# Online Appendix: Not for Publication

This appendix includes supplemental information and additional analyses. Appendix A provides detailed derivations of the model. Appendix B describes additional policy details. Appendix C describes the data sources. Additional results of reduced-form analysis, structural estimation and simulations are reported in Appendix D, E and F, respectively.

# A Model Appendix

## A.1 Static Model

This section documents derivations of the static models following the setup of the firm problem in Section 1.

### A.1.1 Partial Irreversibility

Assume the purchase price of capital is $p^b$ and the resale price is $p^s < p^b$. The firm's problem is now:

$$\max \left\{ \underbrace{\max_{K>K_0} (1-\tau)A^{1-\theta}K^{\theta} - p^b(K-K_0)}_{\text{Invest}}, \underbrace{\max_{K<K_0} (1-\tau)A^{1-\theta}K^{\theta} - p^s(K-K_0)}_{\text{Disinvest}}, \underbrace{(1-\tau)A^{1-\theta}K_0^{\theta},}_{\text{Inaction}} \right\}$$

The optimal capital level $K$ is characterized as follows.

- There exists an upper threshold $\bar{A}$ such that firms invest if their productivity is sufficiently high $A > \bar{A}$. In particular, the optimal capital $K^b = A\left[\frac{(1-\tau)\theta}{p^b}\right]^{1/(1-\theta)}$ and

$$\bar{A} = \left[\frac{p^b}{(1-\tau)\theta}\right]^{\frac{1}{1-\theta}} K_0. \tag{A.1}$$

- There exists a lower threshold $\underline{A}$ such that firms disinvest if their productivity is sufficiently low $A < \underline{A}$. In particular, the optimal capital $K^s = A\left[\frac{(1-\tau)\theta}{p^s}\right]^{1/(1-\theta)}$ and

$$\underline{A} = \left[\frac{p^s}{(1-\tau)\theta}\right]^{\frac{1}{1-\theta}} K_0. \tag{A.2}$$

- Firms with productivity $A \in [\underline{A}, \bar{A}]$ remain with $K_0$.

### A.1.2 Fixed Cost

Now assume the firm needs to pay a fixed cost $\xi K^*$ to adjust capital. The firm's problem is now:

$$\max\left\{\underbrace{\max_{K\neq K_0}(1-\tau)A^{1-\theta}K^{\theta}-p(K-K_0)-\xi K^*}_{\text{Adjust}},\underbrace{(1-\tau)A^{1-\theta}K_0^{\theta},}_{\text{Inaction}}\right\},$$

where $K^*$ is given by Equation 1. The optimal profit conditional on adjusting is:

$$(1-\tau)\left[(1-\theta)-\theta\frac{\xi}{p}\right]\left[\frac{(1-\tau)\theta}{p}\right]^{\theta/(1-\theta)}A+pK_0. \tag{A.3}$$

The fixed costs generates a region of inaction where firms would rather produce with the initial capital stock $K_0$ rather than adjust their capital. This region is defined by two values of productivity $\underline{A}$ and $\bar{A}$ at which the firm is indifferent between adjusting and inaction. These values are defined by comparing firm profits from adjusting and inaction:

$$\underbrace{(1-\tau)\left[(1-\theta)-\theta\frac{\xi}{p}\right]\left[\frac{(1-\tau)\theta}{p}\right]^{\theta/(1-\theta)}A+pK_0}_{\text{Profit conditional on adjusting to optimal capital } K^*}=\underbrace{(1-\tau)K_0^{\theta}A^{1-\theta}}_{\text{Profit using initial capital } K_0},\quad A\in\{\underline{A},\bar{A}\}.$$

To see how tax reforms interact with the fixed cost, scale both sides by a factor of $\frac{1}{1-\tau}$ and denote $\text{UCC}=\frac{p}{1-\tau}$:

$$\underbrace{\left[\frac{(1-\theta)}{\theta}\text{UCC}-\frac{\xi}{1-\tau}\right]\left[\frac{\theta}{\text{UCC}}\right]^{1/(1-\theta)}}_{\text{Slope}}A+\underbrace{\text{UCC}K_0}_{\text{Intercept}}=K_0^{\theta}A^{1-\theta}. \tag{A.4}$$

### A.1.3 Convex Adjustment Cost

In the presence of convex adjustment cost, the firm's problem is:

$$\max_{K}(1-\tau)A^{1-\theta}K^{\theta}-p(K-K_0)-D(K),$$

where $p=p_k(1-\tau p_v)$ and where we assume that $D'(K)\geq 0$ and $D''(K)\geq 0$. The firm's FOC is:

$$\theta(1-\tau)A^{1-\theta}K^{\theta-1}=p+D'(K) \tag{A.5}$$

Taking logarithms and differentiating FOC (A.5) w.r.t. $p_k$, we have:

$$
\begin{aligned}
(\theta-1)\frac{1}{K}\frac{\partial K}{\partial p_k} &= \frac{1}{p+D'(K)}\left(\frac{\partial p}{\partial p_k}+D''(K)\frac{\partial K}{\partial p_k}\right)\\
(\theta-1)\varepsilon_{K,p_k} &= \underbrace{\frac{p}{p+D'(K)}}_{s^p}\varepsilon_{p,p_k}+\frac{D'(K)}{p+D'(K)}\varepsilon_{K,p_k}\underbrace{\left(\frac{D''(K)K}{D'(K)}\right)}_{\alpha(K)}\\
(\theta-1)\varepsilon_{K,p_k} &= s^p\varepsilon_{p,p_k}+(1-s^p)\varepsilon_{K,p_k}\alpha(K)\\
\varepsilon_{K,p_k} &= \frac{-s^p}{1-\theta+(1-s^p)\alpha(K)},
\end{aligned}
\tag{A.6}
$$

where the second line multiplies by $p_k$ and arranges terms into elasticities, the third line introduces $s^p=\frac{p}{p+D'(K)}$ and $\alpha(K)=\frac{D''(K)K}{D'(K)}$, and the last line solves for $\varepsilon_{K,p_k}$ and uses the fact that $\varepsilon_{p,p_k}=1$.

Similarly, taking logarithms and differentiating FOC (A.5) w.r.t $(1-\tau)$, we have:

$$
\varepsilon_{K,1-\tau}=\frac{-s^p\varepsilon_{UCC,1-\tau}+(1-s^p)}{1-\theta+(1-s^p)\alpha(K)},
\tag{A.7}
$$

where $\varepsilon_{K,1-\tau}$ is the elasticity of UCC with respect to $1-\tau$.

To interpret Equations A.6 and A.7, note that $s^p$ is the share of the price of capital in the total marginal cost of investment $(p+D'(K))$.[60] By increasing the marginal cost of investment, convex costs dampen the numerator of these elasticities. In addition, note that $\alpha(K)$ is a measure of the curvature of the adjustment cost function $D'(K)$.[61] Larger deviations of $K$ from $K_0$ also increase the marginal cost of investment. This indirect effect of the convex costs also dampens the elasticities by increasing the value of the denominator.

Comparing Equations A.6 and A.7, we note that changes in $1-\tau$ and $p_k$ now have different effects on investment. To see the nature of this difference, note that changes in $1-\tau$ change the after-tax cost of $D(K)$. These adjustment costs are thought to include halts in production. Because these costs are not tax-deductible, we model $D(K)$ as being an after-tax expense.

A particular example of $D(K)$ is the case of quadratic costs. These costs feature prominently in the literature and we use them in our dynamic model. Assuming $D(K)=\frac{\gamma}{2}\left(\frac{K}{K_0}-1\right)^2K_0$ implies $\alpha(K)=\frac{1}{1-K_0/K}$ and $s^p=\frac{p}{p+\gamma\left(\frac{K}{K_0}-1\right)}$. These facts imply the following elasticities:

$$
\varepsilon_{K,p_k}=\frac{-1}{(1-\theta)+\frac{\gamma}{p}\left((2-\theta)\frac{K}{K_0}-(1-\theta)\right)}\quad\text{and}\quad\varepsilon_{K,(1-\tau)}=\frac{-\varepsilon_{UCC,1-\tau}+\frac{\gamma}{p}(K/K_0-1)}{(1-\theta)+\frac{\gamma}{p}\left((2-\theta)\frac{K}{K_0}-(1-\theta)\right)}.
$$

[60] Note $s^p\in[0,1]$ as long as $D'(K)\geq 0$.

[61] In the context of expected utility theory, $\alpha(K)$ is the Arrow-Prat measure of risk aversion, or the coefficient of relative risk aversion. Note $\alpha(K)\geq 0$ as long as $D(K)$ is convex.

## A.2 Profit Function

In this section, we micro-found the profit function of the form $\Pi = (A^{\Pi})^{1-\theta} K^{\theta}$ by a simple firm optimization problem. Assume the final good market is perfectly competitive. Firms use capital, labor and intermediate goods for production. The production function features decreasing-return-to-scale (DRTS) with the following form:

$$Y = A^{1-\eta}[(K^{\alpha}L^{1-\alpha})^{1-\sigma}M^{\sigma}]^{\eta},$$

where $\eta$ is the span-of-control parameter, $\sigma$ is the share of intermediate goods, and $\alpha$ is the capital share in value added. Capital $K$ is pre-determined while labor $L$ and intermediate goods $M$ are chosen contemporaneously after productivity $A$ is realized.

Given the price of final goods $p_c$ which is normalized to one, wage $w$, the price of intermediate goods $p^M$ and corporate income tax rate $\tau$, the firm's problem is:

$$\max_{L,M} (1-\tau)\{A^{1-\eta}\left[(K^{\alpha}L^{1-\alpha})^{1-\sigma}M^{\sigma}\right]^{\eta} - wL - p^M M\}.$$

Solving the FOCs, we obtain the optimal labor and intermediate inputs:

$$\begin{aligned} L^* &= \left\{\eta\left[\frac{(1-\alpha)(1-\sigma)}{w}\right]^{1-\sigma\eta}\left[\frac{\sigma}{p^M}\right]^{\sigma\eta} A^{1-\eta}\right\}^{\frac{1}{1-\eta[(1-\alpha)(1-\sigma)+\sigma]}} K^{\frac{\alpha(1-\sigma)\eta}{1-\eta[(1-\alpha)(1-\sigma)+\sigma]}}, \\ M^* &= \frac{w}{(1-\alpha)(1-\sigma)}\frac{\sigma}{p^M}L^*. \end{aligned}$$

Thus, the optimal revenue and profit are:

$$\begin{aligned} R^* &= \left\{\underbrace{\left[\frac{(1-\alpha)(1-\sigma)}{w}\right]^{\frac{1-\sigma\eta}{1-\eta}}\left[\frac{\sigma}{p^M}\right]^{\frac{\sigma\eta}{1-\eta}} A}_{A^R}\right\}^{1-\underbrace{\frac{\alpha(1-\sigma)\eta}{1-\eta[(1-\alpha)(1-\sigma)+\sigma]}}_{\theta}} K^{\frac{\alpha(1-\sigma)\eta}{1-\eta[(1-\alpha)(1-\sigma)+\sigma]}} = (A^R)^{1-\theta}K^{\theta}, \\ \Pi^* &= \{1-\eta[(1-\alpha)(1-\sigma)+\sigma]\}\, R^* \\ &= \left\{\underbrace{(1-\tau)^{\frac{1}{1-\theta}}\{1-\eta[(1-\alpha)(1-\sigma)+\sigma]\}^{\frac{1}{1-\theta}} A^R}_{A^{\Pi}}\right\}^{1-\theta} K^{\theta} = (A^{\Pi})^{1-\theta}K^{\theta}, \end{aligned} \tag{A.8}$$

where the parameter $\theta$, and profit shocks $A^{\Pi}$ are defined by:

$$\theta = \frac{\alpha(1-\sigma)\eta}{1-\eta[(1-\alpha)(1-\sigma)+\sigma]},$$
$$A^{\Pi} = (1-\tau)^{\frac{1}{1-\theta}} \{1-\eta[(1-\alpha)(1-\sigma)+\sigma]\}^{\frac{1}{1-\theta}} \left[\frac{(1-\alpha)(1-\sigma)}{w}\right]^{\frac{1-\sigma\eta}{1-\eta}} \left[\frac{\sigma}{p^M}\right]^{\frac{\sigma\eta}{1-\eta}} A.$$

## A.3 Value Function and Normalization

This section details the derivation of the value function.

### A.3.1 Original Value Function

The per-period profit is $\Pi(K, A^{\Pi})$, where $K$ is pre-determined capital and $A^{\Pi}$ is a profit shock realized at the beginning of the period. Firms pay the input VAT at rate $\nu$ on purchases of new investment, which is not allowed to be deducted from the output VAT. Firms also pay the CIT at rate $\tau$ on profits. Capital depreciates at rate $\delta$. Besides the economic depreciation rate, we also consider a straight-line accounting depreciation rate ($\hat{\delta}$) that determines the deductibility of capital usage from the CIT.

Firms face adjustment frictions including a convex cost ($\frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K$), a random fixed cost ($\xi K^*$), and partial irreversibility from the non-deductible VAT on new equipment purchases.

Let $D$ be the depreciation allowances accumulating over time. Since the accounting depreciation rate $\hat{\delta}$ differs from the economic depreciation rate $\delta$, firms track the depreciation allowance $D$ besides capital stock $K$. The firm's state variables are $(K, D, A^{\Pi}, \xi)$. We assume that the fixed cost is i.i.d drawn from the distribution $G(\xi)$ and we define the *ex ante* value function:

$$V^0(K, D, A^{\Pi}) = \int_0^{\bar{\xi}} V(K, D, A^{\Pi}, \xi) dG(\xi). \tag{A.9}$$

The firm's problem in recursive formulation is:

$$V(K, D, A^{\Pi}, \xi) = \max\{V^b(K, D, A^{\Pi}, \xi), V^s(K, D, A^{\Pi}, \xi), V^i(K, D, A^{\Pi}, \xi)\},$$

where

$$
\begin{aligned}
V^b(K,D,A^\Pi,\xi) &= (1-\tau)\Pi(K,A^\Pi)+\tau\hat{\delta}D \\
&+ \max_{I>0}\left\{-[1+\nu-\tau\hat{\delta}(1+\nu)]I-\frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K-\xi K^* + \beta\mathbb{E}[V^0(K',D',A^{\Pi'})|A^\Pi]\right\} \\
V^s(K,D,A^\Pi,\xi) &= (1-\tau)\Pi(K,A^\Pi)+\tau\hat{\delta}D \\
&+ \max_{I>0}\left\{-[1+\quad -\tau\hat{\delta}(1+\nu)]I-\frac{\gamma}{2}\left(\frac{I}{K}K\right)^2 -\xi K^* + \beta\mathbb{E}[V^0(K',D',A^{\Pi'})|A^\Pi]\right\} \\
V^i(K,D,A^\Pi,\xi) &= (1-\tau)\Pi(K,A^\Pi)+\tau\hat{\delta}D+\beta\mathbb{E}[V^0(K(1-\delta),D(1-\hat{\delta}),A^{\Pi'})|A^\Pi]
\end{aligned}
$$

The capital stock $K$ and depreciation allowance $D$ evolve according to the following laws of motion:

$$
\begin{aligned}
K' &= (1-\delta)K+I \\
D' &= (1-\hat{\delta})[D+(1+\nu)I].
\end{aligned}
$$

### A.3.2 Simplification

Winberry (2018) shows that the impact of the depreciation schedule $\hat{\delta}$ on the deductibility of a unit of new capital can be summarized by the sufficient statistic $p_v$, which is defined recursively as

$$p_v = \hat{\delta} + (1-\hat{\delta})\beta\mathbb{E}[p_v']. \tag{A.10}$$

Furthermore, the function $V(K,D,A^\Pi,\xi)$ has the same solution as the following value function

$$\tilde{V}(K,A^\Pi,\xi) = \max\{\tilde{V}^b(K,A^\Pi,\xi),\tilde{V}^s(K,A^\Pi,\xi),\tilde{V}^i(K,A^\Pi,\xi)\},$$

where

$$\tilde{V}^0(K, A^\Pi) = \int_0^{\bar{\xi}} \tilde{V}(K, A^\Pi, \xi) dG(\xi)$$

$$\tilde{V}^b(K, A^\Pi, \xi) = \max_{I>0} \ (1-\tau)\Pi(K, A^\Pi) - \left[ [1+\nu-\tau p_v(1+\nu)]I + \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K + \xi K^* \right] + \beta \mathbb{E}[\tilde{V}^0(K', A^{\Pi'})|A^\Pi]$$

$$\tilde{V}^s(K, A^\Pi, \xi) = \max_{I<0} \ (1-\tau)\Pi(K, A^\Pi) - \left[ [1 \qquad -\tau p_v(1+\nu)]I + \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K + \xi K^* \right] + \beta \mathbb{E}[\tilde{V}^0(K', A^{\Pi'})|A^\Pi]$$

$$\tilde{V}^i(K, A^\Pi, \xi) = (1-\tau)\Pi(K, A^\Pi) + \beta \mathbb{E}[\tilde{V}^0(K(1-\delta), A^{\Pi'})|A^\Pi]$$

We sketch the brief proof here. Rewrite the value function as

$$V(K, D, A, \xi) = (1-\tau)\Pi(K, A) + \tau\hat{\delta}D + \max_I - \left\{ [1+\nu-\tau\hat{\delta}(1+\nu)]\mathbb{1}_{I>0} + [1-\tau\hat{\delta}(1+\nu)]\mathbb{1}_{I\leq 0} \right\} I - \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K - \xi K^* \mathbb{1}_{I\neq 0} + \beta \mathbb{E}[V(K', D', A', \xi')|A] \tag{A.11}$$

Consider the set of functions of the form $f(K, A, D, \xi) = g(K, A, \xi) + \tau p_v D$, where $p_v = \hat{\delta} + (1-\hat{\delta})\mathbb{E}[p_v']$, and the operator $T$ defined by the right hand side of Bellman Equation (A.11).

<u>Claim:</u> The operator $T$ maps a function of the form $f(K, A, D, \xi) = g(K, A, \xi) + \tau p_v D$ to itself.
Proof: Applying the operator $T$ to $f(K, A, D, \xi)$, we get that

$$Tf(K, A, D, \xi) = (1-\tau)\Pi(K, A) + \tau\hat{\delta}D + \max_I - \left\{ [1+\nu-\tau\hat{\delta}(1+\nu)]\mathbb{1}_{I>0} + [1-\tau\hat{\delta}(1+\nu)]\mathbb{1}_{I\leq 0} \right\} I - \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K - \xi K^* \mathbb{1}_{I\neq 0} + \beta \mathbb{E}[g(K', A', \xi') + \tau p_v' D'|A]$$

By the law of motion for the depreciation allowance $D' = (1-\hat{\delta})[D + (1+\nu)I]$, we have that

$$
\begin{aligned}
Tf(K,A,D,\xi) &= (1-\tau)\Pi(K,A) + \tau\hat{\delta}D + \max_I - \left\{[1+\nu-\tau\hat{\delta}(1+\nu)]\mathbb{1}_{I>0} + [1-\tau\hat{\delta}(1+\nu)]\mathbb{1}_{I\leq 0}\right\} I \\
&- \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K - \xi K^* \mathbb{1}_{I\neq 0} + \beta\mathbb{E}[g(K',A',\xi')|A] + \tau(1-\hat{\delta})\beta\mathbb{E}[p_v']D + \tau(1-\hat{\delta})\beta\mathbb{E}[p_v'](1+\nu)I \\
&= (1-\tau)\Pi(K,A) + \tau[\hat{\delta} + (1-\hat{\delta})\beta\mathbb{E}[p_v']]D + \\
&\max_I - \left\{[1+\nu-\tau(1+\nu)(\hat{\delta}+(1-\hat{\delta})\beta\mathbb{E}[p_v'])]\mathbb{1}_{I>0} + [1-\tau(1+\nu)(\hat{\delta}+(1-\hat{\delta})\beta\mathbb{E}[p_v'])]\mathbb{1}_{I\leq 0}\right\} I \\
&- \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K - \xi K^* \mathbb{1}_{I\neq 0} + \beta\mathbb{E}[g(K',A',\xi')|A] \\
&= \Pi(K,A) + \tau p_v D + \max_I - \{[1+\nu-\tau(1+\nu)p_v]\mathbb{1}_{I>0} + [1-\tau(1+\nu)p_v]\mathbb{1}_{I\leq 0}\} I \\
&- \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K - \xi K^* \mathbb{1}_{I\neq 0} + \beta\mathbb{E}[g(K',A',\xi')|A], \qquad \text{(A.12)}
\end{aligned}
$$

where the last equation follows the definition of $p_v = \hat{\delta} + (1-\hat{\delta})\mathbb{E}[p_v']$. Note that the right-hand side of Equation (A.12) is also a function of the form $h(K,A,\xi) + \tau p_v D$. That is, the operator $T$ maps function $f(K,A,D,\xi) = g(K,A,\xi) + \tau p_v D$ to itself. Since the set of functions $f(K,A,D,\xi)$ is a closed set, there exists a unique fixed point and the fixed point lies in the set. By the definition of value function, which is the fixed point, it follows that $V(K,A,D,\xi)$ is of the form:

$$
V(K,A,D,\xi) = \tilde{V}(K,A,\xi) + \tau p_v D. \qquad \text{(A.13)}
$$

Substituting Equation (A.13) back into the original value function (Equation (A.11)) and canceling-out common terms on both sides, we have

$$
\begin{aligned}
\tilde{V}(K,A,\xi) = (1-\tau)\Pi(K,A) + \max_I - \{[1+\nu-\tau p_v(1+\nu)]\mathbb{1}_{I>0} + [1-\tau p_v(1+\nu)]\mathbb{1}_{I\leq 0}\} I \\
- \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K - \xi K^* \mathbb{1}_{I\neq 0} + \beta\mathbb{E}[\tilde{V}(K',A',\xi')|A].
\end{aligned}
$$

### A.3.3 Further Normalization

Recall that we decompose profit shocks into three components $A_{it}^{\Pi} = \exp(\omega_i + b_t + \varepsilon_{it})$, where $\omega_i$ is firm-specific permanent heterogeneity, $b_t$ is the aggregate shock, and $\varepsilon_{it}$ is the idiosyncratic transitory shock. The state variables are then $(K,\omega,b,\varepsilon,\xi)$. Note that both the profit function and the investment cost function are homogeneous of degree one in the pair $(K, A^{\Pi})$, and thus in $(K, \exp(\omega))$. This implies that the value function $V(K,\omega,b,\varepsilon,\xi)$ is also homogeneous of degree one in the pair $(K, \exp(\omega))$.

We can further normalize the value function to $v(k,b,\varepsilon,\xi)$ by defining $k = K/\exp(\omega)$, where the normalized value function is given by:

$$v(k,b,\varepsilon,\xi) = \max(v^b(k,b,\varepsilon,\xi), v^s(k,b,\varepsilon,\xi), v^i(k,b,\varepsilon,\xi)),$$

where

$$v^0(k,b,\varepsilon) = \int_0^{\bar{\xi}} v(k,b,\varepsilon,\xi)dG(\xi)$$

$$v^b(k,b,\varepsilon,\xi) = \max_{i>0}\ (1-\tau)\pi(k,b,\varepsilon) - \left[[1+\nu-\tau p_v(1+\nu)]i + \frac{\gamma}{2}\left(\frac{i}{k}\right)^2 k + \xi k^*\right] + \beta\mathbb{E}\left[v^0\left(k',b',\varepsilon'\right)|b,\varepsilon\right],$$

$$v^s(k,b,\varepsilon,\xi) = \max_{i<0}\ (1-\tau)\pi(k,b,\varepsilon) - \left[[1-\tau p_v(1+\nu)]i + \frac{\gamma}{2}\left(\frac{i}{k}\right)^2 k + \xi k^*\right] + \beta\mathbb{E}\left[v^0\left(k',b',\varepsilon'\right)|b,\varepsilon\right],$$

$$v^i(k,b,\varepsilon,\xi) = (1-\tau)\pi(k,b,\varepsilon) + \beta\mathbb{E}\left[v^0\left(k'(1-\delta),b',\varepsilon'\right)|b,\varepsilon\right].$$

The law of motion for capital $k$ is

$$k' = (1-\delta)k + i,$$

where investment is normalized by $i = k' - (1-\delta)k = I/exp(\omega)$.

# B Policy Background

This appendix section documents details of the VAT reform (Section B.1) and the CIT reform (Section B.2). Table F.1 summarizes the impact of VAT and CIT reforms on the user cost of capital (UCC).

## B.1 VAT Reform

The VAT reform had four stages. Effective on July 1, 2004, stage I started from eight industries in four provinces and cities in Northeast China (Heilongjiang, Jilin, Liaoning, and Dalian city). The eight industries include equipment manufacturing, petrochemical, metallurgical, automotive manufacturing, shipbuilding, agricultural product processing, military manufacturing, and new- and high-tech industries.

On July 1, 2007, the reform was extended to twenty-six cities in another six provinces (Henan, Hubei, Shanxi, Anhui, and Jiangxi) with eight qualified industries including equipment manufacturing, petrochemical, metallurgical, automotive manufacturing, agricultural product processing, electricity, mining and new- and high-tech industries.

One year later, on July 1, 2008, stage III extended the reform to five cities and leagues in eastern Inner Mongolia with the same eight industries as those in Northeast China. At the same time, due to the Wenchuan earthquake, the government allowed firms in the "key earthquake devastated areas of Wenchuan" to deduct input VAT on equipment. Except for several regulated industries, all other industries were covered.[62]

On January 1, 2009, the reform was unexpectedly extended to all industries across the country. Together with the national expansion of VAT reform, the deduction method of input VAT on equipment changed as well. At the early stages of the reform, the government first collected input VAT and then returned it to firms. To alleviate tax losses, at the beginning of each year the government usually set a limit on the tax return—the increase in VAT payable from the previous year. At the end of the year, if revenue permitted, the full amount of the input VAT on fixed assets would be returned. Since 2009, however, the government switched to the tax credit accounting method so that firms deduct input VAT on equipment from total output VAT directly.

## B.2 CIT Reform

In 2008, the Chinese government implemented a Corporate Income Tax (CIT) reform that harmonized the CIT rate for domestic and foreign firms. This reform reduced the CIT rate for domestic firms from 33% to 25% and it raised CIT rate for foreign firms from lower rates to 25% (e.g., see Chen et al. (2019)).

In spite of the changes to the CIT, the effect on the user cost of capital (UCC) was limited since the CIT only distorts the capital price through depreciation deductions. Table F.1 summarizes the VAT rate, CIT rate, and UCCs for domestic and foreign firms from 2007 to 2011. We report two UCC's—a theoretical one and the sample average. The theoretical UCC is calculated using the statutory VAT rate as well as the CIT rate ($= (1 + \nu_{\text{statutory}})(1 - \tau_{\text{statutory}} p_v)/(1 - \tau_{\text{statutory}})$); the sample average UCC is calculated using statutory VAT rate and the empirical CIT rate ($= (1 + \nu_{\text{statutory}})(1 - \tau_{\text{empirical}} p_v)/(1 - \tau_{\text{empirical}})$).[63] While the theoretical UCC drops by 3.8 percentage points in 2008, we do not see a decrease in the sample average. Notably, the UCC then drops by 18.1 percentage points following the VAT reform in 2009. The theoretical and sample average UCC for foreign firms barely changed. This confirms that the VAT reform is the major driving force behind the user cost of capital during this period.

[62] The regulated industries include coke processing, electrolytic aluminum production, small-scale steel production, and small thermal power generation.

[63] The empirical CIT rate is calculated as $\tau$ = actual CIT payable/net profit. We do not observe the separate VAT paid for equipment so we use statutory VAT rate for both measures.

# C Data

In this section, we provide more details of the data we use and how we construct the key variables in our empirical analysis.

### Comparison to ASM

To examine the data quality, we compare our main data set, the administrative tax records from the Chinese State Administration of Tax—Tax data henceforth—to the Annual Survey of Manufacturing (ASM), which is widely used in research on Chinese firms. Since we only have ASM data from 1998 to 2007 and the Tax data from 2007 to 2011, our comparison is based on a merged sample in year 2007. In particular, we compare the following three groups of firms: 1) unmatched Tax firms, i.e., firms existing only in the Tax data; 2) unmatched ASM firms, i.e., firms existing only in ASM; 3) matched firms, i.e., firms existing in both the Tax data and ASM. For matched firms, we further investigate whether major measures—sales and fixed assets—from the two data sets match well or not. Figure F.1 shows the inverse hyperbolic sine (IHS) measures for sales (Panel A) and fixed assets (Panel B) for the three groups.

There are two patterns worth noting. First, the Tax data cover a wider range of firms compared to the ASM. The ASM only covers those firms with annual sales over 5 million RMB, which yields a sharp cutoff in the sales distribution. The sales distribution of firms existing only in the Tax data, however, is left to that of other firms, indicating the Tax data covers many smaller firms. Second, the sales measures from the two data sets overlap well for matched firms. The measure of fixed assets show the same data patterns as the one of sales.

### Investment Measure

We construct our measure of equipment investment by subtracting the increase in buildings from total increase in fixed assets for production. We do so because the direct measure of equipment investment only exists in 2007 and is missing from 2008 to 2011 in the Tax data. To test the validity of this measure, we compare the 2007 indirect measure the 2007 direct measure and find that the indirect measure is equal to the direct measure for 84.68% of observations, which is reassuring. For coherence, we thus use the indirect measure for all the five years.

# D Additional Reduced-Form Results

In this section, we present additional reduced-form results.

## D.1 Inverse Probability Weighting (IPW)

This appendix section documents details of the inverse probability weighting (IPW) method that we use in robustness checks. One concern of our empirical strategy is that domestic and foreign firms might not have similar observable characteristics. To address this concern, we reweight our data to match the distribution of firm characteristics between domestic and foreign firms.

We first generate propensity scores for being treated by estimating a probit model. The model takes the following form:

$$G_i = \mathbb{1}\{\alpha + X_i\beta + \Delta Y_i\gamma + u_i > 0\}, \tag{D.1}$$

where $G_i$ is the treatment variable, $X_i$ is a vector of firm-specific variables including whether a firm had VAT preferential treatment (and for export), whether it is an exporter, its sales and number of workers. $\Delta Y_i$ includes investment growth measured by whether a firm invests or not, investment rate and IHS investment.[64] The error term $u_i$ is independently and identically drawn from normal distribution. We use information in the pre-reform years to conduct the analysis. That is, we use data in 2007 for all firm-specific terms and use data in 2007 and 2008 for investment growth terms. Table F.2 reports the estimates of the probit model.

We use the specification in column (6) to generate propensity scores for reweighting. Figure F.2 plots the distribution of propensity scores for domestic and foreign firms, respectively. This figure shows that the distributions of propensity scores overlap. Panel (B) of Figure F.3 shows that after reweighting, domestic and foreign firms are balanced in observable characteristics including investment, sales, fixed assets, and the number of workers.

## D.2 Event Study Estimates

Table F.3 reports coefficients used in Figure 6 from 2007 to 2011. Particularly, we run the following regression:

$$Y_{ijt} = G_i\gamma_t + \mu_i + \varepsilon_{ijt}, \tag{D.2}$$

where $G_i$ is an indicator that equals one for domestic firms, and $\mu_i$ is firm fixed effects. The dependent variable $Y_{ijt}$ is the investment measure for firm $i$ in industry $j$ at time $t$: Columns (1) to (3) report the results at the extensive margin—i.e., the fraction of firms investing; Columns (4) to (6) report the results at the intensive margin—i.e., investment rate. In columns (1) and (3) we control for industry-year fixed effects to account for industry-specific trends; in columns (2) and (5) we control for province-year fixed effects; in columns (3) and (6) we add both industry-

[64] Growth in log investment is not included because of collinearity with the indicator of firm's investing.

and province-year fixed effects.

These results confirm that domestic and foreign firms had parallel trends before 2008 since the coefficients on 2007 are economically small and statistically insignificant at both the extensive and intensive margin. At the extensive margin, column (1) shows that the reform increased the fraction of domestic firms that invest in equipment by 6.9 percentage points in 2009, which equals to 14.1% of the pre-reform average fraction of domestic firms investing. Despite of slight decrease, the effects are stable in the following years. The estimates are robust when we add province-year fixed effects. Similar results hold for the investment rate.

Table F.4 conducts the same robustness checks performed in our difference-in-differences analysis and shows that the event study coefficients are robust across specifications. Particularly, in columns (2) and (5) we adjust the regressions with inverse probability weighting (IPW); in columns (3) and (6) we use unbalanced samples at the variable level. Despite slight variation in magnitudes, our baseline estimates are robust.

## D.3 User-Cost-of-Capital Investment Elasticities

As a complement to the difference-in-differences analysis, in this appendix we quantify how changes in the user-cost-of-capital (UCC) driven by the reform affected investment outcomes. In particular, we estimate the following regression

$$Y_{ijt} = \beta \log(\text{UCC}_{ijt}) + \mu_i + \delta_{jt} + X'_{it}\gamma + \varepsilon_{ijt}, \tag{D.3}$$

where UCC is the user cost of capital from Equation 5. As in Equation 7, we control for firm fixed effects, industry-by-year fixed effects, and we show robustness of our results to controlling for industry-by-year fixed effects and firm-level characteristics.

Two challenges prevent OLS from delivering unbiased estimates of $\beta$ in Equation D.3. First, both investment and the CIT rate, and thus the UCC, might be correlated with unobserved firm characteristics. For instance, if politically connected firms have lower productivity and enjoy a lower corporate tax rate, an OLS estimation of $\beta$ would bias $\beta$ toward zero. Second, measurement error in investment and the UCC would also bias the estimate toward zero.

To solve these problems, we use a synthetic UCC as an instrument for the actual UCC. In the synthetic UCC, we allow for $\nu$ to change with the reform but we hold all other aspects of the UCC constant. Table F.5 shows that this instrument is a powerful predictor of the actual UCC since, as we discuss in Section 2, the VAT reform had a large effect on the cost of capital. The exclusion restriction that the synthetic tax change identifies changes in the UCC and is not correlated with differential shocks between foreign and domestic firms is consistent with the difference-in-differences results in the previous section.

Table F.7 reports estimates of semi-elasticities of investment with respect to the UCC. The coefficients on UCC are all negative, indicating investment increases as the UCC declines. While OLS estimates are biased toward zero, we find that IV estimates are much larger in magnitude. Columns (2)–(8) in the first panel show that cutting the UCC by 10% leads to an increase in the fraction of firms investing by 2.4-3.1 percentage points. Similarly, cutting the UCC by 10% would increase the investment rate by about 2%. Relative to the average investment rate of 10%, the second row of results implies an investment elasticity of -2 with respect to the user cost of capital. Indeed, the third column shows UCC elasticities between -2.4 and -2.1 for the sample of firms with positive investment. Finally, the last row of Table F.7 shows larger estimates for the IHS, which arise from the larger weight the IHS places on extensive-margin responses.

Table F.7 shows that regardless of how we measure outcomes, the estimates of $\beta$ are very stable across specifications that control for different levels of fixed effects or for firm-level controls. In particular, the last column controls for corporate income tax rates, which ensures that our identifying variation only comes from changes driven by the VAT reform.

# E Additional Structural Estimation Results

This appendix provides additional details on the structural estimation.

## E.1 Productivity Estimation via System GMM

We now document details related to estimating the curvature parameter of profit function ($\theta$) and the persistence of idiosyncratic shocks ($\rho_\varepsilon$) using the system GMM estimator of Blundell and Bond (2000).

Following Appendix A.2, we start by taking logarithms of Equation A.8:

$$r_{it} = (1-\theta)a_{it}^R + \theta k_{it}. \tag{E.1}$$

Since we observe sales $r_{it}$ and capital $k_{it}$, we can thus back out log revenue shocks $a_{it}^R$ by $a_{it}^R = \frac{1}{1-\theta}(r_{it} - \theta k_{it})$, which differ from $a_{it}^\Pi$ by a constant. Without loss of generality, we write $a_{it}^R = b_t + \omega_i + \varepsilon_{it}$, where $b_t$, $\omega_i$, $\varepsilon_{it}$ are aggregate shock, firm permanent component and firm transitory shock, respectively. Let $m_{it}$ denote classical measure error or any other unexpected optimization errors. Then, combined with Equation (E.1), we have

$$r_{it} = \theta k_{it} + (1-\theta)b_t + (1-\theta)\omega_i + (1-\theta)\varepsilon_{it} + m_{it}.$$

Recall that the firm transitory shock $\varepsilon_{it}$ follows an AR(1) process i.e., $\varepsilon_{it} = \rho_\varepsilon \varepsilon_{i,t-1} + e_{it}$, where $e_{it}$ is an innovation term independently and identically distributed across firms and over time. We exploit the AR(1) property of $\varepsilon_{it}$ to difference out the persistent component in $\varepsilon_{it}$. We can then get the following revenue equation:

$$r_{it} = \rho_\varepsilon r_{i,t-1} + \theta k_{it} - \rho_\varepsilon \theta k_{i,t-1} + b_t^* + \omega_i^* + m_{i,t} - \rho_\varepsilon m_{i,t-1} + (1-\theta)e_{it}, \tag{E.2}$$

where $b_t^* = (1-\theta)b_t - \rho_\varepsilon(1-\theta)b_{t-1}$ is year fixed effect and $\omega_i^* = (1-\theta)(1-\rho_\varepsilon)\omega_i$ is the firm fixed effect. We complement Equation (E.2) with its first-differenced (FD) equation:

$$\Delta r_{it} = \rho_\varepsilon \Delta r_{i,t-1} + \theta \Delta k_{it} - \rho_\varepsilon \theta \Delta k_{i,t-1} + \Delta b_t^* + \Delta m_{i,t} - \rho_\varepsilon \Delta m_{i,t-1} + (1-\theta)\Delta e_{it}. \tag{E.3}$$

We construct a GMM estimator using two sets of moments based on both the level Equation (E.2) and FD Equation (E.3). The first set of moments is

$$\mathbb{E}[z_{i,t-s}^D(\Delta m_{i,t} - \rho_\varepsilon \Delta m_{i,t-1} + (1-\theta)\Delta e_{it})] = 0,$$

where $z_{i,t-s}^D = [r_{i,t-s}, k_{i,t-s}]$, $s \geq 3$. Intuitively, we use lagged revenue and capital in levels ($r$ and $k$) to instrument for the FD equation. The second set of moments is

$$\mathbb{E}[z_{i,t-s}^L((1-\theta)(1-\rho_\varepsilon)\omega_i + m_{i,t} - \rho_\varepsilon m_{i,t-1} + (1-\theta)e_{it})] = 0,$$

where $z_{i,t-s}^L = [\Delta r_{i,t-s}, \Delta k_{i,t-s}]$, $s \geq 2$. Here, we use the first difference of lagged revenue and capital ($\Delta r$ and $\Delta k$), to instrument for the level equation.[65] In our data, we have the moment condition

$$\mathbb{E}[Z_i' U_i] = 0, \quad \forall i,$$

where

$$Z_i = \begin{bmatrix} Z_i^D & \mathbf{0} \\ \mathbf{0} & Z_i^L \end{bmatrix} = \begin{bmatrix} r_{i,07} \ k_{i,07} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & r_{i,07} \ k_{i,07} \ r_{i,08} \ k_{i,08} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \Delta r_{i,08} \ \Delta k_{i,08} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \Delta r_{i,08} \ \Delta k_{i,08} \ \Delta r_{i,09} \ \Delta k_{i,09} \end{bmatrix}$$

$$U_i = \begin{bmatrix} U_i^D \\ U_i^L \end{bmatrix} = \begin{bmatrix} \Delta m_{i,10} - \rho_\varepsilon \Delta m_{i,09} + (1-\theta)\Delta e_{i,10} \\ \Delta m_{i,11} - \rho_\varepsilon \Delta m_{i,10} + (1-\theta)\Delta e_{i,11} \\ (1-\theta)(1-\rho_\varepsilon)\omega_i + m_{i,10} - \rho_\varepsilon m_{i,09} + (1-\theta)e_{i,10} \\ (1-\theta)(1-\rho_\varepsilon)\omega_i + m_{i,11} - \rho_\varepsilon m_{i,10} + (1-\theta)e_{i,11} \end{bmatrix}$$

[65] The identification of the *first-differenced* equation relies on the sequential exogeneity, as well as classical measurement error assumption; the identification of the *level* equation is that the changes in revenue and capital are uncorrelated to firm-specific permanent component and the measurement error.

We then estimate $\theta$ and $\rho_\varepsilon$ using the GMM estimator.

## E.2 Markup

An alternative way to obtain the revenue equation in Appendix A.2 is to assume that the firm has a CRTS production function and faces a CES demand function with elasticity $1/\zeta$. This simple monopolistic competitive model yields a constant markup, which maps to our estimate of $\theta$. In this case, we can write the curvature of profit function ($\theta$) as a function of other primitive parameters

$$\theta = \frac{\alpha(1-\sigma)(1-\zeta)}{1-(1-\zeta)[(1-\alpha)(1-\sigma)+\sigma]}, \tag{E.4}$$

where $\alpha$ is the share of capital out of value added and $\sigma$ is the share of materials. The gross markup equals to $1/(1-\zeta)$. To be consistent with the empirical markup calculated from data, we consider the markup excluding capital cost, which equals $1/\{(1-\zeta)[(1-\alpha)(1-\sigma)+\sigma]\}$. Using Equation (E.4) we obtain:

$$\text{markup}_{theoretical} = \frac{1}{\theta}\frac{\alpha(1-\sigma)}{(1-\alpha)(1-\sigma)+\sigma} + 1.$$

Given an estimate of $\theta$ and values of $\alpha$ and $\sigma$ we can calculate the markup. Setting $\alpha = 1/2$ (Bai et al., 2006) and $\sigma = 0.7$ (Jones, 2011), the theoretical markup is 1.224.

In data, we calculate the markup by

$$\text{markup}_{empirical} = \frac{\text{total sales}}{\text{major business costs}}.$$

The average empirical markup is around 1.223. It is reassuring that the theoretical markup calculated from our estimate of $\theta$ is comparable to the empirical markup from data.

## E.3 Productivity Decomposition

In this appendix we document details of the productivity decomposition we use to obtain the standard deviation of firm idiosyncratic and permanent shocks ($\sigma_\varepsilon, \sigma_\omega$), and the persistence and standard deviation of aggregate shocks ($\rho_b$, $\sigma_b$).

We first construct revenue shocks using the estimate $\hat{\theta}$

$$\hat{a}^R_{it} = r_{it} - \hat{\theta} k_{it}.$$

Here we use "purified" revenue—projecting revenue on higher-order polynomials of capital and labor—to get rid of disturbances such as measurement errors. With $\hat{a}_{it}$ in hand, we exploit the AR(1) property of $\varepsilon_{it}$ to write:

$$\hat{a}_{it} - \hat{\rho}_\varepsilon a_{it-1} = b_t - \hat{\rho}_\varepsilon b_{t-1} + (1 - \hat{\rho}_\varepsilon)\omega_i + e_{it}, \tag{E.5}$$

where $e_{it}$ is an innovation term of $\varepsilon_{it}$ independently and identically distributed across firms and over time. We run a regression of $\hat{a}_{it} - \hat{\rho}_\varepsilon \hat{a}_{it-1}$ on time dummies and obtain the residual: $u_{it} = (1 - \hat{\rho}_\varepsilon)\omega_i + e_{it}$.

We then calculate the variance of $\omega_i$ and $\varepsilon_{it}$ from $var(u_{it})$ and $cov(u_{it}, u_{it-1})$ solving the following equations:

$$\sigma_\omega^2 = \frac{cov(u_{it}, u_{it-1})}{(1 - \hat{\rho}_\varepsilon)^2} \quad \text{and} \quad \sigma_\varepsilon^2 = \frac{var(u_{it}) - cov(u_{it}, u_{it-1})}{(1 - \hat{\rho}_\varepsilon{}^2)}.$$

Lastly, we recover $(\rho_b, \sigma_b)$ using the coefficients on time dummies from the regression above. Denote the coefficients by $\beta_t$. Then $\rho_b$ and $\sigma_b$ jointly solve the following equations:

$$\begin{aligned} var(\beta_t) &= (-2\hat{\rho}_\varepsilon \rho_b + 1 + \hat{\rho}_\varepsilon{}^2)\sigma_b^2 \\ cov(\beta_t) &= [-\hat{\rho}_\varepsilon \rho_b^2 + (1 + \hat{\rho}_\varepsilon{}^2)\rho_b - \hat{\rho}_\varepsilon]\sigma_b^2. \end{aligned}$$

We bootstrap this procedure 100 times to obtain standard errors for these parameters.

## E.4 Adjustment Cost Estimation

In this appendix we report additional results for estimation using method of simulated moments (MSM). The criterion function is:

$$g(\phi) = [\hat{m} - m(\phi)]' W [\hat{m} - m(\phi)].$$

We use grid-search to find the parameter values that minimize the criterion function $g(\phi)$. Using the grid-search results as initial values, we further refine our estimates by pattern-search. To confirm our estimates minimizes the criterion function, we plot the loss function against each parameter in Figure F.4, holding the other two parameters at their estimated values. For example, Panel (A) plots log loss function $\log(g)$ against convex adjustment cost $\gamma$, with $\bar{\xi}$ held at its estimate $\hat{\bar{\xi}} = 0.119$ and $\delta$ held at $\hat{\delta} = 0.071$. The loss function is convex and rises steeply around our estimated value, confirming that our estimates minimize the criterion function.

## E.5 Sensitivity Analysis

Lastly, we construct the sensitivity measures proposed by Andrews et al. (2017):

$$\Lambda = -(G'WG)^{-1}G'W \times g(m),$$

where $G$ is the Jacobian matrix, $W$ is the weighting matrix (identity matrix here), and $g(m)$ is a vector of moments with misspecification. Here, we consider the misspecification to be a 10% deviation from the moment value. Table F.8 reports the complete sensitivity matrix.

For the parameter $\xi$, changes in the share of investment rate below 10% and 30% have the largest effect. An increase in the share below 10%—which implies greater inaction—results in larger fixed costs. For the parameter $\delta$, we find that moments that skew the distribution toward zero also lower the value of this parameter. For the parameter $\gamma$, an increase in serial correlation results in a lower estimate of convex costs. These results are consistent with our discussion of identification in Section 5.2.

# F Additional Simulation Results

This appendix discusses additional simulation results. First, we show that our baseline simulation results are robust to the following extensions: 1) allowing for an upward-sloping capital supply; 2) allowing the net-of-tax resale price to be less than one; 3) aggregate productivity shocks; and 4) allowing changes in the CIT to impact the weighted average cost of capital (WACC) which is affected by CIT cut. Lastly, we show VAT and CIT cuts with the same UCC reduction may have different effectiveness in stimulating investment.

## F.1 Robustness of Policy Simulations

We first show that our baseline simulation results are robust to the following extensions.

#### Upward-sloping Capital Supply

In our baseline model we assume that capital price—net of taxes—is constant. One concern is that the capital price is endogenous and increases as the demand goes up (e.g., Goolsbee, 1998). We relax the assumption of constant capital price by incorporating an upward-sloping capital supply. We assume a functional form of capital supply, which allows us to solve for the price change from the quantity change, i.e., investment response. The capital supply has constant elasticity:

$$p^K = I^{1/\varepsilon^s},$$

where $\varepsilon^s$ is the elasticity of capital supply with respect to pre-tax capital price. Following estimates from House and Shapiro (2008), we set $\varepsilon^s$ to be 10.[66] Using our difference-in-difference estimate for investment rate—36% increase—it follows that the capital price increases by 3.6%.

As a robustness check to our main simulation, we feed in a 3.6% increase in capital price to the model—both the purchase and resale price of capital—in response to the reform. In particular, the VAT reform reduces the purchase price of capital from $(1-\tau p_v)(1+17\%)$ to $(1+3.6\%)\times(1-\tau p_v)$, and increases the resale price of capital from $1-\tau p_v(1+17\%)$ to $(1+3.6\%)\times(1-\tau p_v)$. Column (2) of Table F.10 reports the simulation results. Even after accounting for this price response, the reform results in a substantial increase in investment. While the drop-in capital price is smaller, the decrease in partial irreversibility continues to stimulate investment.

### Resale Price

Our baseline model assumes that the net-of-tax resale price is the same as the net-of-tax purchase price of capital. One concern is that the capital market for used capital is imperfect and that the resale price is smaller than the purchase price even without taxes. To explore this possibility, we reduce the resale price from one (as in the baseline model) to 0.95 (Cooper and Haltiwanger, 2006). As we show in column (3) of table F.10, the results do not change. Both the pre-reform static moments and simulated investment responses—i.e., the average investment rate and the fraction of firms investing—to various tax reforms are almost identical to our baseline results. This is because, even without the imperfect resale price of capital, the VAT and fixed cost generate considerable inaction. Hence, lowering the resale price has little impact on overall investment patterns.

### Aggregate Productivity Shocks

Since the VAT reform took place in 2009 as one of the measures to deal with the financial crisis, the response to the reform may reflect a concomitant drop in aggregate productivity. To explore this possibility, we feed in a one standard-deviation drop in (permanent) aggregate productivity at the same time of the tax reform. Column (4) of Table F.10 reports the results of this simulation. Our results are robust to allowing for a concomitant productivity drop.

[66] House and Shapiro (2008) estimate the elasticity of supply to be between 6 and 14 using Bonus Depreciation in the US.

### Weighted Average Cost of Capital

Our model assumes that changes in CIT do not affect the cost of capital. Note that this assumption has no effect on our estimation. However, the effects of changes in CIT may be different if the CIT affects the costs of capital.

Here, we extend the constant interest rate $r$ by allowing the CIT to impact the weighted average cost of capital (WACC). WACC considers two ways through which a firm raises capital—equity and debt. Because the cost of interest payments for debt financing, but not for equity financing, are deductible from the tax base of corporate income tax (CIT), changing the CIT rate affects the cost of debt financing, and thus how firms discount future profit. The WACC is defined as follows:

$$\text{WACC} = \text{Share}_{\text{debt}}(1-\tau)r + (1-\text{Share}_{\text{debt}})r_k,$$

where $\text{Share}_{\text{debt}}$ is the share of capital financed through debt and, accordingly, $(1-\text{Share}_{\text{debt}})$ is the share of capital financed through equity. $r$ is the real interest rate and $r_k$ is the capital return. In the simulation, we calibrate the share of debt financing to be 0.65 to match the average debt to capital ratio. To focus on how the policy—CIT rate here—we keep $r$ and $r_k$ constant and match baseline discount rate at 95%.

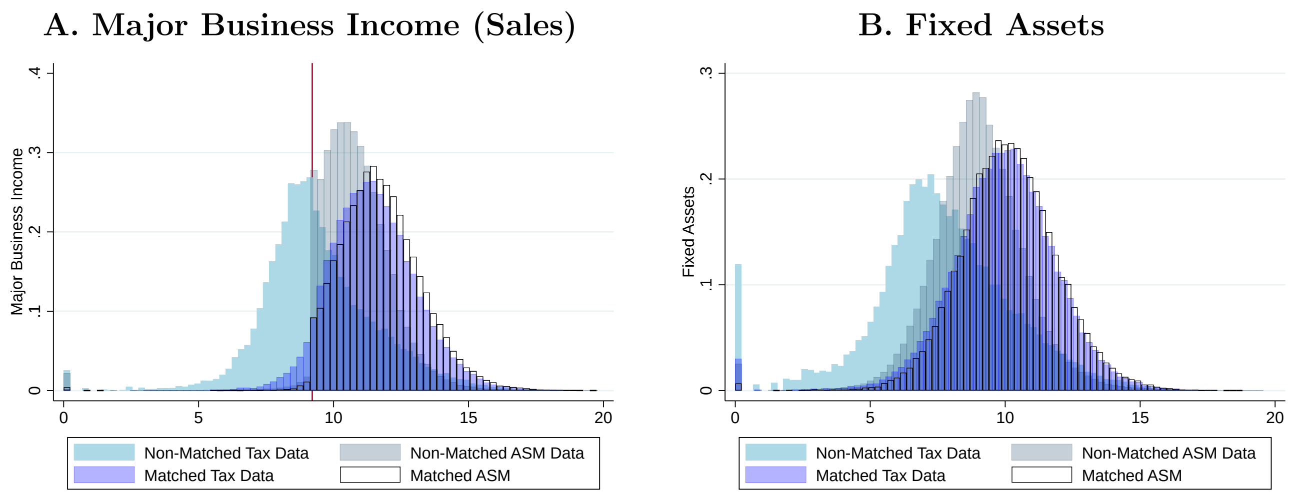
Table F.11 reports the simulation results allowing for interactions between the CIT and the WACC. In particular, the discount rate $\beta = \frac{1}{1+\text{WACC}}$. The CIT rate affects the cost of capital through two channels. First, as in our baseline simulation with constant WACC, it reduces the after-tax price of capital $\frac{(1+\nu)(1-\tau p_v)}{1-\tau}$. Additionally, it increases the expected return on capital, $\frac{1}{\beta} - (1-\delta)$, by reducing the discount rate $\beta$. Column (3) reports the results when the CIT cut changes the WACC and thus the discount rate. Due to the second channel—increasing expected return of capital—which offsets the decreasing capital price, the response of investment rate is smaller. The tax revenue loss is larger since the investment increase is smaller with the same reduced tax rate. Similarly, the increase in firm value is smaller as well. As a result, the ratios of investment and firm value to tax revenue are also smaller.

## F.2 UCC Elasticities are Not Sufficient Statistics

To show that the UCC is not a sufficient statistic, Table F.12 displays the investment responses at the intensive margin (i.e., average investment rate) and the extensive margin (i.e., the fraction of firms investing) to different reforms with the same UCC reduction. We use the estimated frictions, i.e., $\gamma = 1.43$, $\bar{\xi} = 0.12$, to simulate tax cuts. Table F.12 shows the results with initial VAT rate at 17% and CIT rate at 15.4%. We compare two reforms with the same reduction in UCC: 1) VAT reform cuts VAT from 17% to 14.2% (i.e., 2.8% rate reduction), and 2) CIT reform cuts CIT rate from 15.4% to 5.4% (i.e., 10% rate reduction). Both reforms reduce UCC by 2.4%. Column (3) also allows the CIT cut to affect the WACC, as in the last section. Because these different reforms have the same effect on the UCC, the fact that the effects on investment differ implies that UCC elasticities are not sufficient statistics for the effects of different policies on investment.

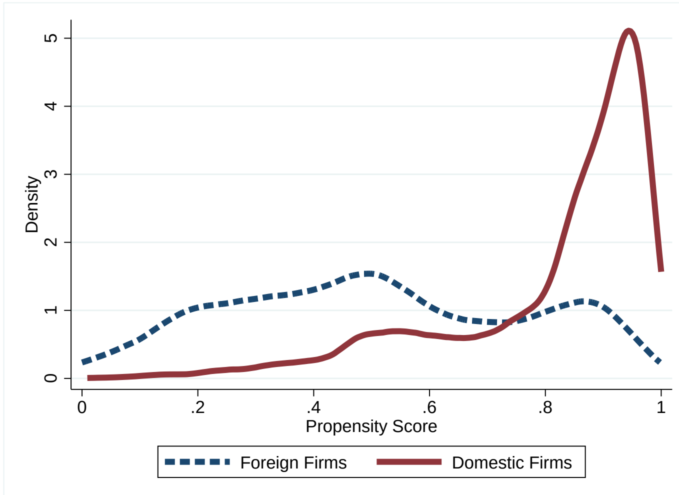
Note that, while a 10% CIT cut has a stronger effect on investment than a 2.8% VAT cut, the CIT cut is far less effective than the VAT cut since the former also leads to large decreases in tax revenue. Furthermore, once we consider the effect on the WACC, the CIT cut is even less effective at stimulating investment.

**Figure F.1: Comparison of Matched and Unmatched Firms in Tax Data and ASM**



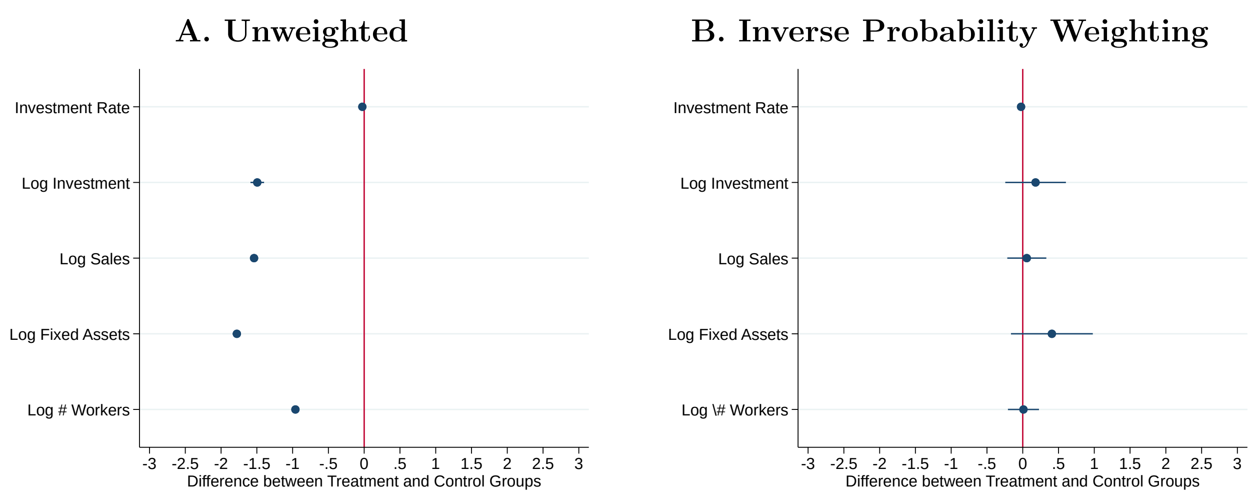

*Notes:* This figure compares variables from the Tax Data and the Annual Survey of Manufactures (ASM) for 2007. We compare three groups of firms: 1) unmatched Tax firms, i.e., firms existing only in the Tax data, 2) unmatched ASM firms, i.e., firms existing only in ASM, and 3) matched firms. Panel A shows the distribution of sales (in the inverse hyperbolic sine (IHS) transformation). The light blue area indicates the sales distribution of unmatched Tax firms. The grey area indicates the sales distribution of unmatched ASM firms. The dark blue color indicates the sales distribution of matched firms using the measure from Tax data; the transparent area with black borders indicates the distribution of matched firms using the measure from ASM. Similarly, Panel B shows the distribution of IHS measures of fixed assets.

**Figure F.2: Distribution of Propensity Score**




*Notes:* This figure plots the distributions of estimated propensity scores for domestic firms (solid line) and foreign firms (dash line), respectively. The propensity score is estimated using a probit model (see Equation (D.1)). The estimation results are reported in column (6) in Table F.2. The dependent variable is an indicator = 1 if a firm is in the treatment group, i.e., domestic firms. The regressors include: whether a firm had VAT preferential treatment, whether a firm had export VAT preferential treatment, whether it is an exporter, sales, logarithm of the number of workers, growth in the fraction of firms investing, growth in the investment rate, growth in the log investment, and growth in the IHS measure of investment. The regression is performed using pre-reform data form 2007 and 2008. All regressions include region and industry fixed effects, and firm fixed effects.

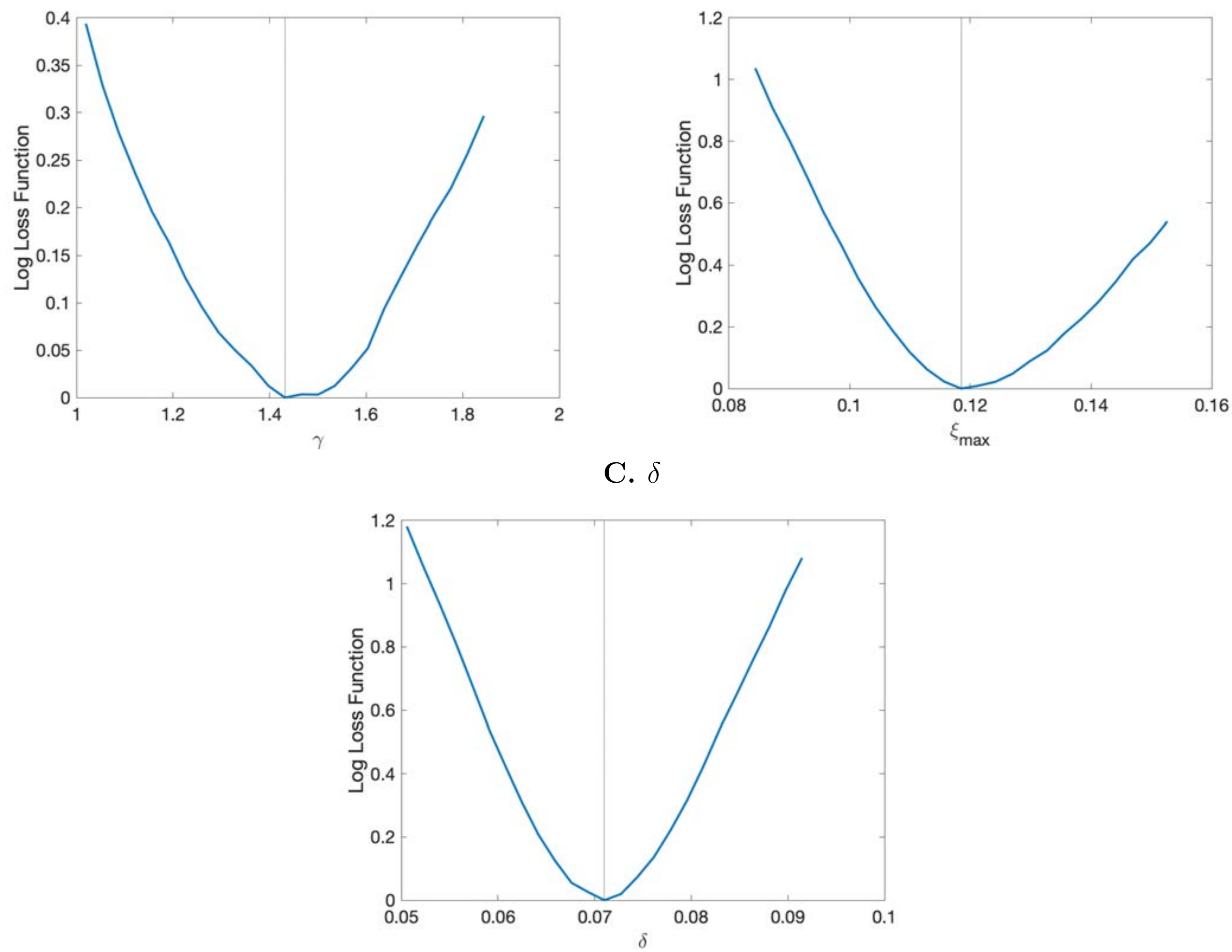
**Figure F.3: Mean Difference between Treatment and Control Groups**




*Notes:* This graph shows the difference in major variables between the treatment group (i.e., domestic firms) and control group (i.e., foreign firms). The left panel shows the differences before weighting; The right panel shows the differences using inverse probability weighting (IPW). The propensity score is estimated using probit model (see Equation (D.1)). The estimation results are reported in column (6) in Table F.2.

**Figure F.4: Loss Function from Structural Estimation**

**A.** $\gamma$ **B.** $\bar{\xi}$

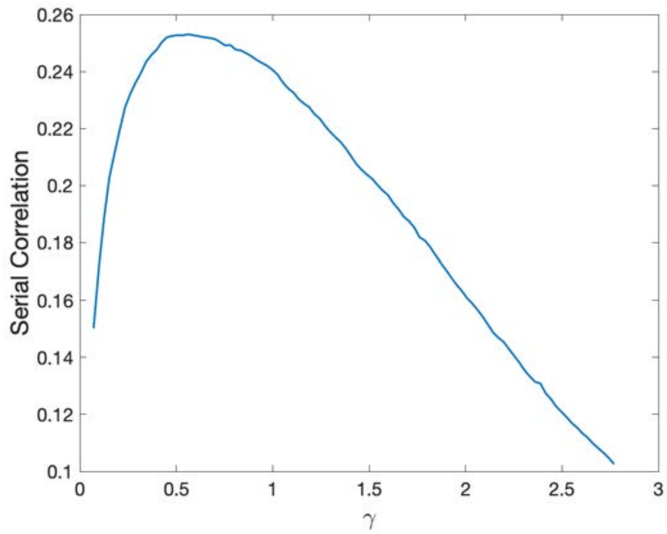



*Notes:* This graph displays the loss function against each parameter, holding the other two parameters at optimal values. The loss function is calculated by:

$$g(\phi) = [\hat{m} - m(\phi)]'\hat{W}[\hat{m} - m(\phi)],$$

where the moments $m(\phi)$ include six pre-reform static moments, as well as two investment responses from reduced-form analysis (see Section 5.2). We use the identity matrix as the weighting matrix. Panel A plots log loss function against values of $\gamma$, holding $\bar{\xi}$ and $\delta$ at their optimal values. The vertical line indicates the estimated $\gamma = 1.432$. Panel B and C plot the log loss function against $\bar{\xi}$ and $\delta$, respectively.

**Figure F.5: Correlation between Serial Correlation and Convex Adjustment Cost $\gamma$**




*Notes:* This graph plots simulated serial correlation against convex cost $\gamma$, holding the other two parameters at their estimated values, i.e., fixed cost $\bar{\xi} = 0.119$ and depreciation rate $\delta = 0.710$.

**Table F.1: Changes in Tax Rate, Theoretical and Effective User Cost of Capital**

| Year | CIT(%) | VAT (%) | User Cost of Capital | | |
|---|---|---|---|---|---|
| | | | Theoretical | Sample Avg. | #Obs |
| | (1) | (2) | (3) | (4) | (5) |
| *A. Domestic Firms* | | | | | |
| 2007 | 33 | 17 | 1.284 | 1.222 | 30,789 |
| 2008 | 25 | 17 | 1.247 | 1.233 | 44,893 |
| 2009 | 25 | 0 | 1.066 | 1.042 | 53,580 |
| 2010 | 25 | 0 | 1.066 | 1.037 | 56,579 |
| 2011 | 25 | 0 | 1.066 | 1.040 | 56,955 |
| *B. Foreign Firms* | | | | | |
| 2007 | 20 | 0 | 1.049 | 1.023 | 15,984 |
| 2008 | 25 | 0 | 1.066 | 1.038 | 16,842 |
| 2009 | 25 | 0 | 1.066 | 1.035 | 20,394 |
| 2010 | 25 | 0 | 1.066 | 1.038 | 20,596 |
| 2011 | 25 | 0 | 1.066 | 1.044 | 20,555 |

*Notes*: This table displays summary statistics of user cost of capital (UCC) of domestic and foreign firms, respectively. UCC is calculated by UCC $= (1+\nu)(1-\tau p_v)/(1-\tau)$, where $\nu$ is VAT rate, $\tau$ is CIT rate, $p_v = 0.803$ is discounted present value of capital depreciation schedule. Column (1) and (2) report the statutory rates of CIT and VAT for domestic and foreign firms, respectively. Theoretical UCC is calculated using statutory VAT and CIT rates. Sample average refers to the average UCC in data, which is calculated using statutory VAT rate but empirical CIT rate. The sample average statistics are calculated using full balanced panel, i.e., firms existing for five years in the sample. Empirical CIT rate is calculated by $\tau =$ actual CIT payable/net profit, which is closer to the "effective" CIT rate.

**Table F.2: Estimates of Probit Model of Propensity Score**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Had VAT PT | 0.112*** | 0.106** | 0.116*** | 0.131* | 0.119*** | 0.107** |
| | (0.020) | (0.044) | (0.038) | (0.067) | (0.037) | (0.046) |
| Had Export VAT PT | -0.797*** | -0.896*** | -0.902*** | -0.770*** | -0.925*** | -0.866*** |
| | (0.042) | (0.094) | (0.085) | (0.130) | (0.083) | (0.097) |
| Exporter | -1.004*** | -0.287** | -0.309*** | -0.373** | -0.280*** | -0.328*** |
| | (0.250) | (0.112) | (0.100) | (0.157) | (0.098) | (0.115) |
| Sales | -0.001*** | -0.001*** | -0.001*** | -0.001*** | -0.001*** | -0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Log Workers | -0.375*** | -0.545*** | -0.653*** | -0.356*** | -0.547*** | -0.651*** |
| | (0.024) | (0.045) | (0.050) | (0.101) | (0.045) | (0.050) |
| % Firms Investing Growth | | -0.267 | | | | 2.953 |
| | | (0.346) | | | | (1.872) |
| Investment Rate Growth | | | -0.272 | | | -1.049** |
| | | | (0.358) | | | (0.496) |
| Log Investment Growth | | | | -0.020 | | |
| | | | | (0.099) | | |
| IHS Investment Growth | | | | | 0.022 | 0.102* |
| | | | | | (0.019) | (0.058) |
| #Obs | 77,939 | 21,433 | 20,172 | 5,836 | 21,422 | 20,170 |
| Industry FE | Y | Y | Y | Y | Y | Y |
| Region FE | Y | Y | Y | Y | Y | Y |

*Notes:* This table displays probit regression results for the propensity score estimation in Equation (D.1). The dependent variable is an indicator = 1 if a firm is in the treatment group. The variables on the right hand side include: whether a firm had VAT preferential treatment, whether a firm had export VAT preferential treatment, whether it is an exporter, sales, logarithm of the number of workers, growth in the fraction of firms investing, growth in the investment rate, growth in the log investment, and growth in the IHS measure of investment. The regression is performed using pre-reform data form 2007 and 2008. All regressions include region and industry fixed effects, and firm fixed effects. Standard errors are clustered at the firm level.

**Table F.3: Estimates of Event Study**

| | Extensive Margin | | | Investment Rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 2007 | 0.006 | 0.004 | 0.011 | -0.000 | -0.007 | -0.005 |
| | (0.013) | (0.014) | (0.014) | (0.006) | (0.006) | (0.006) |
| 2008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) |
| 2009 | 0.069*** | 0.045*** | 0.055*** | 0.044*** | 0.043*** | 0.043*** |
| | (0.013) | (0.013) | (0.013) | (0.005) | (0.005) | (0.005) |
| 2010 | 0.051*** | 0.047*** | 0.050*** | 0.034*** | 0.032*** | 0.035*** |
| | (0.014) | (0.015) | (0.015) | (0.005) | (0.005) | (0.006) |
| 2011 | 0.064*** | 0.044*** | 0.049*** | 0.029*** | 0.027*** | 0.028*** |
| | (0.014) | (0.015) | (0.015) | (0.006) | (0.006) | (0.006) |
| $N$ | 86870 | 86870 | 86870 | 81270 | 81270 | 81270 |
| $N_{\text{firms}}$ | 17374 | 17374 | 17374 | 16254 | 16254 | 16254 |
| $R^2$ | 0.009 | 0.015 | 0.019 | 0.008 | 0.007 | 0.011 |
| Industry × Year FE | Y | | Y | Y | | Y |
| Province × Year FE | | Y | Y | | Y | Y |

*Notes:* This table estimates event study regressions of the form:

$$Y_{it} = G_i \times \gamma_t + \mu_i + \varepsilon_{ijt},$$

where $G_i$ is an indicator that equals one for domestic firms, and $\mu_i$ is firm fixed effects. Dependent variable $Y_{ijt}$ is the investment measure for firm $i$ in industry $j$ at time $t$: Column (1) to (3) report the estimated $\gamma_t$ ($t = 2007, \cdots, 2011$) at the extensive margin—i.e., the fraction of firms investing; Column (4) to (6) report the results at the intensive margin—i.e., investment rate. In column (1) and (3) we control for industry-year fixed effects; in column (2) and (5) we control for province-year fixed effects; in column (3) and (6) we add both industry- and province-year fixed effects. Standard errors are clustered at the firm level.

Table F.4: Event Study: Robustness Checks

| | Extensive Margin | | | Investment Rate | | |
|---|---|---|---|---|---|---|
| | Baseline | IPW | Unbalanced | Baseline | IPW | Unbalanced |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 2007 | 0.006 | 0.044 | -0.001 | -0.000 | 0.012 | -0.003 |
| | (0.013) | (0.028) | (0.011) | (0.006) | (0.011) | (0.005) |
| 2008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) |
| 2009 | 0.069*** | 0.108*** | 0.058*** | 0.044*** | 0.045*** | 0.046*** |
| | (0.013) | (0.026) | (0.010) | (0.005) | (0.009) | (0.004) |
| 2010 | 0.051*** | 0.092*** | 0.058*** | 0.034*** | 0.032*** | 0.039*** |
| | (0.014) | (0.032) | (0.010) | (0.005) | (0.011) | (0.004) |
| 2011 | 0.064*** | 0.091** | 0.059*** | 0.029*** | 0.030** | 0.032*** |
| | (0.014) | (0.045) | (0.010) | (0.006) | (0.013) | (0.004) |
| $N$ | 86870 | 82785 | 221069 | 81270 | 79195 | 215813 |
| $N_{\text{firms}}$ | 17374 | 16557 | 60870 | 16254 | 15839 | 60513 |
| $R^2$ | 0.009 | 0.053 | 0.006 | 0.008 | 0.034 | 0.005 |
| Industry × Year FE | Y | Y | Y | Y | Y | Y |

*Notes:* This table conducts robustness checks for the event study regressions of the form:

$$Y_{it} = G_i \times \gamma_t + \mu_i + \varepsilon_{ijt},$$

where $G_i$ is an indicator that equals one for domestic firms, and $\mu_i$ is firm fixed effects. Dependent variable $Y_{ijt}$ is the investment measure for firm $i$ in industry $j$ at time $t$: Column (1) to (3) report the estimated $\gamma_t$ ($t = 2007, \cdots, 2011$) at the extensive margin—i.e., the fraction of firms investing; Column (4) to (6) report the results at the intensive margin—i.e., investment rate. We report the baseline results (column (1) and (4)) In column (2) and (5) we adjust the regressions by inverse probability weighting (IPW, see Section D.1). In column (3) and (6) we use the unbalanced sample for the analysis (i.e., unbalanced at the variable level but balanced at the firm level). All regressions include industry-year fixed effects and firm fixed effects. Standard errors are clustered at the firm level.

**Table F.5: Estimates of Difference-in-Difference Regressions: UCC**

| | UCC | | | Log UCC | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Domestic × Post | -0.193*** | -0.194*** | -0.194*** | -0.171*** | -0.171*** | -0.171*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $N$ | 77677 | 77677 | 77677 | 77677 | 77677 | 77677 |
| $N_{\text{firm}}$ | 17371 | 17371 | 17371 | 17371 | 17371 | 17371 |
| $R^2$ | 0.735 | 0.736 | 0.737 | 0.762 | 0.762 | 0.763 |
| Industry × Year FE | Y | | Y | Y | | Y |
| Province × Year FE | | Y | Y | | Y | Y |

*Notes:* This table estimates difference-in-difference regressions of the form:

$$Y_{it} = \gamma G_i \times Post_t + \mu_i + \delta_{jt} + \varepsilon_{ijt},$$

where $Y_{it}$ is the user cost of capital (UCC), $G_i$ is the treatment indicator, and $Post_t$ is the post-reform indicator. Particularly, the dependent variable for column (1) to (3) is $UCC = (1+\nu)(1-\tau p_v)/(1-\tau)$ where $\nu$ is the statutory VAT rate, $\tau$ is the empirical CIT rate, and $p_v$ is the discounted present value of capital depreciation schedule. The dependent variable for column (4) to (6) is the logarithm of UCC. Column (1) and (4) control for industry-year fixed effects. Column (2) and (5) control for province-year fixed effects. Column (3) and (6) include both fixed effects. All regressions include firm fixed effects. Standard errors are clustered at the firm level.

**Table F.6: Robustness Check: Investment Including Leasing**

| | Extensive Margin | | | Investment Rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Domestic × Post | 0.059*** | 0.044*** | 0.046*** | 0.035*** | 0.037*** | 0.038*** |
| | (0.010) | (0.010) | (0.010) | (0.004) | (0.004) | (0.004) |
| $N$ | 86870 | 86870 | 86870 | 81270 | 81270 | 81270 |
| $N_{\text{firm}}$ | 17374 | 17374 | 17374 | 16254 | 16254 | 16254 |
| $R^2$ | 0.010 | 0.016 | 0.020 | 0.008 | 0.007 | 0.011 |
| Industry × Year FE | Y | | Y | Y | | Y |
| Province × Year FE | | Y | Y | | Y | Y |

*Notes:* This table estimates difference-in-difference regressions of the form:

$$Y_{it} = \gamma G_i \times Post_t + \mu_i + \delta_{jt} + \varepsilon_{ijt},$$

where $Y_{it}$ is a measure of investment including leasing, $G_i$ is the treatment indicator, and $Post_t$ is the post-reform indicator. We construct an alternative investment measure to include leased equipment. The dependent variable for column (1) to (3) is a dummy variable set to 1 if the leasing-included investment rate is positive. The dependent variable for column (4) to (6) is leasing-included investment rate. Column (1) and (4) control for industry-year fixed effects. Column (2) and (5) control for province-year fixed effects. Column (3) and (6) include both fixed effects. All regressions include firm fixed effects. Standard errors are clustered at the firm level.

## Table F.7: UCC Semi-Elasticity Regressions Results

| | OLS | IV | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Year FE | Year FE | Industry-Year FE | Province-Year FE | Both FE | Cash Flow | Firm Controls | CIT Rate |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Panel A. Dependent Variable: Dummy Variable if Firms Investing* | | | | | | | | |
| log UCC | -0.055* | -0.317*** | -0.318*** | -0.263*** | -0.266*** | -0.238*** | -0.260*** | -0.277*** |
| | (0.031) | (0.058) | (0.060) | (0.062) | (0.064) | (0.064) | (0.064) | (0.074) |
| $N$ | 77677 | 77661 | 77661 | 77661 | 77661 | 74959 | 77265 | 77661 |
| *Panel B. Dependent Variable: Investment Rate* | | | | | | | | |
| log UCC | -0.056*** | -0.198*** | -0.208*** | -0.215*** | -0.220*** | -0.217*** | -0.201*** | -0.217*** |
| | (0.013) | (0.023) | (0.023) | (0.024) | (0.025) | (0.025) | (0.025) | (0.030) |
| $N$ | 73115 | 73102 | 73102 | 73102 | 73102 | 71731 | 72743 | 73102 |
| *Panel C. Dependent Variable: Log Investment* | | | | | | | | |
| log UCC | -0.945*** | -2.406*** | -2.401*** | -2.209*** | -2.235*** | -2.244*** | -2.136*** | -2.122*** |
| | (0.193) | (0.291) | (0.301) | (0.314) | (0.322) | (0.328) | (0.319) | (0.403) |
| $N$ | 19607 | 19607 | 19606 | 19604 | 19603 | 19164 | 19594 | 19603 |
| *Panel D. Dependent Variable: IHS Investment* | | | | | | | | |
| log UCC | -0.896*** | -4.211*** | -4.236*** | -3.967*** | -3.986*** | -3.785*** | -3.816*** | -3.540*** |
| | (0.231) | (0.501) | (0.515) | (0.526) | (0.535) | (0.542) | (0.533) | (0.616) |
| $N$ | 77677 | 77661 | 77661 | 77661 | 77661 | 74959 | 77265 | 77661 |

*Notes:* This table estimates (semi-)elasticity regression of the form:

$$Y_{it} = \beta \log(\text{UCC}_{it}) + \mu_i + \delta_{jt} + X'_{it}\gamma + \varepsilon_{it},$$

where $\text{UCC}_{it}$ is the user cost of capital of firm $i$ at time $t$. The dependent variables are an indicator of positive investment, investment rate, log investment and IHS measure of investment that are reported in Panel A to D, respectively. Column (1) uses OLS estimator. Column (2) to (8) uses theoretical UCC as instrument, where theoretical UCC is calculated by statutory tax rates. Column (1) and (2) controls for year fixed effects. Column (2) controls for industry-year fixed effects. Column (4) controls for province-year fixed effects. Column (5) to (8) add both industry- and province-year fixed effects. Column (6) controls for firm's cash flow (scaled by fixed assets). Column (7) controls for fourth-order polynomials of sales, profit margin (=profit/revenue) and age. Column (8) controls for statutory CIT rate. All regressions include firm fixed effects. Standard errors are clustered at the firm level.

**Table F.8:** Sensitivity Analysis of Structural Moments

| Moments | 10% Change | | |
|---|---|---|---|
| | $\gamma$ | $\bar{\xi}$ | $\delta$ |
| *Pre-Reform Static Moments* | | | |
| Avg. Investment Rate | -0.0058 | 0.0007 | 0.0006 |
| Share<0.1 | -0.5705 | 0.0218 | -0.0065 |
| Share<0.2 | -0.1568 | -0.0011 | -0.0098 |
| Share<0.3 | 0.5000 | -0.0322 | -0.0108 |
| Serial Correlation | -0.0562 | -0.0052 | 0.0002 |
| SD. Investment Rate | -0.0739 | 0.0047 | 0.0013 |
| *Reduced-Form Investment Responses* | | | |
| Extensive DID | -0.0163 | -0.0002 | -0.0001 |
| Intensive DID | -0.0118 | 0.0002 | 0.0000 |

*Notes:* This table displays sensitivity matrix:

$$\Lambda = -(G'WG)^{-1}G'W \times g(m),$$

where $G$ is the Jacobian matrix, $W$ is the weighting matrix (identity matrix here), and $g(m)$ is a vector of moments with misspecification. Here, we consider the misspecification to be a 10% deviation from the moment value.

**Table F.9: Structural Estimation and Reduced-Form Moments of Investment Spikes**

| | Extensive Margin<br>% Firms Investing with $IK > 0.2$ | Intensive Margin<br>Spike Investment Rate |
|---|---|---|
| Data | 0.073 | 0.035 |
| Model | 0.064 | 0.036 |

*Notes:* This table displays additional reduced-form moments regarding investment spike, complementing Table 7. The first row reports difference-in-difference estimates of investment spike responses (column (3) and (6) in Table 4). The extensive margin refers to the fraction of firms whose investment rate is larger than 0.2, i.e., $\mathbb{1}\{IK_{it} \geq 0.2\}$ where $IK_{it}$ is the investment rate of firm $i$ at time $t$. The intensive margin refers to the spike investment rate, i.e., $IK_{it}^{spike} = IK_{it} \times \mathbb{1}\{IK_{it} \geq 0.2\}$. The second row reports model simulated responses of investment spikes. We use the estimated frictions, i.e., $\gamma = 1.43$, $\bar{\xi} = 0.12$, for the simulation.

**Table F.10: Robustness of Simulating 17% VAT Cut**

| Change in | Baseline (1) | Upward-Sloping Capital Supply (2) | Resale Price $p_s = 0.95$ (3) | Aggregate Productivity Drop (4) |
|---|---|---|---|---|
| Average Investment Rate | 0.290 | 0.231 | 0.290 | 0.294 |
| Aggregate Investment Rate | 0.290 | 0.232 | 0.290 | 0.294 |
| Fraction of Firms Investing | 0.098 | 0.090 | 0.098 | 0.102 |
| Tax Revenue | -0.279 | -0.277 | -0.279 | -0.277 |
| Firm Value | 0.114 | 0.090 | 0.114 | 0.114 |
| Ratio of Investment to Tax Revenue | 1.039 | 0.836 | 1.035 | 1.062 |
| Ratio of Firm Value to Tax Revenue | 0.410 | 0.325 | 0.409 | 0.413 |

*Notes:* This table displays simulation results for the baseline policy reform—17% VAT cut—with the following extensions. Column (1) is the baseline simulation results. Column (2) assumes the capital supply is upward sloping with the functional form of $p^K = I^{1/\varepsilon^s}$. The elasticity of capital supply with respect to pre-tax capital price $\varepsilon^s$ is set to 10. Column (3) assumes the net-of-tax resale price to be 0.95. In column (4), we feed in a one standard deviation permanent drop of aggregate productivity.

**Table F.11: Simulating Tax Reforms Incorporating Weighted Average Cost of Capital (WACC)**

| Change in | Baseline | CIT Cut 15.4% to 10% | |
|---|---|---|---|
| | 17% | Constant WACC | Varying WACC |
| | (1) | (2) | (3) |
| Average Investment Rate | 0.29 | 0.09 | 0.03 |
| Aggregate Investment Rate | 0.29 | 0.10 | 0.04 |
| Fraction of Firms Investing | 0.10 | 0.06 | 0.02 |
| Tax Revenue | -0.28 | -0.19 | -0.23 |
| Firm Value | 0.11 | 0.10 | 0.05 |
| Ratio of Investment to Tax Revenue | 1.04 | 0.54 | 0.18 |
| Ratio of Firm Value to Tax Revenue | 0.41 | 0.54 | 0.21 |

*Notes:* This table displays simulation results for CIT cut from 15.4% to 10% which changes weighted average cost of capital (WACC), and thus discount rate $\beta = \frac{1}{1+\text{WACC}}$. WACC is calculated as

$$\text{WACC} = \text{Share}_{\text{debt}}(1-\tau)r + (1-\text{Share}_{\text{debt}})r_k,$$

where $\text{Share}_{\text{debt}}$ is the share of capital financed through debt and, accordingly, $(1-\text{Share}_{\text{debt}})$ is the share of capital financed through equity. We calibrate the share of debt financing to be 0.65 to match the average debt to capital ratio. We keep real interest rate $r$ and capital return $r_k$ constant to match baseline discount rate.

Table F.12: Tax Cuts with Same UCC Reduction

| Change in | VAT Cut | CIT Cut | |
|---|---|---|---|
| | | Constant WACC | Varying WACC |
| | (1) | (2) | (3) |
| Tax Rate (%) | -2.8 | -10 | -10 |
| UCC (%) | -2.4 | -2.4 | -2.4 |
| Average Investment Rate (Non-negative, %) | 4.7 | 16.5 | 5.5 |
| Fraction of Firms Investing (%) | 2.3 | 11.1 | 4.1 |
| Tax Revenue (%) | -2.9 | -35.7 | -41.9 |
| Ratio of Investment Rate to Tax Revenue | 1.62 | 0.46 | 0.18 |

*Notes:* The table shows the results with initial VAT rate at 17% and CIT rate at 15.4%. We compare two reforms with the same reduction in UCC: 1) VAT reform cuts VAT from 17% to 14.2% (i.e., 2.8% rate reduction), and 2) CIT reform cuts CIT rate from 15.4% to 5.4% (i.e., 10% rate reduction). Those two reforms have the same impacts on UCC, reducing UCC by 2.4%. We use the estimated frictions, i.e., $\gamma = 1.43$, $\bar{\xi} = 0.12$, to simulate tax cuts. In column (2) we simulate CIT cut with fixed interest rate. In column (3) we use weighted-average cost of capital (WACC) for simulation. WACC is calculated as

$$\text{WACC} = \text{Share}_{\text{debt}}(1-\tau)r + (1-\text{Share}_{\text{debt}})r_k,$$

where $\text{Share}_{\text{debt}}$ is the share of capital financed through debt and, accordingly, $(1 - \text{Share}_{\text{debt}})$ is the share of capital financed through equity. We calibrate the share of debt financing to be 0.65 to match the average debt to capital ratio. We keep real interest rate $r$ and capital return $r_k$ constant to match baseline discount rate. Ratio of investment rate to tax revenue is calculated by dividing the percentage change in average investment rate by the percentage change in tax revenue.