requirements. The period-by-period nonnegative cash-flow constraint further amplifies this response. As a result, output contracts more sharply in the C sector, and employment shifts toward the NC sector. The two-sector model captures a compositional effect of corporate taxation in addition to its aggregate effects: the tax increase reallocates economic activity toward the less capital-intensive sector. The contraction in firm mass is accompanied by an approximately 1% increase in average firm size, with a larger increase among C firms, and a decline in average productivity. The tax increase thus results in

an aggregate economy with fewer, larger, and less productive firms.

The channel decomposition shows that, following an increase in the corporate income tax rate, the direct effects and general equilibrium price effect operate in opposite directions. Higher taxes raise exit rates and reduce output and employment, particularly among capital-intensive firms. This direct exit response is consistent with the increase in exit observed empirically. As prices adjust, however, the relative price of C goods rises, dampening exit and supporting output and employment. In the new steady state, these general equilibrium effects more than offset the direct effect, leaving both entry and exit rates below their baseline levels. The decomposition thus helps reconcile the empirical increase in exit with the model's long-run decline in exit. The entry response is minimal in the calibrated model, while the empirical estimates for entry are statistically insignificant.

As an illustrative extension, I examine how lower entry costs affect firm dynamics and aggregate outcomes, motivated by the potential for artificial intelligence to lower the costs of starting a business. A 2.3% reduction in entry costs increases firm mass and output and raises average productivity through greater entry and stronger competition. This exercise highlights how changes in barriers to entry can shape both the scale of economic activity and the composition of firms.

Literature Review This paper connects research on business taxation and firm dynamics with studies of heterogeneous tax responses and sectoral reallocation. Its central focus is how incomplete capital-cost deductibility interacts with capital intensity to shape entry, exit, and equilibrium outcomes.

The paper contributes to the literature on business taxation in models of firm dynamics. The workhorse model for this strand of literature was first introduced in Hopenhayn (1992). Following that, Bartelsman et al. (2013) and Clementi and Palazzo (2016) integrate capital investment and adjustment costs into this framework. Clementi and Palazzo (2016) have a time-to-build capital and focuses more on the propagation impact of aggregate shocks through firm entry and exit dynamics. My work is closely related to the work by Sedlácek and Sterk (2019), which investigates the impact of the US tax reform with a corporate income tax cut and a change in the expensing regime on long-term firm dynamics and aggregate economies. The transmission channel includes the direct impact, which is the impact on the incumbent firm when holding the wage constant, and an indirect channel, which evaluates the impact on incumbent firms from changes in equilibrium wages and the total number of firms. Different from their paper, this paper compares the long-run impact of tax rate changes on business dynamics coming from firms with different capital intensities. The deductibility of capital costs is incomplete in my model, which is a key source of differences in responses. The heterogeneity matters, as the differences across labor and capital after-tax costs are important in affecting the extensive and intensive margins of firms and aggregate outcomes. Erosa and González (2019) study

corporate income tax's impact on firm dynamics with an exogenous exit probability and focus on growth over firms' life cycles. Neira and Singhania (2022) study the impact of the US corporate income tax rate on the start-up rate with a general equilibrium model that features workers' occupational choices. The exit decision is endogenous upon productivity draws but is exogenous for incumbent firms. Different from their papers and motivated by the empirical differences in exit patterns across industries with different capital intensities, my model allows both entry and exit decisions to respond endogenously to taxation. Building on this literature, my model combines differences in capital intensity with incomplete capital-cost deductibility and endogenous entry and exit. This framework allows me to examine heterogeneous responses to a common tax change and distinguish direct tax effects from equilibrium adjustments.

The paper also contributes to the literature that studies capital-cost taxation and heterogeneous responses. Kaymak and Schott (2023) developed a heterogeneous-firm equilibrium model in which corporate tax cuts reallocate production toward capital-intensive firms, lowering the labor share in manufacturing. Although my paper and Kaymak and Schott (2023) share model features in capital intensity, productivity, and endogenous entry decisions, my paper introduces endogenous exit. Crawford and Markarian (2024) use the difference-in-differences approach with public firm data from the U.S. and Canadian firms and show that the Tax Cuts and Jobs Act of 2017 (TCJA) increases firm investment for American firms. In particular, capital-intensive firms and financially constrained firms exhibit the largest increases in investment, which the authors attribute to changes in the expensing schedule provision in TCJA. Liu and Williams (2019) document different state-level output and employment responses to federal-level corporate tax shocks. It shows that greater capital intensity strengthens the output response to tax cuts when all the firms are subject to corporate income tax. In a two-sector model with both corporate and noncorporate sectors, greater noncorporate-sector capital intensity can weaken the response through labor reallocation. My paper instead examines sectors with different capital intensities facing a common business-income tax change, emphasizing endogenous entry and exit and their implications for sectoral and aggregate outcomes. Other papers focus on other policies that might induce a heterogeneous impact on investment, such as accelerated depreciation policies[1]. Some papers focus on its impact on investment growth (as in Zwick and Mahon (2017)) and others on the labor market (as in Curtis et al. (2021)). Garrett et al. (2020) argue that the impact of the bonus depreciation policy differs by asset type, depending on the duration of the capital. My paper connects heterogeneous responses to firm dynamics by examining how incomplete capital-cost deductibility affects entry, exit, and investment across sectors with different capital intensities facing

[1]The accelerated depreciation policy is a tax stimulus that accelerates the deduction schedule of investment costs from firms' taxable income. This policy alters the timing of depreciation, providing incentives for firms as it increases the present discounted value of their cumulative deductions, thus lowering the tax.

a common business income tax. The model traces these decisions into changes in firm mass, sectoral employment, and aggregate outcomes.

This paper also relates to empirical research on business taxation and business activity with micro-level evidence. Most of the papers use data from the U.S. For example, Giroud and Rauh (2019) utilize micro-level multi-state firm data to study the impact of state-level corporate tax on employment and the number of establishments. They find that employment and the number of establishments have tax elasticities of -0.4 and -0.5, respectively. The authors also shed light on sector heterogeneity and find that more localized firms or highly labor-intensive industries respond more to taxation changes than the average. Other similar studies include Ljungqvist and Smolyansky (2014) and Suárez Serrato and Zidar (2016) but with additional focus on impacts on wages. But those studies document impacts on the total number of establishments, while my empirical analysis focuses on establishment entry and exit decisions. Other studies use German micro-level data. Kindsgrab (2022) studies the effect of German municipal business tax on establishment entry. Riedel et al. (2020) examine the effects of local business taxation on firm formation in German municipalities, including spillover effects on firm formation in neighboring jurisdictions. Using German establishment-level data, this paper complements these studies by examining entry and exit responses across industries with different capital intensities. The larger estimated exit response in the capital-intensive subsample motivates the model's emphasis on heterogeneous tax exposure. Empirical studies also document heterogeneous tax responses across firm size Zwick and Mahon (2017), Chi et al. (2026), Fuest et al. (2018) and age Harju et al. (2022). My empirical analysis complements this evidence by examining establishment entry and exit responses across industries with different capital intensities.

The remainder of the paper is organized as follows. Section 2 presents the empirical motivation of the paper. Section 3 uses a toy model to illustrate the key mechanism proposed in the paper. The full model is introduced in Section 4. Section 5 describes the estimation of the model parameters and presents counterfactual analysis. Section 6 concludes.

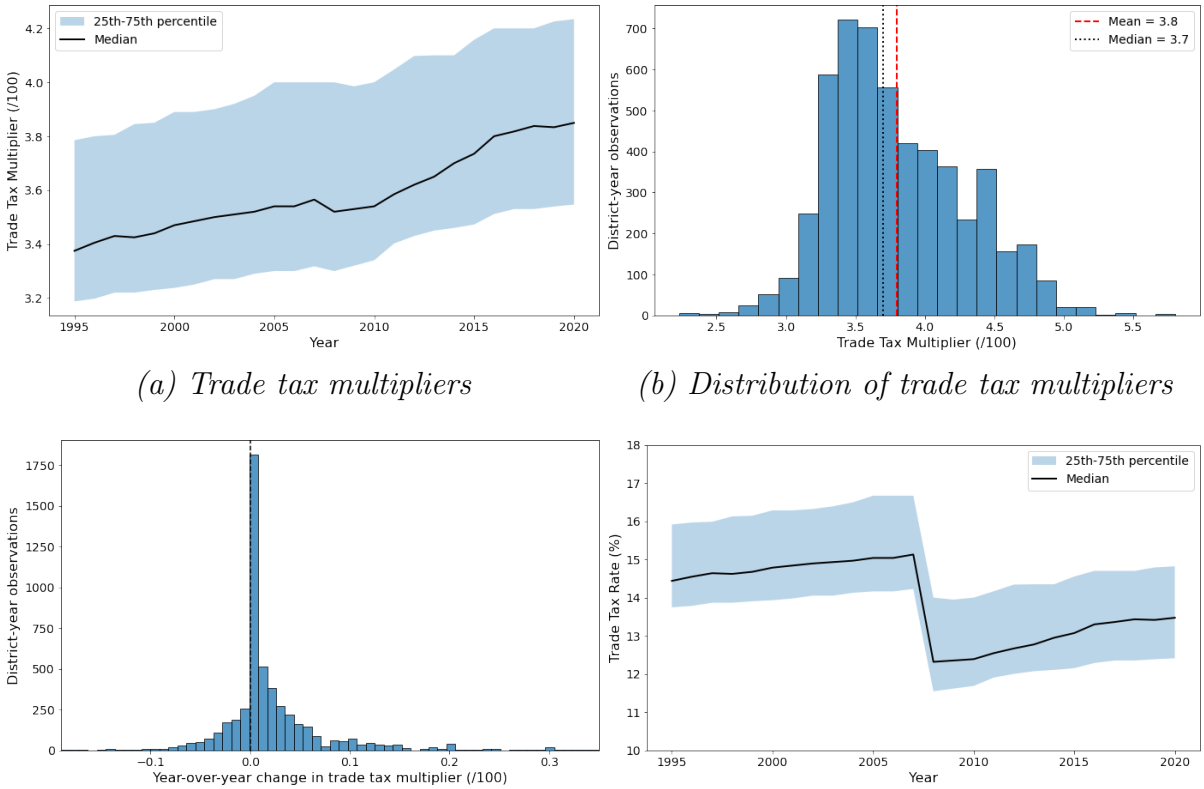
2 Empirical Motivations

The empirical section combines rich variations in German local business tax, trade tax, with annual representative employer survey data conducted by the Institute for Employment Research (IAB) to investigate the effect of local business tax on business entry and exit decisions. Specifically, the section plans to examine the heterogeneous effects across establishment age groups, size groups, and capital intensities.

2.1 Tax system in Germany

Germany provides a useful setting for this analysis because trade tax rates vary across municipalities and over time, and the tax applies to commercial businesses across legal forms. The business income tax in Germany consists of a federal-level corporate income tax and a municipality-level trade tax. The federal-level corporate income tax is a uniform tax rate[2] and there has been only one reform that changed the federal tax rate from 25% to 15% in 2008 since 2001. Notice that only corporations are subject to the corporate income tax, and the profits of partnerships and sole proprietorships are passed through and taxed at the individual income tax rate of the owners.

Figure 1: German district-level average trade tax rate over time



(a) Trade tax multipliers

(b) Distribution of trade tax multipliers

(c) Trade tax multiplier changes

(d) Trade tax rates

Notes: The average trade tax rate was sourced from Regional Database Germany. Panel (b) displays their distribution from 2008 onward. Panel (c) displays the central 99% of year-over-year changes in district-level trade tax multipliers.

On the other hand, trade tax in Germany applies to all commercial businesses regardless of legal form.[3] The trade tax rate is regulated by a base rate set by the federal government and a scaling factor (municipal multiplier) determined by each municipality,

[2]The corporate income tax is also subject to a solidarity surcharge, which has remained at 5.5% since 1998.

[3]Different from corporations, sole proprietors and partnerships receive an annual earnings allowance of €24,500 before trade tax. In addition, freelancers, businesses in agriculture, non-profit organizations, and public-sector enterprises are also exempt from the trade tax.

which is the smallest local government unit in Germany. The paper examines changes in average trade tax rates at the district level because the survey data identify establishment locations only at that level. Figure 1 shows variations of the average trade tax at the district level. District-level trade tax multipliers generally increased between 1995 and 2020 as shown in Figure 1(a). The median rose from approximately 3.4 to 3.8, with a brief decline around 2008 followed by a stronger increase after 2010. The shaded area represents the 25th–75th percentile range, which shifted upward and widened modestly over time, indicating persistent and slightly increasing variation across districts. As shown in Figure 1(b), from 2008 onward, district-level trade tax multipliers are concentrated between 3.0 and 4.5, with a mean of 3.8 and a median of 3.7. Figure 1(c) plots the central 99% of year-over-year changes in district-level trade tax multipliers from 2008 onward. Most changes are concentrated around zero, with a longer right tail among the displayed observations. In the full sample, changes range from -2.2 to 1.05. The 2008 reform reduced the federal base rate applicable to corporations from 5% to 3.5% and abolished trade tax deductibility. Figure 1(d) shows a sharp decline in the median trade tax rate around the reform, followed by a gradual increase.[4]

The depreciation schedule is also an important factor when evaluating taxation's impact especially due to this paper's focus on capital intensity. In Germany, the depreciation schedule is regulated at the federal level by a standard depreciation table. The depreciation table for general-purpose fixed assets (abbreviated to "AfA Table AV") shows the standard useful life (Section 7, Paragraph 1, Sentence 2 of the Income Tax Act) for fixed assets that are not used for a specific industry. The " AfA Table AV" applies to all fixed assets acquired or manufactured after December 31, 2000.

2.2 Establishment data

I use the IAB Establishment Panel (IAB-BP[5]) to observe establishment characteristics and link establishments' district information to district-level trade tax changes. For a business with establishments in multiple municipalities, the unified trade tax assessment amount is allocated across those municipalities, with each municipality applying its own tax rate to its allocated share.

[4]Before 2008, trade tax was deductible from its own tax base. The reported pre-2008 trade tax rates are adjusted accordingly. Before 2008, the 5% rate applied to corporations; individuals and partnerships previously faced a graduated schedule. After the 2008 reform, the trade tax base of 3.5% is applied to all entities.

[5]Bellmann, Lisa; Gensicke, Miriam; Grau Katrin; Kohaut, Susanne; Möller, Iris; Oberfichtner, Michael; Schwengler, Barbara; Tschersich, Nikolai; Umkehrer, Matthias (2026): "IAB-Betriebspanel (IAB-BP) – Version 9324 v1. Forschungsdatenzentrum (FDZ) der Bundesagentur für Arbeit (BA) im Institut für Arbeitsmarkt- und Berufsforschung (IAB). DOI: 10.5164/IAB.IABBP9324.de.en.v1. Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently via remote data access. Bellmann et al. (2026)

The IAB-BP data is an annual representative employer survey database and serves as the central source for German labor market demand analysis. To better capture the entry and exit information of establishments, I also supplement the IAB-BP data with the entry and exit extension files from the Establishment History Panel (BHP) [6], which is a cross-sectional establishment-level dataset created by aggregating the administrative worker-level data.

One of the key measurement challenges is to identify the entry and exit of an establishment. Establishment- and firm-level datasets often record when a business is first surveyed, enters the dataset, or becomes publicly listed, rather than when it begins operating. This dataset makes extra efforts to try to classify establishment entries and exits more precisely based on employment and its flows. In the main dataset, an establishment's start-up year is defined as the first year in which it has at least one employee subject to social security contributions on June 30. Then, using the entry and exit extension files, I exclude establishments whose recorded entry type reflects a spin-off or an identification-number change. The decisive factor in determining the entry type is the proportion of workers who were employed in the predecessor and the new establishments. I apply a similar procedure to identify establishment closures. Details on entry/exit type classifications can be found in Hethey-Maier and Schmieder (2013).[7]

Capital intensity is measured at the industry level as gross fixed capital formation per worker. For each industry under the NACE Rev.2 classification, I calculate it by dividing gross fixed capital formation by labor input using Eurostat data from 2000 to 2020. By ranking the average ratios, I classify the industries as capital-intensive (C) if the measure is above the median and as non-capital-intensive (NC) if below the cutoff. Detailed industry classification can be found in Appendix Table A.1. Other regional aggregates, such as population, are taken from German regional datasets.

2.3 Empirical methodology

The empirical specification for the exit decision is

$$Y_{i,d,s,t} = \beta_0 + \beta_1 \Delta\tau_{d,t} + \beta_2 \Delta\tau_{d,t-1} + \beta_3 \Delta\tau_{d,t-2} + X'_{i,t}\gamma + Z'_{d,t}\rho + \delta_d + \alpha_{s,t} + \varepsilon_{i,d,s,t} \quad (1)$$

[6] Ganzer, Andreas; Schmucker, Alexandra; Wolter, Stefanie (2024): "Establishment History Panel 1975–2023 (BHP 7523 v1)". Research Data Centre of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB). DOI: 10.5164/IAB.BHP7523.de.en.v1 Data access was provided via remote desktop/on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and remote execution. Ganzer et al. (2024)

[7] Entry and exit years occasionally differ between the IAB-BP and BHP files, primarily because the IAB-BP excludes establishments that employ only marginal part-time workers, whereas the BHP includes them. I use the entry and exit years reported in the IAB-BP as the primary measures. I supplement these measures with information from the BHP to identify the type of entry or exit and to fill in values missing from the IAB-BP.

, where i indexes establishments, d indexes districts, s indexes sectors, and t indexes years. The dependent variable $Y_{i,d,s,t}$ equals one if establishment i is recorded as exiting in year t, and zero otherwise. The variable $\Delta\tau_{d,t}$ is the district-level trade tax rate percentage-point change, and

$$\Delta\tau_{d,t} = \tau_{d,t} - \tau_{d,t-1}.$$

Equation 1 includes the contemporaneous tax changes and two lags. The vector X_{it} contains establishment-level controls, including an establishment's legal form, size, and age. Legal forms of establishments include individual company (sole proprietor), partnerships, corporation (GmbH, AG, cooperative), and Non-commercial/public-law/other. Establishments are divided into three size categories based on their number of employees: small establishments with 1 to 19 employees, medium establishments with 20 to 199 employees, and large establishments with at least 200 employees. The vector $Z_{d,t}$ contains time-varying district-level characteristics, such as population, other taxation, such as property taxes, as well as GDP growth.

All specifications include district fixed effects, δ_d, which absorb differences across districts, such as local economic conditions. In specifications pooling all samples, I include sector-by-year fixed effects, $\alpha_{s,t}$, which control for common shocks varying across each sector group over years. In specifications where the samples are restricted to capital-intensive establishments, I include year fixed effects.

The main threat to identification is that trade tax changes are not randomly assigned: a municipality may raise its rate when its fiscal position or local economy deteriorates, and those same conditions may raise establishment exit. District fixed effects remove time-invariant differences across locations, and year or sector-by-year fixed effects absorb aggregate and industry-specific shocks, including the 2008 Business Tax Reform. Time-varying district controls (population, local GDP growth, and property tax changes) capture local economic and fiscal conditions directly. In an alternative specification that adds leads of tax changes, the lead coefficients are statistically insignificant (results available upon request), suggesting that tax increases do not systematically follow local downturns. Because remaining endogeneity cannot be fully ruled out, I interpret the estimates as conditional associations that motivate the quantitative model.

With respect to the entry decision, empirical data can only observe those who chose to enter the market but not those who intended to but did not due to various reasons. Given this, instead of using the entry dummy as the response variable, I aggregate the establishment-level observations to the district-sector-year level and run a similar specification in Equation (2).

$$Y_{d,s,t} = \alpha + \sum_{\ell=0}^{3} \beta_\ell \Delta\tau_{d,t-\ell} + Z'_{d,t}\rho + \delta_d + \alpha_{s,t} + \varepsilon_{d,s,t} \tag{2}$$

2.4 Trade tax and establishment dynamics

Table 1 estimates the relationship between changes in local trade tax rates and establishment exit decisions. In Table 1, columns 1-4 present the results for all establishments, establishments in capital-intensive industries, small-sized establishments, as well as small-sized and capital-intensive establishments, respectively. Columns 5-8 report regressions for the same set of samples but include additional control variables, such as local GDP growth and property tax rate changes.

Table 1: Impact of trade tax change on exits

	(1) All	(2) C	(3) Small	(4) Small C	(5) All	(6) C	(7) Small	(8) Small C
Trade tax change	0.005***	0.011***	0.006***	0.012**	0.005***	0.011***	0.006**	0.012**
	(0.002)	(0.004)	(0.002)	(0.005)	(0.002)	(0.004)	(0.002)	(0.005)
Trade tax change: lag 1	0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.003)
Trade tax change: lag 2	0.002	0.003	0.002	0.003	0.002	0.003	0.002	0.003
	(0.001)	(0.003)	(0.002)	(0.003)	(0.001)	(0.003)	(0.002)	(0.003)
Size: 1–19 employees	0.017***	0.026***			0.017***	0.026***		
	(0.002)	(0.006)			(0.002)	(0.006)		
Size: 20–199 employees	0.003	0.007			0.003	0.007		
	(0.002)	(0.004)			(0.002)	(0.005)		
Establishment age	-0.003***	-0.003***	-0.003***	-0.004***	-0.003***	-0.003***	-0.003***	-0.004***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Age squared	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log population	-0.044	-0.031	-0.053	-0.027	-0.047	-0.038	-0.056	-0.035
	(0.063)	(0.108)	(0.069)	(0.124)	(0.063)	(0.107)	(0.069)	(0.124)
Sole proprietor	0.014***	0.021**	0.014***	0.019*	0.014***	0.021**	0.014***	0.018*
	(0.003)	(0.008)	(0.004)	(0.011)	(0.003)	(0.009)	(0.004)	(0.011)
Partnership	0.005	0.009	0.006	0.008	0.005	0.009	0.005	0.007
	(0.005)	(0.010)	(0.006)	(0.013)	(0.005)	(0.011)	(0.006)	(0.013)
Corporation	-0.002	0.006	-0.002	0.003	-0.002	0.006	-0.003	0.003
	(0.003)	(0.008)	(0.004)	(0.011)	(0.003)	(0.008)	(0.004)	(0.011)
Short controls	Yes	Yes	Yes	Yes	No	No	No	No
Long controls	No	No	No	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	No	Yes	No	Yes	No	Yes	No
Year x Sector FE	Yes	No	Yes	No	Yes	No	Yes	No
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Establishment-year obs.	79,784	32,905	52,935	19,762	77,664	32,029	51,648	19,269
R-Squared	0.023	0.047	0.023	0.051	0.023	0.047	0.023	0.051

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. *Standard errors clustered by district in parentheses. The sample period is 2008-2017. Regressions are adjusted using panel weights. Columns 1–4: short controls; columns 5–8: long controls. C denotes capital-intensive industries; Small denotes 1–19 employees. Outcome: establishment exit indicator (0/1). Short controls: size indicators, age, age squared, log population, and legal form. Long controls add property tax A/B changes and GDP change.*

The contemporaneous coefficient of tax rate changes is positive and statistically significant across all specifications. In the full sample, column (1) indicates that a one-percentage-point increase in trade tax rate is associated with a 0.5-percentage-point increase in the annual probability of establishment exit. This correlation doubles for capital-intensive establishments, ranging from 1.1 to 1.2 percentage points, as shown in columns (2) and (4). Notice that the average exit rate in the full sample is about 2.6% in this panel sample. So the observed changes in exit rate associated with tax rate changes are about 20-40% of the average exit rate. Both columns (1) and (2) also indicate that compared to establishments with more than 200 employees, those with fewer than 20 employees have a statistically significantly higher exit probability. The negative coefficient

of age shows that exit probability is declining as establishments mature. Establishments' legal forms are also significantly correlated with exit probabilities. Compared to the non-commercial establishments, the individual company (sole proprietor) is more likely to have a higher exit rate. With more controls in columns (5) to (8), the results still hold. Notice that the impact of Germany's Business Tax Reform Act of 2008 is controlled for with the year fixed effect. Appendix B provides a robustness check by excluding observations in sectors exempt from the trade tax, such as non-profit organizations, agriculture, and public sectors.

Table 2 presents the estimated relationship between changes in the local trade tax rate and establishment entry. The dependent variable in columns (1) and (2) is the establishment entry rate, while that in columns (3) and (4) is the percentage-point change in entry rate. Table 2 shows that an increase in the trade tax rate is associated with a decrease in establishment entry rate or slower growth in entry rate across the specifications. In addition, the point estimates are also larger in absolute value in the capital-intensive subsample than in the full sample. Although these estimates do not reach conventional levels of statistical significance, they can offer suggestive evidence that trade tax increases discourage entries and capital-intensive establishments behave differently than an average establishment with the same level of changes in trade tax. The insignificance of the coefficients might partly reflect the smaller number of observations after aggregating the data from an establishment-level to district-level data sample, and the low frequency of entry events.

Table 2: Impact of trade tax change on entries

	(1)	(2)	(3)	(4)
	All: level	C: level	All: change	C: change
Trade tax change	-0.019	-0.034	-0.047	-0.090
	(0.024)	(0.046)	(0.056)	(0.110)
Trade tax change: lag 1	-0.001	-0.002	0.004	0.002
	(0.003)	(0.005)	(0.016)	(0.025)
Trade tax change: lag 2	-0.001	-0.001	-0.005	-0.008
	(0.002)	(0.004)	(0.006)	(0.011)
Year FE	Yes	Yes	Yes	Yes
Sector indicators	Yes	No	Yes	No
Year x Sector FE	Yes	No	Yes	No
District-sector FE	Yes	Yes	Yes	Yes
District-sector-year obs.	7,975	3,949	6,458	3,194
R-Squared	0.093	0.093	0.005	0.005

Notes: Standard errors clustered by district in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *The sample period is 2008-2020. Regressions are adjusted using log of population. Columns 1–2: entry-rate levels; columns 3–4: entry-rate changes. C denotes capital-intensive industries. Outcome: entry rate (percent) in columns 1–2; change in percentage points in columns 3–4. Entry rate is 100 times entrants divided by the average of current and prior-year establishment totals. Changes compare consecutive observed rows within each district-sector panel. Controls: log population, property tax A/B changes, and GDP change.*

3 Key Mechanism in a Simple Model

This section uses a toy two-sector firm model to illustrate the key mechanism that causes the disproportional impacts of tax rate changes on different firm types. The important assumption is that the capital cost is not expensed immediately. Corporate income tax affects firms' marginal cost of capital but not the unit cost of labor. That is because capital expenditures will be depreciated in a delayed manner, while the labor cost will be deducted immediately. When the corporate income tax rate increases, the delayed expensing of capital costs and the time value of money induce a disproportionate impact on capital-intensive firms.

3.1 Firm's problem

In a simplified model, there are two types of firms, where C firms represent capital-intensive firms and NC firms represent non-capital-intensive firms. For illustrative purposes, imagine an extreme case where a C firm only requires capital and an NC firm only requires labor for production.

The value function of C firms can be expressed as follows:

$$V^C(k_{-1}) = \max_k (1-\tau)[f^C(k) - c_f] - (1-\lambda\tau)[k - (1-\delta)k_{-1}] + \beta V^C(k) \tag{3}$$

, where $i = k - (1-\delta)k_{-1}$. Here, λ, the effective expense rate, is a reduced-form way to show the present value of future deductions[8], such as literal expensing, depreciation allowances, and investment tax credits. Since capital cost is not expensed immediately, λ is strictly smaller than 1.

First-order condition of equation (3) w.r.t. k becomes:

$$(1-\tau)\frac{\partial f}{\partial k} - (1-\lambda\tau) + \beta\frac{\partial V^C}{\partial k} = 0$$

$$\frac{\partial f}{\partial k} = \Omega = (\frac{1-\lambda\tau}{1-\tau})(\frac{r+\delta}{1+r}) \tag{4}$$

, where Ω is the user cost of capital, $\beta = \frac{1}{1+r}$.

$$\frac{\partial \Omega}{\partial \tau} = \frac{r+\delta}{1+r} \cdot \frac{1-\lambda}{(1-\tau)^2} > 0, \text{ with } \lambda < 1 \tag{5}$$

The partial derivatives of equation (4) with respect to the tax rate τ yield equation (5), which shows that an increase in the tax rate will increase the user cost of capital when λ is smaller than 1. So, the tax rate will distort C firms' capital choices by increasing the user cost of capital. In addition, as the tax rate increases, the distortion increases.

[8] As in Barro and Furman (2018) and Sedlácek and Sterk (2019)

By contrast, the value function for an NC firm is as follows:

$$V^{NC}(w) = \max_{l}(1-\tau)[f^{NC}(l) - c_f] - (1-\tau)wl$$

And the first-order condition w.r.t. l becomes:

$$(1-\tau)\frac{\partial f}{\partial l} - (1-\tau)w = 0$$

$$\frac{\partial f}{\partial l} = w$$

The unit cost of labor does not depend on the tax rate.

4 Quantitative Model

4.1 Model Environment

This paper is built off of the classic firm entry-exit model by Hopenhayn (1992) with endogenous entry and exit decisions by firms. Similar to Clementi and Palazzo (2016) and Sedlácek and Sterk (2019), this model also incorporates capital investment and corporate income tax. This model's contribution is to add heterogeneity in capital intensities across industries. There are two types of competitive firms: capital-intensive (C) firms and non-capital-intensive (NC) ones. They differ in the amount of capital they need for a unit of production, and the produced goods are heterogeneous as well. The representative household provides labor, receives firms' profits, and consumes the produced goods. Prices of goods, wages, and mass measures are determined endogenously with free-entry conditions of firms and clearing of aggregate demand and supply of goods.

4.2 Timing of Firms

Time is discrete and continues forever. The timeline of the model is illustrated in Figure 2. For incumbent firms, when making continue or exit decisions, they do not know the realized productivity level in the current period. If a firm chooses to continue to produce, the productivity level is realized and they start to produce by choosing optimal levels of capital and labor. They also need to pay a fixed operation cost in each period of production. If the firm chooses to exit, it needs to sell the remaining undepreciated capital from the previous period. For entrants, they are free to enter the market after paying an entry cost. After entering, an entrant draws its initial lagged value of productivity from a distribution and starts to behave as an incumbent.

4.3 Firm's Problem

4.3.1 Production

The two types of firms, $i = \{C, NC\}$, have different capital share parameters, α^C and α^{NC}. Firms use both capital and labor as production inputs, and C firms use capital more inten-

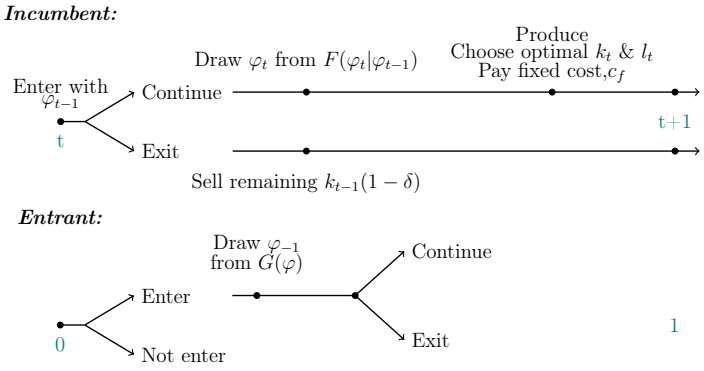


Figure 2: Timeline

sively than NC firms. Productivity shock $\varphi \in S \equiv [0,1]$ follows a Markov process independent across firms with conditional distribution $F(\varphi|\varphi_{-1})$. The distribution is strictly increasing in φ, meaning a firm with high productivity today is more likely to have high productivity next period. Firms behave competitively, taking prices in the output and input markets as given. Entry costs, operating costs, and investment are denominated in units of the firm's own sector output.

The production function for a type-i firm is

$$y^i = \varphi \left(k^{\alpha^i} \ell^{1-\alpha^i} \right)^{\theta}$$

4.3.2 Incumbent's problem

Given a vector for prices $z^i = \{p^i, w\}$, incumbent firms need to make exit decisions:

$$V^i(\varphi_{-1}, k_{-1}; z^i) = \max \left\{ V_c^i(\varphi_{-1}, k_{-1}; z^i), V_x^i(k_{-1}; z^i) \right\} \tag{6}$$

If they choose to continue, firms need to maximize the present value of after-tax profits. In addition, firms are subject to a nonnegative cash-flow constraint ($\pi^i \geq 0$), which requires current revenues to cover production costs, such as operating and investment costs. This restriction rules out external borrowing. In addition, the existence of fixed operation costs provides a mechanism for firm exit. If there were no fixed costs, then the firm would not exit and could just wait for a possible higher productivity realization.

If an incumbent firm chooses to continue, the value function is:

$$V_c^i(\varphi_{-1}, k_{-1}; z^i) = \max_{l,k:\pi^i \geq 0} \pi^i(\varphi, k, l; k_{-1}, z^i) + \beta \int V(\varphi, k; z'^i) dF(\varphi|\varphi_{-1}) \} \tag{7}$$

, where

$$\pi^i = (1-\tau) \left[p^i y^i(\varphi, k, \ell) - w\ell - p^i c_f - p^i g(k_{-1}, k) \right] - p^i (1 - \lambda\tau) x$$

and investment is $x = k - (1-\delta)k_{-1}$. Capital is subject to adjustment cost $g(k_{-1}, k)$, which follows $g(k_{-1}, k) = \zeta_0(x)k_{-1} + \frac{\zeta_1}{2}(\frac{x}{k_{-1}})^2 k_{-1}$ as in Clementi and Palazzo (2016). If there is new investment, x, the adjustment cost contains a non-convex part and a convex part. The fixed

cost parameter $\zeta_0(x) = 0$ if $x = 0$ and $\zeta_0(x) > 0$ if $x \neq 0$. The gradual expensing of capital cost is captured with an effective expensing rate, λ, which is a reduced-form way to show the present value of future deductions (also in Barro and Furman (2018) and Sedlácek and Sterk (2019)).

If they choose to exit, they will sell the undepreciated part of capital from last period and pay for the adjustment cost of selling the assets. I assume that the sale proceeds equal the remaining tax basis (also in Sedlácek and Sterk (2019)), so liquidation generates no taxable capital and the firm retains the full resale value. Adjustment costs are fully tax deductible. So, the value function for exit becomes:

$$V_x^i(k_{-1}; z^i) = (1 - \delta)k_{-1} - (1 - \tau)g(k_{-1}, 0) \tag{8}$$

4.3.3 Entrant's problem

The potential entrants are exogenously assigned to work in the C or NC industry. Entrants need to pay the entry cost first, and then the productivity is revealed. The model assumes that the entry cost is not tax-deductible, as it is a cost associated with red tape and the business plan development, following the same assumption as in Sedlácek and Sterk (2019). The initial lagged productivity is drawn from a lognormal distribution, $G(\varphi)$. The value function for the entrants is:

$$V_e^i(\varphi, 0; z^i) = max\Big\{0, -p^i c_e^i + \int V^i(\varphi_{-1}, 0; z^i) dG(\varphi_{-1})\Big\} \tag{9}$$

So the free-entry condition requires that

$$p^i c_e^i = \int V^i(\varphi_{-1}, 0; z^i)\, dG(\varphi_{-1})$$

After entry, in the same period, entrants behave the same as an incumbent. So, in this environment, there are entrants that enter and exit in the same year when they can not sustain a non-negative after-tax profit in the first period of production.

4.4 Other Agents

Representative households consume according to the standard CES preferences over two types of goods C^C and C^{NC}. Labor is elastic and perfectly mobile across sectors. $\sigma = 1/(1 - \rho)$ is the elasticity of substitution. The aggregate consumption good is

$$C \equiv \Big[\omega(C^C)^{\frac{\sigma-1}{\sigma}} + (1 - \omega)(C^{NC})^{\frac{\sigma-1}{\sigma}}\Big]^{\frac{\sigma}{\sigma-1}}$$

and the CES price index P is $P = [\omega(p^C)^{1-\sigma} + (1 - \omega)(p^{NC})^{1-\sigma}]^{\frac{1}{1-\sigma}}$. ω is the weight on the capital-intensive good. σ is the elasticity of substitution between the two sectoral goods. The household's utility function is $U = u(C) - \nu L$.

The government is assumed to run a balanced budget by collecting taxes from firms and rebating them to households in a lump-sum way.

4.5 Equilibrium

The competitive equilibrium consists of prices $\{z^{i,*}\}$, mass of entrants $\{m^{i,*}\}$, exit threshold$\{\varphi^{i,*}\}$, distribution of firms$\{\mu(\varphi)^{i,*}\}$ such that

- With given prices,$\{z^{i,*}\}$, individual firms decide on entry or exit from the market, as well as the required optimal labor, $l^{i,*}$, and capital, $k^{i,*}$, inputs for production.
- Household's problem determines aggregate demand for consumption goods (C^i) and labor supply (L).
- Firms' distribution is stationary: $\mu_t^i(k^*, \varphi_t) = \int_{\varphi \geq \varphi^{i,*}} F(\varphi_t|\varphi_{t-1})\mu_{t-1}^i(d\varphi) + m_t^i G(\varphi)$
- Goods markets for the two types of goods clear with $Y^i = C^i + I^i + G^i + \pi^i$, where I includes aggregate investments, adjustment cost, entry cost, and fixed cost of operation. $Y^{i,s} = \mu^i * f^i$. G^i is the public goods, and π^i is the after-tax firm profits.
- Labor market clears: $L = \mu^C * l^C + \mu^{NC} * l^{NC}$

5 Quantitative Results

5.1 Calibration

Parameters listed in Table 3 are taken directly from the data or from the literature. The annual discount factor, β, is set so that the annual risk-free return is 2%, reflecting the average policy rate in Germany since the 2000s. θ, the span of control, governs the returns to scale of the industries. In the literature, it is widely agreed that micro-level returns to scale (RTS) are more likely to be decreasing. Many estimations of RTS are based on the U.S. setting (Basu and Fernald (1997)). In McAdam et al. (2024), the authors estimated the RTS for five countries in the Euro area[9], and the RTS estimates range from 0.74 to 1.22. Sedlácek and Sterk (2019) and Clementi and Palazzo (2016) study firm dynamics in models calibrated to the U.S. economy, setting the span of control parameters to 0.9 and 0.8, respectively. Setting the span of control to be 0.8 lies in the reasonable range according to the literature. The depreciation rate, δ, and constant elasticity of substitution, σ are taken from the literature. λ is estimated using broad asset categories following the standard German depreciation table weighted by the asset shares in 2010. Notably, economic depreciation is not incorporated, so it might be even lower once considered. Prices of goods produced by non-capital-intensive firms are normalized to 1. The tax rate is calculated from German administrative data and includes federal-level corporate income tax, solidarity surtax, and municipal trade tax from 2008 to 2018.

Parameters listed in Table 4 are jointly calibrated to align the model with key features of the data. The main datasets used are Eurostat data from 2000 to 2020, and IAB data for the period 2000-2020. For moments calculated from survey data, sampling weights are properly applied. Operation cost is calibrated by targeting the average exit rate of incumbent firms

[9]Countries include Belgium, France, Italy, Portugal, and Spain.

Table 3: Assigned parameters

Parameter	Description	Value/Source
β	Annual discount factor	0.9804
θ	Span of control	0.8
δ	Depreciation rate	0.1, Clementi and Palazzo (2016)
λ	Imperfect deductibility of capital costs	0.87
p^{NC}	Price of NC goods	1
σ	Constant elasticity of substitution	2.9, Broda and Weinstein (2006)
τ	Corporate tax rate	0.2955
ν	Disutility of labor	0.01, Sedlácek and Sterk (2019)

in the data. Entry costs for the two types of firms are targeted to match the average entry rate across all the establishments and the exit rate of new entrants for C firms. The exit rate of new entrants is defined as the share of entrants that enter and exit within the same year. Production parameters, α_C and α_{NC}, are calibrated by targeting the capital share of C and NC industries using Eurostat data. Adjustment cost parameters, ζ_0 and ζ_1, are calibrated by targeting moments related to investment behaviors estimated in the IAB data. The investment rate is defined as the ratio of total investment in the previous year to business volume in that year. The inaction rate is defined as the fraction of periods in which the investment rate is less than 1%, following definitions commonly used in the literature, such as Clementi and Palazzo (2016). The persistence of productivity shock for incumbents is calibrated by targeting the ratio of employment of large firms (those at the 90th percentile) to that of the median firm. Finally, households' CES preference weight is calibrated to match the relative output sizes of the C and NC sectors, using Eurostat data.

Table 4: Jointly calibrated parameter values

Parameter	Description	Estimate	Targeted Moment	Data/Source	Model
c_f	Operation cost	0.3452	Average exit rate for incumbents	0.0191,IAB	0.0206
c_e^C	Entry cost, C firms	0.4433	Exit rate of entrants, C	0.0895, IAB	0.0913
c_e^{NC}	Entry cost, NC firms	1.6691	Entry rate	0.0232, IAB	0.0206
α_C	Production parameter, C	0.3786	Capital share, C	0.5029, Eurostat	0.5029
α_{NC}	Production parameter, NC	0.1569	Capital share, NC	0.3255, Eurostat	0.3255
ζ_0	Adjustment cost, non-convex part	0.0016	Inaction rate	0.1940, IAB	0.1685
ζ_1	Adjustment cost, convex part	0.9465	Average investment rate	0.1113, IAB	0.1392
ρ_s	Persistence of incumbents' productivity shocks	0.7159	Relative size of 90th/50th firm	4.4, IAB	4.9695
σ_s	S.D. of incumbents' productivity shocks	0.2480	S.D. of investment rate	0.4643, IAB	0.4525
ω_C	CES preference weight	0.5701	Relative size of C/NC sector	1.0737, Eurostat	1.0738

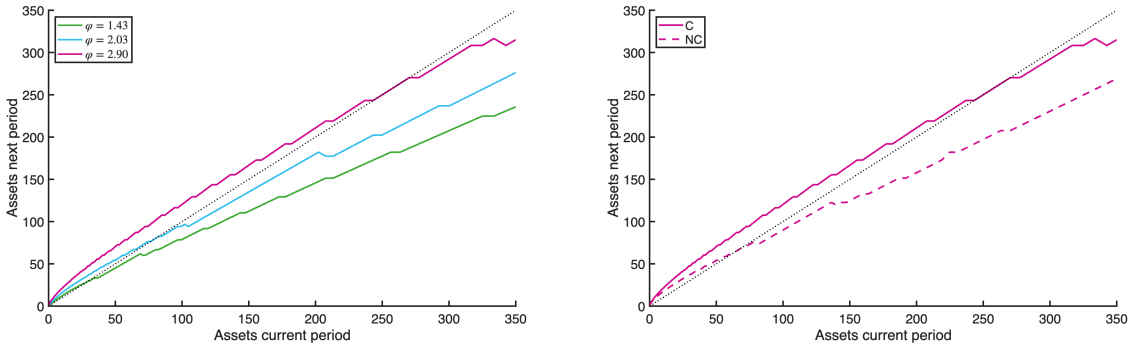
5.2 Model Dynamics

Figure 3 shows firms' capital decisions. As expected, as the productivity level goes up, C firms will increase their asset levels, as shown in Figure 3 (a). The lumpy investment behavior is consistent with non-convex adjustment cost assumption in the model. Figure 3 (b) presents asset levels of continuing firms of both types. The dashed lines indicate the decisions of NC firms and the solid lines are those for the C firms. As expected, C firms invest more than NC firms given the same levels of current-period assets and productivity. In addition, for both firm types, investment increases as productivity goes up.

Incorporating heterogeneity in capital intensity is important for capturing differences in firm

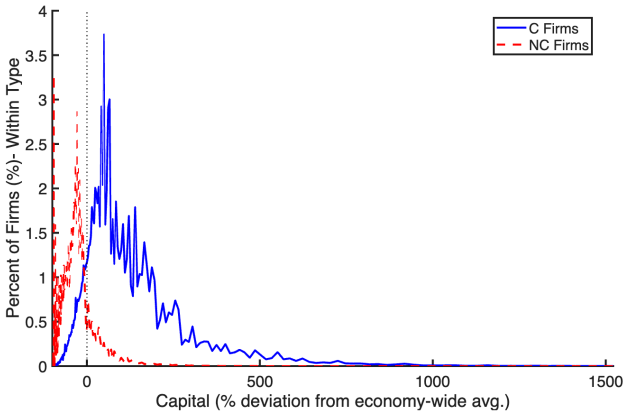
Figure 3: Choices of capital by firm types

(a) C firms by productivity levels *(b) Both firm types by productivity levels*



Notes: The dotted black line is the 45-degree line. Panel (a) shows C firms at the top three of seven productivity levels. Panel (b) compares C and NC firms at the highest productivity level; the pattern is the same at all levels.

Figure 4: Firm distribution by capital levels



distributions across the two types of firms. Figure 4 and Figure 5 present firm distributions across capital and employment levels. Figure 4 shows that C firms optimally choose higher capital levels than NC firms. In addition, C firms are more spread out across different capital levels than the NC firms, and are right-skewed, with some high-capital firms. Figure 5 shows that the employment distributions of both firm types are strongly right-skewed, with a large number of firms operating at relatively low employment levels. In addition, the peak of the NC firms' mass is higher than that of C firms, and the corresponding employment level is lower. These observations indicate that NC firms tend to be smaller and exhibit less dispersion in employment levels. By contrast, C firms' distributions are more spread out.

Table 5 displays firm compositions in the baseline economy. For the economy as a whole, 88% of all the firms continue operating. Out of all the exits, the majority (close to 85%) of them come from entrants. This indicates that it is hard for a new entrant to survive in this economy with the nonnegative profit assumption in the model. But once they survive and start producing, their exit probability decreases substantially. This pattern is more obvious for C firms when comparing results in columns (1) and (2). More than 90% of the capital-intensive

Figure 5: Firm distribution by employment levels

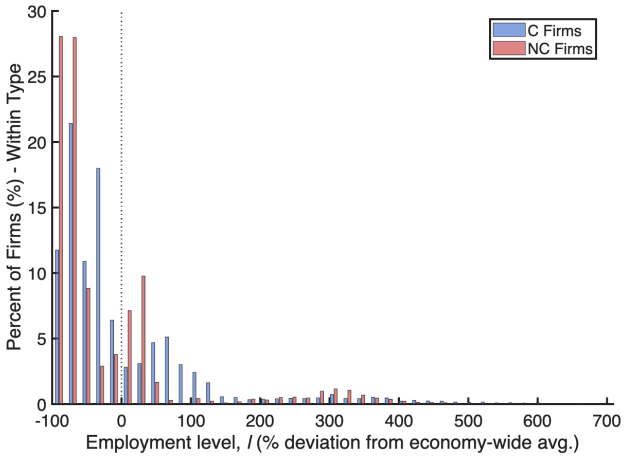


Table 5: Firm Composition: Baseline (% of total firms)

	C Sector	NC Sector	Total
Continuing firms (incl. surviving entrants)	91.56	86.48	88.42
Exiters (all)	8.44	13.52	11.58
Exiting entrants	8.36	10.62	9.76
Exiting incumbents	0.08	2.90	1.82
Entrants	8.44	13.52	11.58

firms continue to produce and only 0.1% of the exits come from incumbent C firms. That is because the current period nonnegative profit assumption for producing is more restrictive for C firms, as they require a larger up-front capital cost. This raises the productivity threshold for entry among C firms. Because entry into the C sector is more selective, firms that enter and produce are, on average, more productive and therefore less likely to exit than firms in the NC sector. Thus, allowing firms to differ in capital intensity enables the model to capture sectoral differences in entry selection and subsequent survival.

5.3 Counterfactual: Increase of Tax Rate by 1 pp

This section examines how a one-percentage-point increase in the tax rate affects firm dynamism and equilibrium outcomes in the calibrated economy. The main findings are as follows. First, firm mass and turnover decline, with a larger contraction in firm mass in capital-intensive industries. Second, employment shifts toward the non-capital-intensive sector, while aggregate employment and consumption fall. Third, the new steady state contains fewer, larger firms with lower average productivity. A channel decomposition then shows how equilibrium price adjustment reverses the direct tax effect on exit.

5.3.1 Steady-State Effects on Firm Dynamics and Aggregate Outcomes

The changes in firm dynamics are summarized in Table 6 and show a decrease in business dynamism with the increase in the tax rate. The columns for the C and NC sectors show that,

although all measures change in the same direction across both sectors, the magnitudes of these changes differ. First of all, the drop in the C sector's total firm mass is approximately three times as large as that in the NC sector. This is consistent with what is shown in the illustrative model, which shows that the user cost of capital increases with an increase in the tax rate. That is why the C firms experience a large decrease in the total mass of firms. Moreover, the decrease in exit rate is larger for C firms, and the decrease in entry rate is larger for NC firms. That is because the productivity threshold for entry was already relatively high for C firms, as they need more up-front investment to begin producing. As a result, fewer firms are residing near the cutoff threshold. By contrast, there are more NC firms near the entry margin, and the increase in tax rate can have a larger impact on the entry rate. In addition, the total number of firms also decreases, and entry and exit rates fall both in the aggregate and within each sector. The decline in exit contrasts with the positive association between taxation and exit documented in the empirical motivations. That is because Table 6 compares two steady states and therefore incorporates equilibrium price adjustments. The channel decomposition below examines how these adjustments shape the opposite exit response.

Table 6: Entry and Exit (Policy 1 vs. Baseline)

	C Sector	NC Sector	Total
Panel A: Masses (% change)			
Total firms	-2.287	-0.741	-1.331
Continuing firms	-2.040	-0.554	-1.141
Entrants	-4.967	-1.936	-2.779
Exiters	-4.967	-1.936	-2.779
Panel B: Rates (pp change)			
Entry rate	-0.002	-0.035	-0.012
Exit rate	-0.231	-0.163	-0.170
Entrant exit rate	-0.229	-0.128	-0.158

Besides firm dynamics, the counterfactual analysis also investigates the impact on aggregate variables, such as employment, its sectoral reallocation, and prices. As shown in Table 7, with a higher tax rate, firms become less profitable, and C firms suffer more than NC firms. With the equilibrium effect, the relative price of C goods to NC goods will go up, and wages go down to encourage more firms to enter the market. In addition, with the tax increase, real output for both firm types goes down, and the aggregate CES consumption goes down as well. There is a decrease in employment in C sectors and a slight increase in employment for the NC sector. This indicates that there is a slight shift from C sectors to NC sectors in the economy with a higher tax rate. This also implies that C firms suffer more from the same tax rate change in both sectors.

This exercise also sheds light on implications for firm distributions and aggregate economic productivity. Average firm size increases in both sectors, with the increase in the C sector more than twice that in the NC sector. Together with the decline in firm mass, this pattern indicates that each sector consists of fewer but larger firms following the tax increase and is consistent with greater market concentration. However, this concentrated firm distribution is accompanied by a less productive economy. Average productivity declines among all operating firms. This is be-

Table 7: Equilibrium Outcomes (Policy 1 vs. Baseline, % change)

	C Sector	NC Sector	Total
Relative price (p_C/p_{NC})	+0.334		
Entrant mass	-4.967	-1.936	-2.779
Output	-1.003	-0.062	
Nominal GDP	-0.672	-0.062	-0.378
Average firm size	+1.593	+0.690	+1.015
Avg productivity, all operating firms	-0.011	-0.080	-0.030
Avg productivity, incumbents (operating)	-0.009	-0.070	-0.025
Employment	-0.479	+0.133	-0.138
Consumption	-0.845	+0.118	
Aggregate consumption (CES)	-0.358		
Wage	-0.194		
Real wage	-0.358		

cause lower entry reduces competition pressure and allows relatively unproductive incumbents to remain active. As a result, the composition of operating firms shifts towards lower-productivity firms. Similar results have also been discussed in an empirical work by Aw et al. (2003).

5.3.2 Channel Decomposition

As briefly mentioned above, there are differences in the exit rate change directions between the quantitative model results and the empirical motivations. The two analyses consider different horizons. In the empirical section, the positive correlation between tax rate and exit is a contemporaneous direct effect. However, in the quantitative model, the changes shown in Table 6 are between two steady states, which include general equilibrium price adjustments with the policy changes over a long-term horizon.

The quantitative model's results shown in Table 6 reflect the combined effects of the direct tax impact and long-run equilibrium price adjustments. For the direct tax impact, holding prices fixed, the unit cost of capital will increase as the tax rate increases, which encourages more firms to exit and discourages entries. However, in the new steady states, the general equilibrium effect will raise goods prices, resulting in more entries with increasing profits. This general equilibrium channel will decrease exits and increase entries. With the price channel dominating total impacts for exit decisions, the total long-run dynamics show decreases in both rates.

Table 8: Channel Decomposition, Steady State: Changes

	Direct tax effect (τ_1, p_0, M_0)		Entry mass adjustment (τ_1, p_0, M_1)		GE price adjustment (τ_1, p_1, M_1)		Total effects (τ_1, p_1, M_1)	
	C	NC	C	NC	C	NC	C	NC
GDP (% of baseline)	-0.898	-0.158	-4.923	-1.933	+4.818	+2.030	-1.003	-0.062
Employment (% of baseline)	-0.898	-0.158	-4.923	-1.933	+5.342	+2.224	-0.479	+0.133
Entry rate (pp)	+0.000	+0.003	-0.000	-0.000	-0.003	-0.038	-0.002	-0.035
Exit rate (pp)	+0.046	+0.013	-0.000	-0.000	-0.278	-0.176	-0.231	-0.163

To quantify the proposed two impact channels, which are direct tax impact and general equilibrium price adjustments, Table 8 displays the key dynamics in the economy by shutting

Table 9: Tax Effects on C Firms Relative to All Firms: Model and Data (Untargeted)

	Data	Model	
		Direct effect	Total effect
Entry rate: C / All	$1.8^{\dagger}$ $(-,-)$	0.09 $(+,+)$	0.18 $(-,-)$
Exit rate: C / All	2.2^{***} $(+,+)$	1.49 $(+,+)$	1.36 $(-,-)$

Notes: Each entry is the change in the C-firm rate divided by the change in the all-firm rate, both in percentage points, for a 1 pp tax increase; signs of the (C, All) changes in parentheses. *** *Both underlying coefficients significant at 1%.* † *Neither underlying coefficient statistically significant. Data: ratio of contemporaneous coefficients on the trade tax change, columns (1) and (2) of Table 2 (entry rate) and Table 1 (establishment exit indicator). Model: Policy 1 steady-state decomposition. Direct effect: new tax rate at baseline prices and entrant mass. Total effect: new general-equilibrium steady state.*

off one channel at a time. Column 1 displays the direct tax effect, which compares the results with the new tax rate (τ_1) with the baseline while holding the price and entrant mass at the baseline level. With this direct tax impact, both GDP and employment decrease, and the exit rates increase. The increase in exit rates is about 0.046 percentage points for C firms, while that is only 0.013 percentage points for NC firms. This can recover the observed large increase in exit rate in the short term, as in the empirical motivation. Column 2 shows the impact of entry mass adjustment. Compared with results in column 1, this allows the entrant mass to adjust. It is shown that, with a stationary distribution of firms, entry and exit rates do not change with this scaling impact, and the aggregate output and employment decrease as total mass drops. Column 3 shows the impact of general equilibrium price adjustment, where the prices are updated to the new steady-state levels. With price increases, exit decreases because production becomes more profitable. Quantitatively, this general equilibrium effect outweighs the direct tax impact; thus, there is a decrease in exit rates in the long term in the total effects.

Table 9 compares the relative tax effects on C firms and all firms in the data and in the model. The data column is the ratio of the contemporaneous coefficients on the trade tax change in columns (2) and (1) of Table 2 for the entry rate and of Table 1 for establishment exit. Signs of the underlying changes are shown in parentheses. For the exit rate, the model's direct effect reproduces the signs of the empirical estimates, with exit rising for both C firms and all firms. The model ratio of 1.49 is about two-thirds of the empirical ratio of 2.2, so the model captures most of the disproportionate effect of the tax on C-firm exit. For the entry rate, neither underlying empirical coefficient is statistically significant, and both 95% confidence intervals include zero. The data therefore do not rule out the positive entry responses the model's direct effect implies.

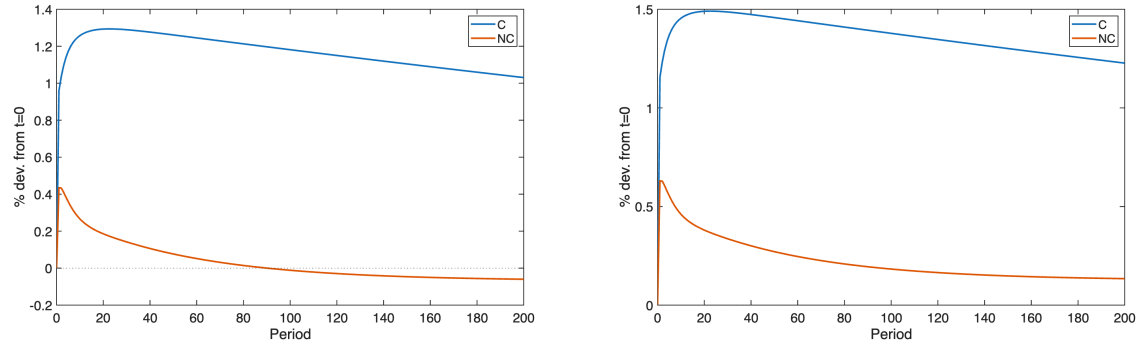
5.3.3 Partial Equilibrium Transition

Figure 6 illustrates the firm distributional transition path from the baseline economy to the new steady states, assuming firms quickly adjust to the new steady states' prices and policy functions. For both types of firms, GDP and employment increase first and gradually decrease as firm distribution becomes stationary. Since the relative price of C goods is higher after the tax change, C firms tend to increase more at the beginning and take longer to reach the new

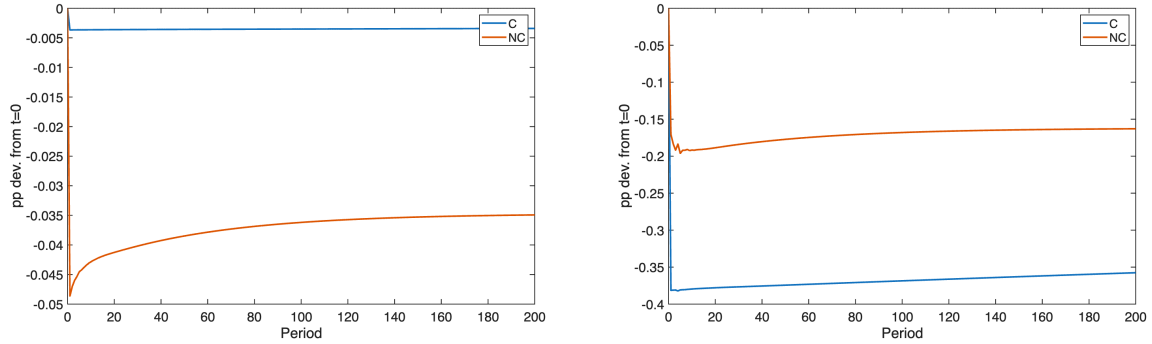
steady state. Entry rates decrease by a very small amount compared to that of exit rates, which is consistent with the insignificant empirical results for entries. The exit rate of C firms decreases more than that of NC firms. Since this is a partial equilibrium transition path, the important price adjustment channel cannot be illustrated in this set of figures.

Figure 6: Transition path (partial equilibrium)

(a) GDP *(b) Employment*



(c) Entry rates *(d) Exit rates*



Notes: Prices are fixed at their new steady-state values. Partial equilibrium means that markets need not clear during the transition, but clear as the firm distribution converges to the new steady state.

5.4 Counterfactual: Lower Business Entry Barrier

This model can also provide evaluations of the effect of different entry barriers on business dynamism. This subsection provides an example of examining the impact of lower business barriers on firms' entry and exit decisions with a fixed tax regime.

There are ongoing debates about the impact of rapidly growing artificial intelligence (AI) on labor market and firm dynamics. As generative AI technologies have become more accessible and less costly, recent evidence suggests a notable increase in AI adoption among small businesses. [10] Lower cost of generative AI may reduce entry barriers by enabling entrepreneurs to form one-person companies. For instance, generative AI tools could be very helpful in tasks such as market research, regulatory compliance, translation, and market strategy development.

[10] Using small-business transaction data, the JPMorgan Chase Institute finds that the share of businesses adopting AI in their first month of operation rose from 1.2% in 2019 to approximately 6.5% in 2025. See *Understanding AI Use by Small Businesses*.

However, it is hard to quantify the extent to which AI helps lower the business entry barriers. One possible proxy for the reduction in entry costs can be defined as the median AI spending. Based on the transaction-level data for small businesses, the initial AI adopter's median AI spending decreases by about 60% from about $50 in 2019 to about $20 in 2024, as reported by JPMorgan Chase. Combined with the previous observation that an average of 3.85% of small businesses adopt AI in the first month of entering the market, it is reasonable to assume that the development of generative AI could lead to a 2.3% reduction in entry cost. While this 2.3% decrease in AI adoption cost does not fully capture the impact of AI on entry cost, it could be a reasonable starting point. So, in this exercise, I model a 2.3% reduction in entry costs for both firm types and evaluate the impact on firm dynamics.

Table 10: Entry and Exit (Policy 2 vs. Baseline)

	C Sector	NC Sector	Total
Panel A: Masses (% change)			
Total firms	+2.491	+1.228	+1.710
Continuing firms	+2.134	+1.018	+1.458
Entrants	+6.374	+2.573	+3.629
Exiters (all)	+6.374	+2.573	+3.629
Panel B: Rates (pp change)			
Entry rate	+0.003	+0.038	+0.017
Exit rate	+0.320	+0.180	+0.219
Entrant exit rate	+0.317	+0.141	+0.202

Table 10 shows that the total number of firms increases for both firm types. This is because more potential entrants find it profitable to enter the market as the entry cost decreases. The increase in the number of C firms is about twice as large as that for NC firms, as they are more bounded by the non-negative profits assumption with the larger up-front investment requirement. Similar to the case of tax changes, the entry rates barely change compared to the changes in exit rates. In general, lower entry cost boosts business dynamics in the economy.

Table 11: Equilibrium Outcomes (Policy 2 vs. Baseline, % change)

	C Sector	NC Sector	Total
Relative price (p_C/p_{NC})		-0.233	
Entrant mass	+6.374	+2.573	+3.629
Output	+0.871	+0.146	
Nominal GDP	+0.636	+0.146	+0.400
Average firm size	-1.759	-1.157	-1.374
Avg productivity, all operating firms	+0.015	+0.123	+0.065
Avg productivity, incumbents (operating)	+0.012	+0.114	+0.058
Employment	+0.337	-0.152	+0.064
Consumption	+0.757	+0.079	
Aggregate consumption (CES)		+0.413	
Wage		+0.298	
Real wage		+0.413	

With the general equilibrium effect shown in Table 11, an increase in firm counts creates higher labor demand that pushes up wages and lowers the relative price of C goods. At the

aggregate level, Table 11 shows that both nominal and real output increase. Average productivity increases, especially for NC firms. So, this could provide illustrative evidence that if AI could substantially lower the entry cost for firms, aggregate productivity could increase as business dynamism increases. The increase in average productivity is larger for NC firms as they are relatively smaller in scale. Total employment increases slightly, with an increase in the C sector but decreases in the NC sector. Total consumption of the two goods increases.

6 Conclusion

This paper examines how business income taxation affects firm dynamics and aggregate outcomes across industries with different capital intensities. Using German establishment-level data, I find that a one-percentage-point increase in the local trade tax rate is associated with a 1.1-percentage-point increase in exit probability among capital-intensive establishments, compared with 0.5 percentage points in the full sample. The estimated entry responses are negative but statistically insignificant. These findings motivate a two-sector general equilibrium model with endogenous entry, exit, and capital accumulation, in which incomplete capital-cost deductibility makes capital-intensive firms more exposed to tax increases.

The calibrated model shows that a higher tax rate reduces the firm mass and firm dynamics, with a substantially larger impact among capital-intensive firms. Employment shifts toward the less capital-intensive sector, while aggregate employment and consumption decline. The new steady state contains fewer, larger firms with lower average productivity. The channel decomposition highlights two opposing forces behind the firm dynamics. Holding prices and entrant mass fixed, higher taxes increase exit, particularly among capital-intensive firms, consistent with the direction of the empirical exit estimates. Equilibrium price adjustments more than offset this direct effect, leading to lower exit rates in the new steady state. The distinction between direct and equilibrium effects is therefore central to interpreting the model's predictions for firm dynamics.

An additional counterfactual shows how lower entry barriers increase firm mass, output, and average productivity in the two-sector setting. Taken together, these findings highlight the importance of capital intensity, capital-cost deductibility, and equilibrium adjustments when evaluating business tax policy. With the inclusion of firm heterogeneity, the paper can better investigate how tax changes affect both the scale of economic activity and its allocation across sectors.

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A Detailed Industry List

Table A.1: Industry Classification by Capital Intensity

NACE Rev. 2	Industry
Panel A: Non-Capital-Intensive (NC) Industries	
I	Accommodation and food service activities
S	Other service activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
Q	Human health and social work activities
K	Financial and insurance activities
M	Professional, scientific, and technical activities
P	Education
O	Public administration and defence; compulsory social security
Panel B: Capital-Intensive (C) Industries	
A	Agriculture, forestry, and fishing
R	Arts, entertainment, and recreation
C	Manufacturing
H	Transportation and storage
N	Administrative and support service activities
B	Mining and quarrying
J	Information and communication
E	Water supply; sewerage, waste management, and remediation activities
D	Electricity, gas, steam, and air conditioning supply
L	Real estate activities

B Robustness Checks for Empirical motivations

Table B.1 provides a robustness check of the results by running the same specifications as in Table 1 but excluding establishments in sectors exempt from the trade tax rate. The results that there are larger point estimates for capital-intensive establishments than those for all samples still hold, although the statistical significance level decreases from 1% to 5% in columns (2) and (6).

Table B.1: Impact of trade tax change on exits excluding public sectors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	C	Small	Small C	All	C	Small	Small C
Trade tax change	0.005***	0.010**	0.006***	0.011**	0.005***	0.011**	0.006***	0.012**
	(0.002)	(0.004)	(0.002)	(0.005)	(0.002)	(0.004)	(0.002)	(0.005)
Trade tax change: lag 1	0.000	-0.001	0.000	-0.000	-0.000	-0.001	-0.000	-0.001
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Trade tax change: lag 2	0.003*	0.003	0.003*	0.003	0.002	0.003	0.003	0.003
	(0.001)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Size: 1–19 employees	0.017***	0.024***			0.017***	0.024***		
	(0.003)	(0.006)			(0.003)	(0.006)		
Size: 20–199 employees	0.003	0.006			0.004	0.006		
	(0.003)	(0.004)			(0.003)	(0.004)		
Establishment age	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Age squared	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log population	-0.071	-0.084	-0.079	-0.084	-0.073	-0.087	-0.081	-0.086
	(0.068)	(0.109)	(0.074)	(0.126)	(0.068)	(0.109)	(0.074)	(0.127)
Sole proprietor	0.017***	0.022**	0.018***	0.018	0.017***	0.022**	0.018***	0.018
	(0.004)	(0.010)	(0.004)	(0.013)	(0.004)	(0.010)	(0.004)	(0.013)
Partnership	0.008	0.009	0.009	0.006	0.008	0.009	0.009	0.006
	(0.005)	(0.012)	(0.006)	(0.015)	(0.006)	(0.012)	(0.006)	(0.015)
Corporation	0.001	0.006	0.001	0.002	0.001	0.006	0.001	0.002
	(0.003)	(0.009)	(0.004)	(0.012)	(0.003)	(0.009)	(0.004)	(0.013)
Short controls	Yes	Yes	Yes	Yes	No	No	No	No
Long controls	No	No	No	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No	No	No	No	No
Year x Sector FE	No	No	No	No	No	No	No	No
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Establishment-year obs.	72010	30056	49254	17834	70148	29303	48076	17412
R-Squared	0.025	0.051	0.025	0.056	0.025	0.051	0.025	0.056

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. *Standard errors clustered by district in parentheses. The sample period is 2008-2017. Regressions are adjusted using panel weights. Columns 1–4: short controls; columns 5–8: long controls. C denotes capital-intensive industries; Small denotes 1–19 employees. Outcome: establishment exit indicator (0/1). Short controls: size indicators, age, age squared, log population, and legal form. Long controls add property tax A/B changes and GDP change.*

C Quantitative Model Computation Steps

1. Solve the individual firm's problem. Given prices, the firm decides on capital and labor inputs, as well as exit decisions. Then, solve for the endogenous prices with the free-entry condition.

2. Guess entrants' mass, and iterate to get the stationary firm distribution with entry and exit decisions.

3. With stationary firm mass, calculate household's demand. Specifically, demand functions for two goods depend on household income, prices of goods, as well as the CES utility parameters.

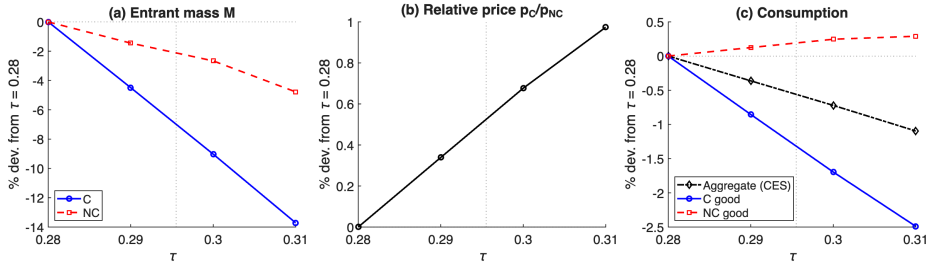
4. Check for goods market clearing conditions.

5. Update entrant mass and return to step 2.

D Tax sensitivity analysis

I examine how the equilibrium responds to changes in the tax rate around the baseline. Figure D.1 reports percentage deviations from the equilibrium at $\tau = 0.28$, the lowest rate on the grid, as the tax rate rises to 0.31. A higher tax lowers after-tax profits, so fewer firms enter. The effect is stronger for C firms because they are more capital-intensive. Over this range, the entrant mass of C firms falls by about 14 percent, while that of NC firms falls by about 5 percent. As C-good supply contracts, the relative price p_C/p_{NC} rises until expected profits again cover the entry cost. The higher relative price shifts demand away from C goods. C-good consumption falls by about 2.5 percent, NC-good consumption rises slightly, and aggregate consumption declines by about 1 percent.

Figure D.1: Entrant mass, relative price, and consumption changes



Notes: Each panel shows the percentage deviation from the equilibrium at $\tau = 0.28$, the lowest tax rate on the grid. The vertical dotted black line marks the baseline tax rate.