Investment Tax Credits and Innovation

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Research Question

► How does firm innovation respond to an investment tax credit reform?

► Which types of firms are more responsive?

- Financially constrained firms
- SOE vs. non-SOE firms
- Foreign owned vs. solely domestically owned firms

Motivation

► Investment tax credit (ITC) is a widely-used tool for the government to encourage firm investment and stimulate the economy.

► How does ITC affect firm investment behavior?

- Hall and Jorgenson, 1967; Abel, 1982; Sen and Turnovsky, 1990; Goolsbee, 1998
- investment tax credit $\Rightarrow$ cost of capital $\Rightarrow$ investment behavior

► Technology is the engine of productivity growth of firms.

- externally purchasing existing technology embodied in physical machines and equipment
- internal innovation

► However, existing papers ignore the effect of investment tax credit on firms' internal innovation and their technology adoption strategies.

► Two Competing Effects
- ▷ Substitution effect
  - Investment in technology advancing machines and equipment and R&D activities can both improve firms' technologies and productivities.
- ▷ Scale effect
  - The decrease in the price of physical capital induces the firm to upsize, associated with an increase in the demand for all input factors.
  - Physical capital can expand firms' risk tolerant capacity, thus may have positive effects on firm innovation, which is normally considered as risky activities.

China's Value-added Tax (VAT) Reform

► September 12, 2004

► Eligible firms are in six industries in three northeastern provinces of China.

► Production-type VAT $\Rightarrow$ Consumption-type VAT

- After the reform, the expenditure on fixed assets (excluding structures) can be deducted from the value-added tax base for affected firms.

► The cost of fixed assets (especially machines and equipment) decreases and the cost of R&D activities is unchanged.

Theoretical Framework

► Suppose that a firm's production combines ordinary inputs (N) and R&D investment (R).

► The ordinary production is a function of physical capital (K) and labor (L): $N = (\alpha K^\psi + (1-\alpha)L^\psi)^{\frac{1}{\psi}}$

► How do R&D activities combine with ordinary inputs?
- Case 1: $\int AN \, dF(A|R) = \int A \, dF(A|R) \cdot N$
  $= R^\beta N^{1-\beta}$ (Assuming $\int A \, dF(A|R) = R^\beta$)
- Case 2: $\alpha K^\psi + \beta L^\psi + (1-\alpha-\beta)R^\psi$

$$\max_{\{K,L,R\}} \left[\beta(\alpha K^\psi + (1-\alpha)L^\psi)^{\rho/\psi} + (1-\beta)R^\rho\right]^{1/\rho} - c_K K - c_L L - c_R R$$
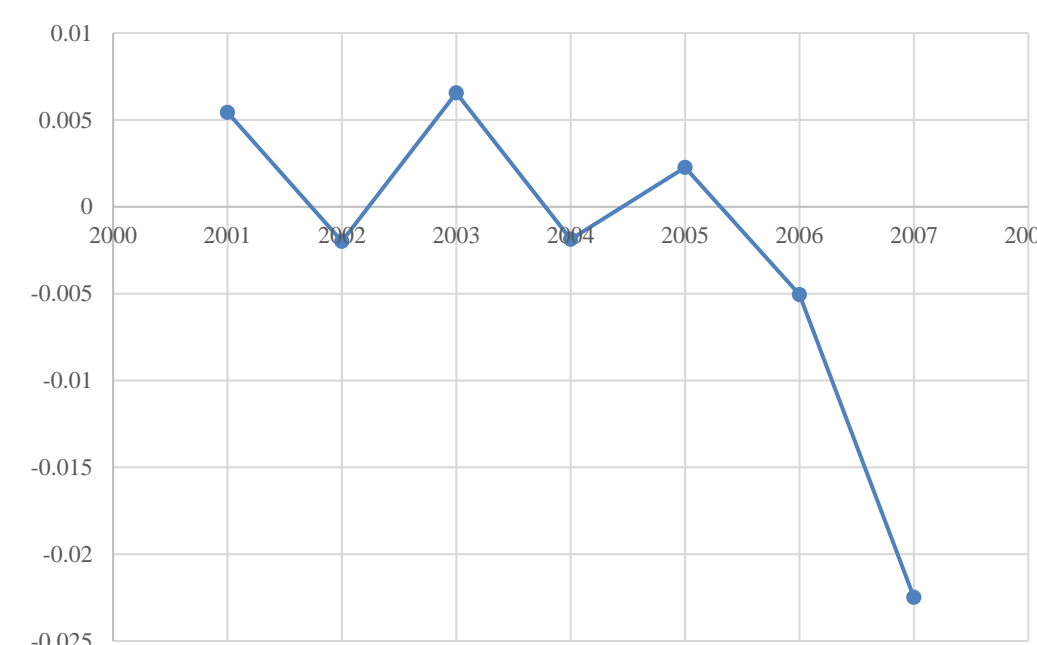$$s.t., \qquad c_K K + c_L L + c_R R = I$$

$$\frac{\partial R^*}{\partial c_K} = \frac{\sigma - 1}{(1 + ((1-\alpha)/\alpha)^{1/(1-\psi)}(c_K/c_R)^{\psi/(1-\psi)}) c_K/R + c_R/K}$$

Prediction: The ITC reform decreases investment in innovative activities when the elasticity of substitution ($\sigma = \frac{1}{1-\rho}$) between ordinary investment and innovative investment is greater than 1.

Empirical Results

Number of patents, DDD: $(Y_{NE-Eind} - Y_{NE-nonEind}) - (Y_{nonNE-Eind} - Y_{nonNE-nonEind})$

$$y_{i,t+1} = \beta \times NE_p \times Eind_j \times Post2004_t + Controls_{i,t} + \lambda_i + \lambda_{p,t} + \lambda_{j,t} + \varepsilon_{i,t+1}$$

The coefficient β conveys the triple-difference estimate of the impact of the VAT reform in 2004 on firms' innovation.

VARIABLES	(1) Ln(1+Pat_{t+1})	(2) Ln(1+Pat_{t+1})	(3) Ln(1+Pat_inv_{t+1})	(4) Ln(1+Pat_utl_{t+1})	(5) Ln(1+Pat_des_{t+1})
NE*Eind*Post2004	-0.0089***	-0.0087***	-0.0036**	-0.0046**	-0.0009**
	(-2.98)	(-2.91)	(-2.44)	(-2.27)	(-2.23)
LnAssets		0.0125***	0.0041***	0.0056***	0.0022***
		(21.70)	(18.23)	(17.79)	(9.00)
Leverage		0.0001	-0.0002	-0.0004	-0.0002
		(0.05)	(-0.43)	(-0.60)	(-0.48)
ROA		0.0100***	0.0026***	0.0038***	0.0029***
		(6.85)	(4.47)	(4.91)	(4.93)
LnFirmAge		-0.0024***	-0.0013***	-0.0015***	-0.0002
		(-3.59)	(-5.07)	(-4.17)	(-0.95)
State Share		-0.0074***	-0.0025**	-0.0035**	-0.0015*
		(-3.02)	(-2.25)	(-2.27)	(-1.85)
Observations	981,273	981,273	981,273	981,273	981,273
Firm FE	Yes	Yes	Yes	Yes	Yes
Year*Province FE	Yes	Yes	Yes	Yes	Yes
Year*Industry FE	Yes	Yes	Yes	Yes	Yes
Clusters (firms)	256,350	256,350	256,350	256,350	256,350
Adjusted R-squared	0.386	0.387	0.265	0.320	0.310

Heterogeneous Effect Analyses

	Ln(1+Pat_{t+1})					
	Financial constraints		SOE vs. non-SOE firms		Foreign owned vs. solely domestically owned firms	
	Low (1)	High (2)	SOE (3)	Domestic private (4)	Foreign (5)	Domestic (6)
NE*Eind*Post2004	-0.0033	-0.0109**	-0.0080	-0.0087**	-0.0040	-0.0088***
	(-1.14)	(-2.18)	(-0.78)	(-2.50)	(-0.4599)	(-2.6753)
LnAssets	0.0052***	0.0227***	0.0185***	0.0136***	0.0180***	0.0138***
	(8.63)	(18.45)	(5.62)	(17.70)	(9.2323)	(18.5308)
Leverage	0.0013	-0.0016	0.0041	0.0004	-0.0018	0.0006
	(1.06)	(-0.67)	(0.84)	(0.25)	(-0.4729)	(0.4484)
ROA	0.0051***	0.0276***	0.0268***	0.0110***	0.0148**	0.0116***
	(3.65)	(6.30)	(2.69)	(6.05)	(2.5639)	(6.5031)
LnFirmAge	-0.0005	-0.0052***	-0.0005	-0.0023***	-0.0051	-0.0023***
	(-0.78)	(-3.95)	(-0.15)	(-2.74)	(-1.5259)	(-2.8137)
State Share	-0.0061**	-0.0090**	-0.0086*	-0.0071*	-0.0404**	-0.0071**
	(-2.35)	(-2.15)	(-1.85)	(-1.77)	(-2.4502)	(-2.3977)
Observations	339,436	382,684	41,512	549,102	128,130	590,958
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year*Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year*Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.287	0.424	0.481	0.379	0.416	0.396

Robustness Checks

► Placebo tests

► PSM analysis

► Alternative sample

► Long-term effects of the 2004 VAT reform

► R&D Expenditure

► Fixed investment response to the 2004 VAT reform

Conclusion and Discussion

► We study the effects of the 2004 value-added tax reform in China, which reduces the relative cost of fixed investment of the eligible firms, using a simple theoretical model and the triple-difference empirical method.

► The reform leads eligible firms to decrease R&D investment, resulting in lower innovation, which is consistent with *substitution effect*.

► The impacts of the reform on innovation are stronger for
- financially more constrained firms
- non-SOE firms
- domestic firms

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