Corporate Tax Credits and Complexity

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Introduction

- Firms use intangible capital to generate profit
  - Investments in many types of knowledge-based, nonphysical assets.
  - R&D, proprietary algorithms, drug formulas, software tools, attributed designs, business practices, services delivery etc
- Consider claiming tax credits for financial benefit
  - R&D credit, patent box, tax returns etc
- However... claiming the credit involves costs:
  - **Timing cost (Opportunity cost)** – Credit is received after incurring cost (possibly 1–3 years later)
  - **Administrative burden** – Detailed recordkeeping, technical documentation, involves hiring external tax/legal advisors
  - **IP Risk (Leakage/Disclosure)**: Must disclose methods, inventions, or internal structures in claims
    - ★ *Trade secret erosion*
    - ★ *Competitor imitation*
    - ★ *Patent invalidation through self-disclosure*

Introduction

US States with R&D Tax Credits (Ranked by Complexity)

State	Corp Tax %	Credit Rate %	Compl (1–3)	Disc (1–3)	State	Corp Tax %	Credit Rate %	Compl (1–3)	Disc (1–3)
CA	8.84	15	3.0	1	NY	7.25	6	1.4	1
CT	7.50	20	2.8	1	IA	5.50	6.5	1.4	1
AZ	4.90	24	2.5	1	MD	8.25	10	1.4	1
AR	5.30	33	2.5	1	MA	8.00	10	1.3	1
MT	6.75	5	2.3	1	ID	6.00	5	1.3	1
PA	8.99	10	2.3	1	UT	4.85	5	1.3	1
IN	4.90	15	2.2	1	CO	4.40	3	1.2	1
WI	7.90	5.75	2.1	1	RI	7.00	22.5	1.2	1
GA	5.75	10	2.0	1	NC	2.50	3.25	1.1	1
ND	4.31	25	2.0	1	OK	4.00	22	1.0	1
HI	4.40	20	1.8	1	NH	7.50	10	1.0	1
NM	5.90	5.5	1.8	1	KS	4.00	6.5	1.0	1
SC	5.00	5	1.7	1	AK	9.40	20	1.0	1
DE	8.70	10	1.6	1	KY	5.00	5	1.0	1
OR	6.60	5	1.5	1	MS	5.00	20	1.0	1
FL	5.50	10	1.5	1	NE	5.58	15	1.0	1
IL	9.50	6.5	1.5	1	NJ	9.00	10	1.0	1
LA	7.50	30	1.5	1	TX	–	5	1.0	1

Sources: Tax Foundation (2024), JLARC Report 562-1 (Appendix F), Maine OPEGA (2019)

Introduction

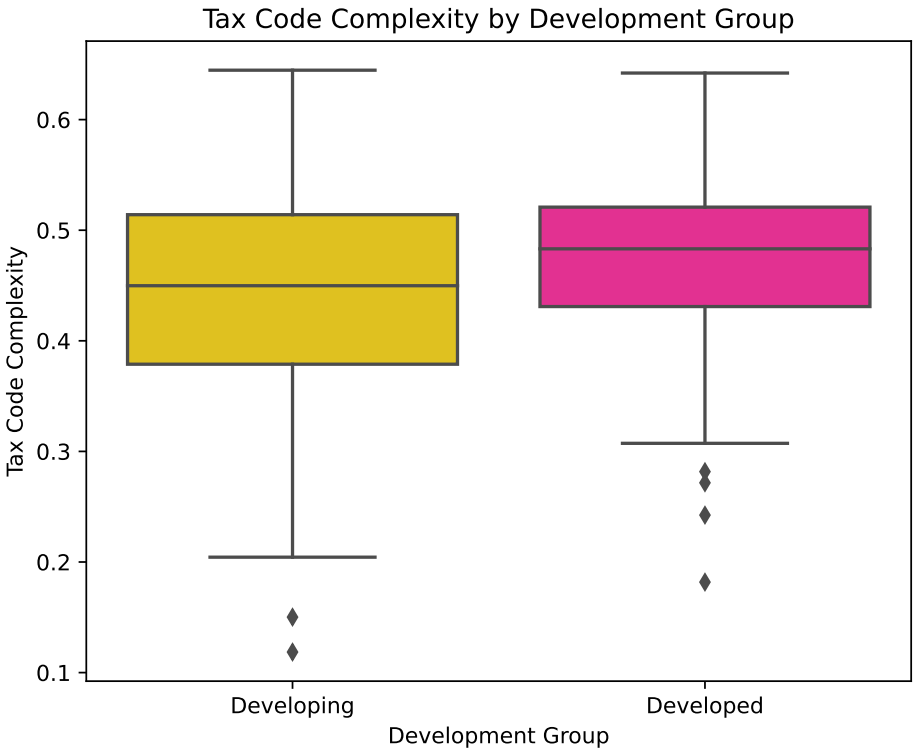
Patent Box Regimes Ranked by Tax Complexity

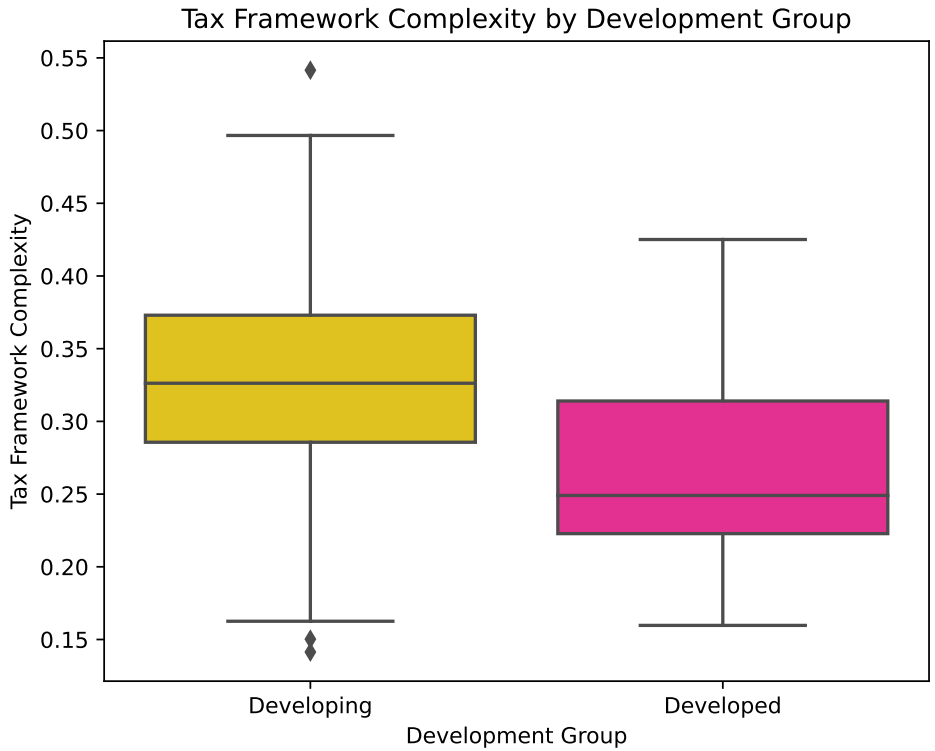
Country	Statutory Rate	ETR	Tax Complexity	Disclosure	IP Scope
Poland	19%	5.0%	0.50	2	Patents, software
Belgium	25%	5.1%	0.45	3	Patents, software, orphan drugs
Italy	24%	14.75%	0.45	2	Patents, software, designs
Portugal	31.5%	12.3%	0.41	2	Patents, software
US	21%	—	0.40	1	No box; R&D credit only
UK	25%	10%	0.39	3	Patents, biotech, software
France	25%	15%	0.39	2	Patents, software
Spain	25%	12%	0.38	2	Patents, software
Luxembourg	21%	5.8%	0.36	2	Patents, trademarks
Hungary	9%	4.5%	0.36	2	Patents, software
Cyprus	12.5%	2.5%	0.36	2	Patents, software
Slovakia	21%	10.5%	0.36	2	Patents, software
Netherlands	25.8%	7–10%	0.35	2	Patents, R&D certs, software
Ireland	12.5%	6.25%	0.33	2	Patents, know-how
Malta	35%	1.75%	0.33	2	Patents, software
Lithuania	15%	5.0%	0.29	2	Patents, software
Switzerland	14.7%	8.8%	0.23	2	Patents, software

Sources: Tax Foundation – Statutory Rates, Tax Foundation – Patent Box Regimes (2023), Tax Foundation – ETR Data, Tax Complexity

Introduction

Stylized facts

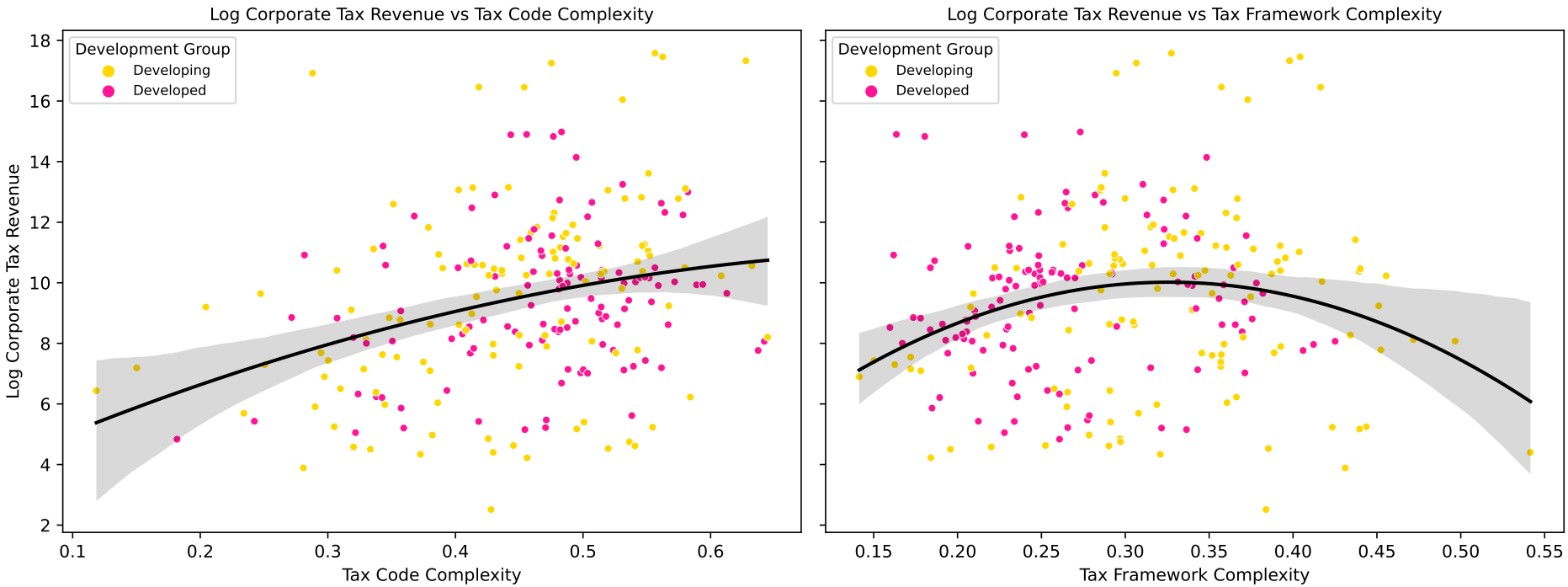




Scatterplots by complexity type and development status

Introduction

Stylized facts



Scatterplots by complexity type and development status

Introduction

Our contribution

- Introduce a model that allows
  - for heteregoneous firms with private returns on intangibles
  - tax credits
  - cost for pursuing credits
  - tax revenue funds public good

Problem

Is there an optimal degree of complexity for tax credits?

Introduction

Preview of results

- We identify two cases that depend on the structure of the model:
  1. A case where asymmetric information matters and mimicking incentives are binding
  2. Only participation constraints matter
- In 1. cost of credit must be high as it induces separation and increases the tax base
- In 2. cost of credit must be low to increase the tax base
- In both cases the cost of credit induces participation of less efficient firms but it is beneficial
- Extensions
  - Behavioral biases
  - Distribution of firms

The model

Firms

- A firm ζ uses a unit of tangible and intangible capital with returns a and u_ζ at a cost k
- Intangible capital is non-observable and non-verifiable
- $u_\zeta \sim [u_l, u_h]$
- Firm is active if pays tax t, but can apply for a tax credit r, at a cost $\gamma c(u_\zeta)$ where $\gamma > 0$, $c'(u_\zeta) > 0$ and $c''(u_\zeta) \geq 0$
- $\Pi_\zeta \triangleq v_\zeta - t + [r - \gamma c(u_\zeta)] \cdot \mathbf{1}_{r \geq 0}$, $v_\zeta \triangleq a + u_k - k$

Non-linear taxation

Timing

1. The regulator announces t and r
2. The firms decide whether to be active in the market and decide whether to pursue the credit or not.

The welfare maximization problem writes as

$$\max_{t,r,u_i,u_j} PS + (u_h - u_l)\, g(R)$$

$$s.t.\ q_i = \frac{u_h - u_i}{u_h - u_l},\ q_j = \frac{u_i - u_j}{u_h - u_l} \text{ or } q_j = \frac{u_j - u_l}{u_h - u_l}$$

$$v_i - t \geq 0 \quad (PC_i)$$

$$v_i - t \geq v_i - t + r - \gamma c(u_i) \quad (IC_i)$$

$$v_j - t + r - \gamma c(u_j) \geq 0 \ (PC_j)$$

$$v_j - t + r - \gamma c(u_j) \geq v_j - t \ (IC_j)$$

Non-linear taxation

- Starting point: Binding (IC_i) and (PC_j)
- From non-binding (PC_i) we have $\frac{\partial \Pi_\zeta}{\partial u_\zeta} = 1 - \gamma c'\left(u_\zeta\right) > 0$
  1. $\gamma c'\left(u_\zeta\right) < 1$ any firm ζ with intangibles $u_i > u_\zeta \geq u_j$ pursues the credit
  2. $\gamma c'\left(u_\zeta\right) > 1$ any firm ζ with intangibles $u_j > u_k \geq u_l$ applies for the credit
- $\gamma c'\left(u_\zeta\right) < 1 \Leftrightarrow$ to a non-binding (PC_i)
- $\gamma c'\left(u_\zeta\right) < 1$ marks Case I and then $\gamma c'\left(u_\zeta\right) > 1$ Case II

Graphic illustration of the two cases

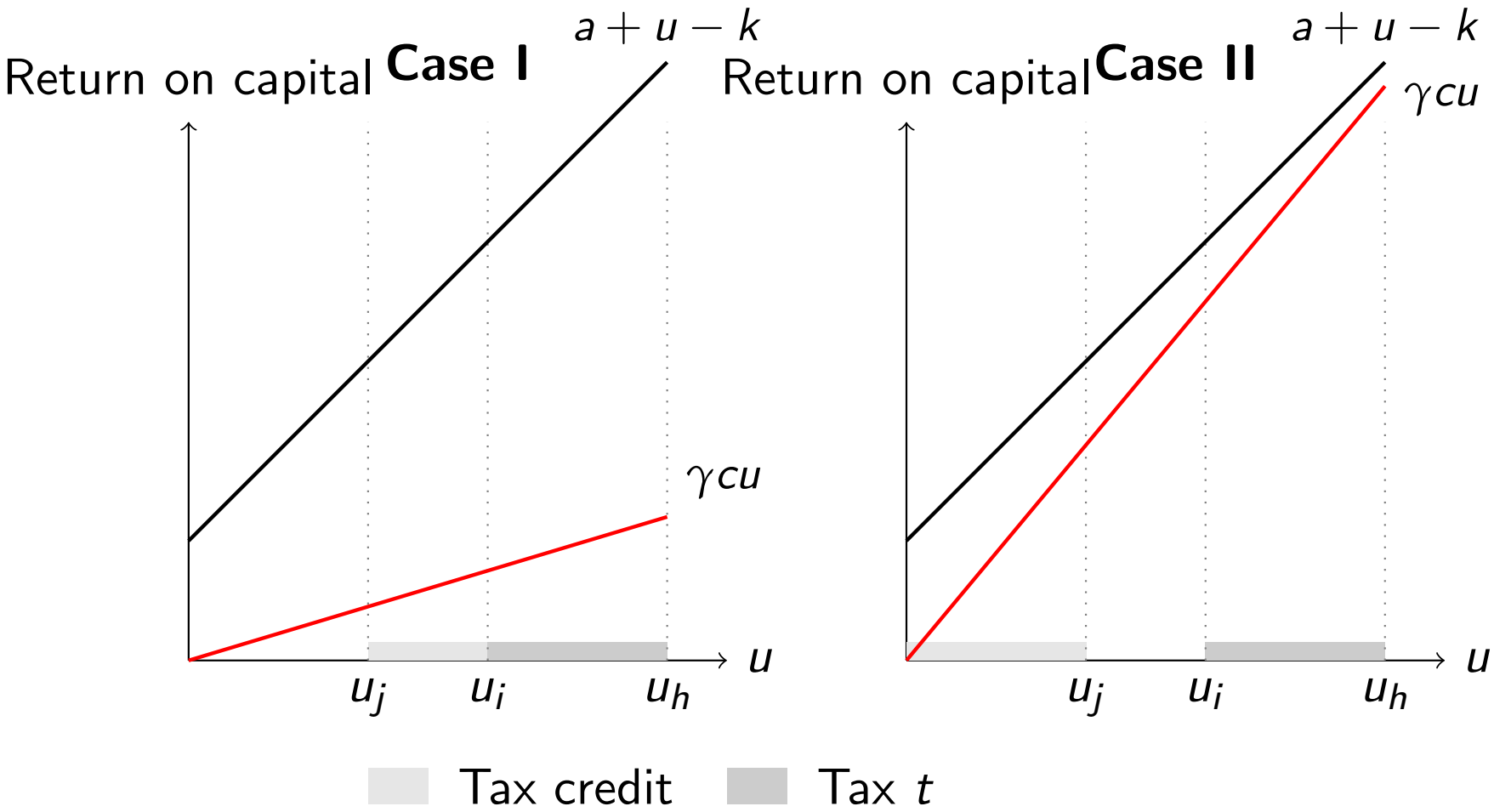


Figure: Return on capital as a function of v under two regimes. Tax credits and taxes are shaded.

Main results

Case I

Lemma

(i) Locally, $\frac{\partial u_i^*}{\partial \gamma} \approx 0$ *and* $\frac{\partial u_j^*}{\partial \gamma} < 0$. *(ii)* $\frac{\partial u_i^*}{\partial \gamma}\Big|_{u_j=u_j^*} \leq 0$ *and* $\frac{\partial u_j^*}{\partial \gamma}\Big|_{u_i=u_i^*} < 0$.

- In (i) increasing the cost of credit increases the tax base as more firms pursue the credit on the bottom
  - counterintuitive as higher γ make credits less attractive
- In (ii) a higher cost of credit reduces also the marginal firm at the top so more firms pay high taxes

Proposition

Locally, $\frac{\partial t^*}{\partial \gamma} \gtrsim 0$ *and* $\frac{\partial r^*}{\partial \gamma} > 0$. *Equality holds when the cost of credit is linear.*

Main results

Case I

Proposition

(i) $\frac{dw^*}{d\gamma} > 0$. *(ii) Locally,* $\frac{dR^*}{d\gamma} > 0$ *if the cost function is not too convex.*

- Separation of the two threshold firms is facilitated as higher γ implies higher $r^* = \gamma c\left(u_i^*\right)$

Proposition

Locally, it holds that $\frac{\partial u_i^*}{\partial k} \approx 0$, $\frac{\partial u_j^*}{\partial k} > 0$, $\frac{\partial t^*}{\partial k} < 0$, $\frac{\partial r^*}{\partial k} \approx 0$, *and* $\frac{\partial^2 w^*}{\partial \gamma \partial k} < 0$.

- The increased cost of capital is partially compensated by the high tax rate which is lowered
- Higher k discourages participation and relaxes the incentive to increase γ as separation is more difficult attained
- Analysis wrt a is reversed as a and k have the exact opposite effects

Main results

Case II

- Now both (PC_i) and (PC_j) are binding
- The firms that lie in between of the two thresholds remain idle

Lemma

(i) Locally, $\frac{\partial u_i^{**}}{\partial \gamma} \approx 0$ *and* $\frac{\partial u_j^{**}}{\partial \gamma} < 0$. *(ii)* $\frac{\partial u_i^{**}}{\partial \gamma}\Big|_{u_j = u_j^{**}} \leq 0$ *and* $\frac{\partial u_j^{**}}{\partial \gamma}\Big|_{u_i = u_i^{**}} < 0$.

- $\frac{\partial u_j^{**}}{\partial \gamma} < 0$ follows directly from costly participation
- As $g''(R) < 0$ increase the number of participating firms that pay t accepting lower consumption of the public good

Proposition

Locally, $\frac{\partial t^{**}}{\partial \gamma} \approx 0$ *and* $\frac{\partial r^{**}}{\partial \gamma} \gtrsim 0$ *if the cost of credit is not too convex and* u_l *is high enough.*

Main results

Case II

Proposition

(i) $\frac{dw^{**}}{d\gamma} < 0$. *(ii)* $\frac{dR^{**}}{d\gamma} < 0$.

- Higher γ makes it more difficult to perfectly discriminate among the firms as it discourages the firms at the lower tail of the distribution
- Lower γ leads to lower credits while bring in more productive firms

Proposition

Locally, $\frac{\partial u_i^{**}}{\partial k} > 0$, $\frac{\partial u_j^{**}}{\partial k} < 0$, $\frac{\partial t^{**}}{\partial k} < 0$, $\frac{\partial r^{**}}{\partial k} > 0$, *and* $\frac{\partial^2 w^{**}}{\partial \gamma \partial k} > 0$.

Graphic illustration of comparative statics for the two cases

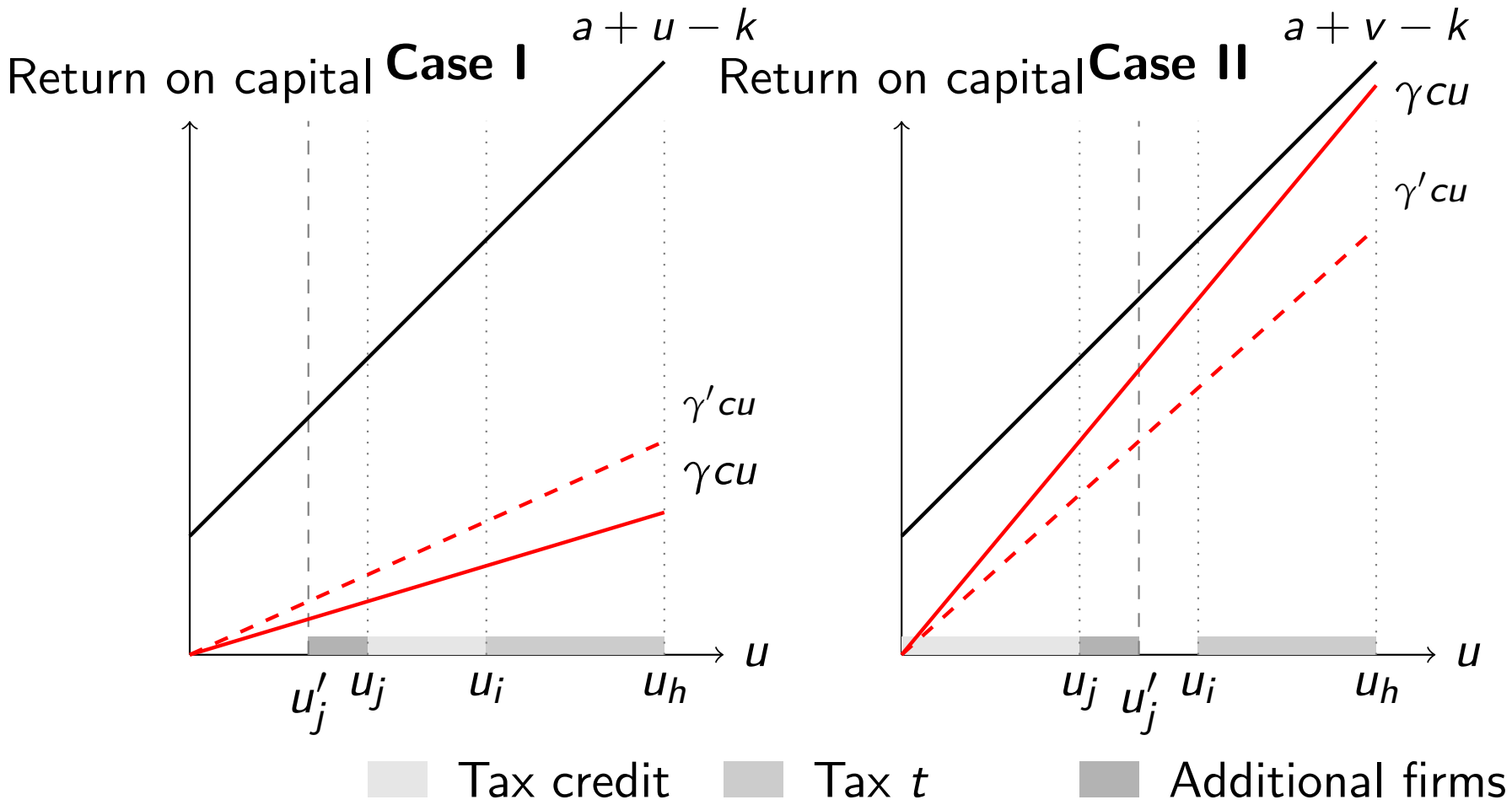


Figure: Effect of changes in γ on firm eligibility. Case I: γ increases; Case II: γ decreases.

Main results

Endogenous cost of credit

- Natural conjecture: in II (PC_i) and (PC_j) are binding and welfare should be higher compared to I where mimicking incentives are present

Proposition

With a linear cost of credit, the regulator chooses an optimal cost of credit $0 < \gamma^* < 1$

- t under both scenarios coincides. But in I it sets a lower r
- All firms active under both scenarios
- Revenue is higher in I and thus public good provision

Robustness

Consumer naïveté

- Naïveté where the firms perceive $\widehat{\gamma}$ regarding the actual value of the cost of credit γ_a

Maximization problem

$$\max_{t,r,u_i,u_j} PS + (u_h - u_l)\, g(R)$$

$$s.t.\ q_i = \frac{u_h - u_i}{u_h - u_l}, q_j = \frac{u_i - u_j}{u_h - u_l}$$

$$v_i - t + [r - \widehat{\gamma} c(u_i)]\, \mathbf{1}_{\widehat{\gamma}_{\min}} \geq 0 \ (PC_i^n)$$

$$v_i - t \geq v_i - t + r - \gamma_a c(u_i) \ (IC_i^n)$$

$$v_j - t + [r - \widehat{\gamma} c(u_j)]\, \mathbf{1}_{\widehat{\gamma}_{\min}} \geq 0 \ (PC_j^n)$$

$$v_j - t + r - \gamma_a c(u_j) \geq v_j - t \ (IC_j^n)$$

- (PC_i^n) and (PC_j^n) *ex ante* constraints
- (IC_i^n) and (IC_j^n) *ex post* constraints

Robustness

Consumer naïveté

- $\frac{\partial u_i^{n*}}{\partial \widehat{\gamma}} \approx \frac{\partial u_i^{n*}}{\partial \gamma_a} \approx 0$, $\frac{\partial u_j^{n*}}{\partial \gamma_a} > 0$ and $\frac{\partial u_j^{n*}}{\partial \widehat{\gamma}} < 0$

Remark

Locally, $\frac{\partial w^{n*}}{\partial \gamma_a} > 0$ *and* $\frac{\partial w^{n*}}{\partial \widehat{\gamma}} < 0$.

- $\frac{\partial u_j^{n*}}{\partial \gamma_a} > 0$ non-trivial as from (IC_i^n) $r^{n*} = \gamma_a c\left(u_i^{n*}\right)$
- As (PC_j^n) is relaxed t can be raised without losing participants at the top, while it reduces participation at the bottom (contrary to the main model)
- Higher welfare is driven by the higher level of the public good
- $\frac{\partial u_j^{n*}}{\partial \widehat{\gamma}} < 0$ this (-) effect is outweighed by higher t from lower $\widehat{\gamma}$
- Naïveté leads to a lower participation
- Deception is beneficial

Robustness

Distribution

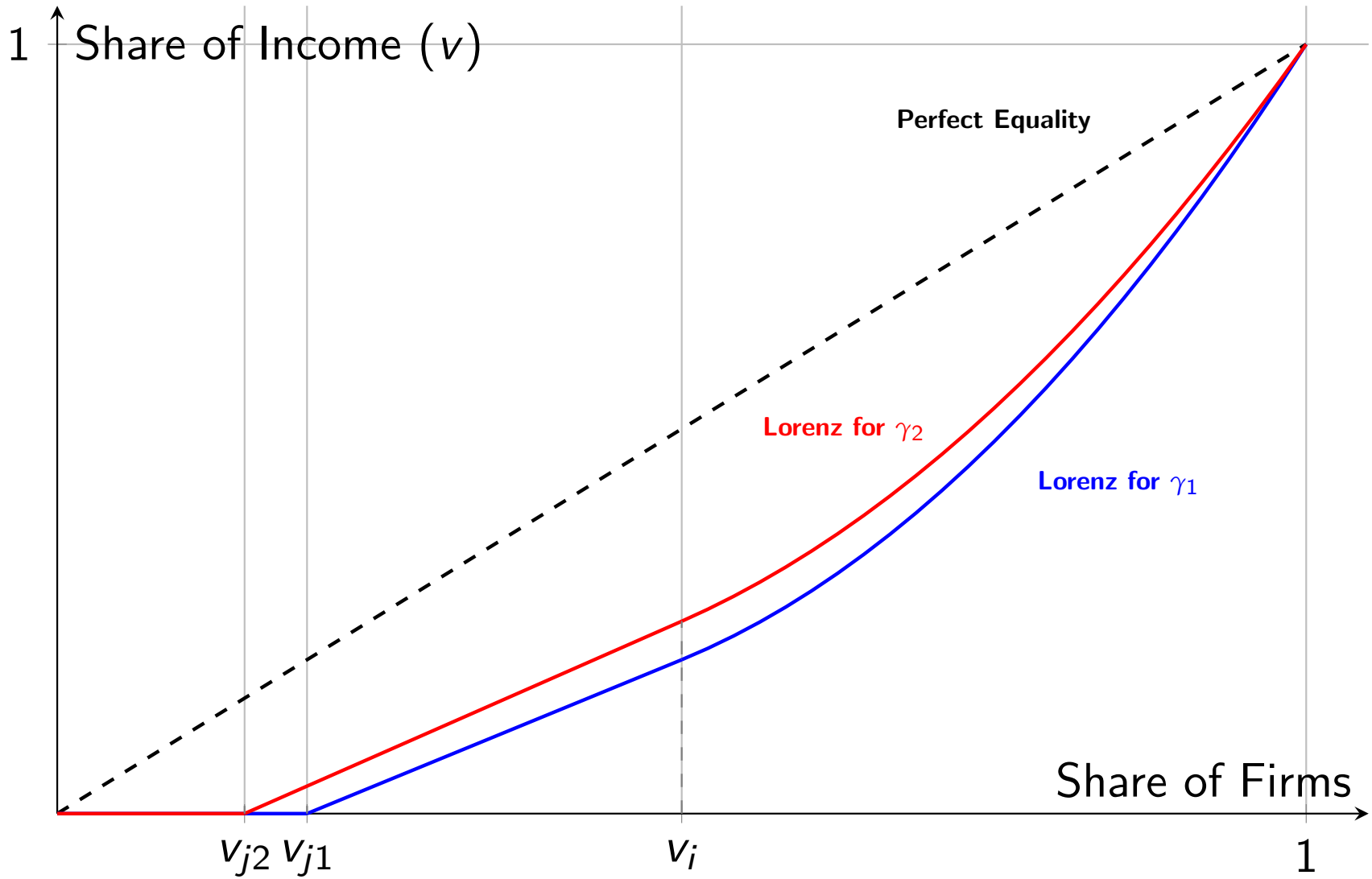


Figure: Increase in cost of credit

Related literature and contribution

- Intangibles and their share in firm valuation Crouzet et al. (2022), Corrado et al. (2022), Li (2025)
- Corporate income tax and R&D investment Devereux et al. (2002), Fuest and Neumeier (2023)
- Optimal design of corporate taxes with private information that separate constrained and uncostrained firms Davilla and Hebert (2023), Pareto improving non-linear tax reforms for income taxation Bierbrauer et al. (2021; 2023), Gerritsen et al. (2024)
- Tax simplicty and bunching for self-employed in France Aghion et al. (2025). Does tax code complexity alter corporate behavior? Zwick (2021)
- Behavioral and taxation Boccanfuso and Ferey (2023), Farhi and Gabaix (2020)

Implications

- We focus on complexity and the channels through which can improve welfare and under certain conditions Pareto improving
- High cost of credit (complexity), but not too high
- Policy implications in tax avoidance, evasion, tax sheltering, bunching, taxation of firms using AI, profit shifting
- Empirical implications in the relationship between complexity and, corporate tax credits, corporate income tax revenues, public good provision (quality)

Thank you!

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