Stabilization vs. Growth

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Stabilization vs. Growth

- Advanced economies feature institutions that provide **soft credit** [Kornai, 1980]
  - Lending arrangements (i.e., evergreening, restructuring) ▸ details
  - Fiscal interventions (i.e., business support during COVID)
  - Unconventional monetary policy

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  2. Firm heterogeneity
  3. Endogenous growth

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  3. Endogenous growth
- **What are the effects of soft credit in a GE model of fluctuations and growth?**

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1. Develop a GE model with key features:
    - Aggregate fluctuations with tractable firm heterogeneity
    - Defaultable firm debt + endogenous firm exit
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2. Calibrate the model
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3. Analyze impact of soft credit interventions
    - Evergreening [today], restructuring and fiscal transfers [in the paper]
    - Impact on balanced growth path, response to shocks & welfare
    - Comparative statics w.r.t. key parameters

This Paper: Key Findings

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Effects of eliminating soft credit (evergreening) in the U.S.:

- GDP growth $\uparrow$ by 11.5% (2%$\rightarrow$2.23%)
- Firm exit, credit spreads, GDP volatility $\uparrow$
- Welfare gains of $\sim$5% - strongly dependent on strength of innovation externalities

Roadmap

Model

Characterization of the model

Calibration and estimation

Results

Roadmap

Model

Characterization of the model

Calibration and estimation

Results

Environment

- Time is discrete and infinite $t = 0, 1, \ldots$
- Demographics:
  - Representative **household** $\Rightarrow$ consumes, works, deposits with intermediaries ▸ details
  - Continuum of risk-neutral **financial intermediaries** $\Rightarrow$ take deposits, lend to firms
  - **Firms** borrow, invest in capital and R&D, hire labor, and produce
- Firms may default & exit, replaced by entrants with no capital $\Rightarrow$ **constant mass**

Firms: Technology

Decreasing returns to scale production function

$$y = (z\varepsilon)^{1-\eta}(\zeta k)^{\alpha} n^{\eta}, \quad \alpha + \eta < 1$$

- z is fundamental productivity (same for all firms in eq.)
- $\varepsilon \sim F[0, \infty)$ is idiosyncratic productivity, i.i.d. across time and firms
- ζ are AR(1) capital quality shocks [Merton, 1973; Brunnermeier & Sannikov, 2014]

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Firms choose z' subject to convex cost

$$\text{R\&D} = \phi \left(\frac{z'}{\underbrace{z^{1-\rho}}_{own} \underbrace{(Z\varepsilon^*)^{\rho}}_{average}} \right)^{\kappa}$$

where ρ disciplines learning externalities [Lucas & Moll, 2014] $\Rightarrow$ estimate on micro data

Firms: Financial Frictions

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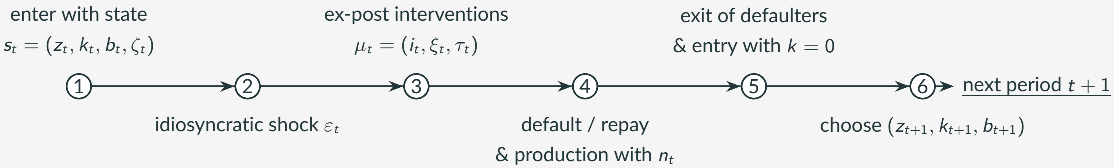
3. **Limited liability:** firms may default on intraperiod debt and exit

Timeline within a period



Ex-post soft credit interventions μ:

- Evergreening: lenders may extend cheaper intraperiod credit i
- Restructuring: lenders may write off fraction ξ of existing debt b [not today]
- Fiscal support: govt may issue targeted transfer τ [not today]

Firm Problem

1. **Enter period with $s \equiv (z, k, b, \zeta)$, observe ε and i, choose to default or not:**

$$V_0(s, \varepsilon) = \max\{V^p(s, \varepsilon), 0\}$$

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2. **If repay, pay fixed cost ν, hire labor n, borrow ℓ, produce:**

$$V^p(s, \varepsilon) = \max_{n,\ell} (z\varepsilon)^{1-\eta}(\zeta k)^{\alpha} n^{\eta} - w \cdot n + \ell - (1 + i)\ell - \nu - b + (1 - \delta)\zeta k + V_1(s)$$

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3. **Exiting firms replaced with entrants; all firms choose (z', k', b'):**

$$V_1(s) = \max_{z', k', b'} -\phi \cdot \left[\frac{z'}{z^{1-\rho}(Z(\varepsilon^*)^{\rho}}\right]^{\kappa} - k' + q \cdot b' + \mathbb{E}[M' \cdot V_0(s', \varepsilon')]$$

$$\text{s.t.} \qquad b' \leq \theta k'$$

Lenders: dynamic problem

- Each firm maintains a relationship with a risk-neutral lender
- Lender chooses deposits d' and price of debt q s.t. deposit funding constraint

$$\begin{aligned} W_1(s) &= \max_{q,d'} \mathbb{E}\{M' \cdot [W_0(s',\varepsilon') - d']\} \\ \text{s.t.} \quad & qb' \leq Q^d \cdot d' \end{aligned}$$

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- **Free entry**: zero expected profits

$$W_1(s) = 0 \Rightarrow q(s) = \frac{\mathbb{E}[M' \cdot W_0(s',\varepsilon')]}{b'}$$

- Ex-post profits/losses are rebated lump-sum to household

Lenders: intraperiod problem

- Lenders raise resources at linear cost ω to fund intraperiod lending
- Hard credit: lend at $i = \omega$ to non-defaulting firms
- Evergreening: internalize effects of i on default decision:

$$W_0(s,\varepsilon) = \max_{i \geq i^{reg}} \underbrace{\mathbf{1}[\varepsilon \geq \bar{\varepsilon}(s;i)]}_{\text{no default}} \underbrace{\{b + (i-\omega)\cdot w \cdot n(s,\varepsilon;i)\}}_{\text{lend, continue}}$$
$$+ \underbrace{\mathbf{1}[\varepsilon < \bar{\varepsilon}(s;i)]}_{\text{default}} \underbrace{(1-\lambda)\zeta k}_{\text{recovery}}$$

- i^{reg}: minimum rate set by regulation

Roadmap

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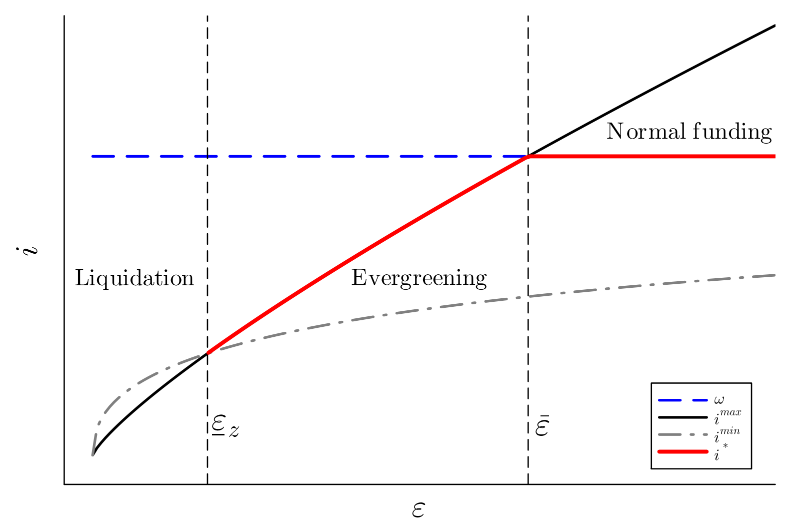
Calibration and estimation

Results

Intraperiod equilibrium: evergreening

▸ details ▸ restructuring ▸ transfers



Dynamic firm decisions

equilibrium balanced growth path

- Standard conditions for debt, capital
- Borrowing constraint always binding
- Innovation choice:

$$\frac{z'}{z} = \underbrace{\left(\varepsilon^*\right)^{\rho \frac{\kappa}{\kappa - \frac{1-\eta}{1-\alpha}}}}_{\text{externality}} \times \underbrace{\left\{ \frac{\mathbb{E}\left[M \cdot \int_{\underline{\varepsilon}'}^{\infty} \frac{\partial V^p}{\partial z'}(s', \varepsilon') \mathrm{d}F(\varepsilon')\right]}{\kappa \phi} \right\}^{\frac{1}{\kappa - \frac{1-\eta}{1-\alpha}}}}_{\text{expected payoff relative to cost}}$$

where

$$\varepsilon^* \equiv \frac{\int_{\underline{\varepsilon}}^{\infty} \varepsilon \mathrm{d}F(\varepsilon)}{1 - F(\underline{\varepsilon})}$$

is the average productivity of incumbent firms

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Calibration strategy

- Calibration to annual U.S. data
  - Treat **evergreening economy** as the benchmark
  - Based on evidence in Faria-e-Castro, Paul & Sánchez (2024)

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  - Treat **evergreening economy** as the benchmark
  - Based on evidence in Faria-e-Castro, Paul & Sánchez (2024)
- Proceed in three steps:
  1. External calibration of standard parameters ▸ details
  2. Direct estimation of parameters related to R&D cost and externality (κ, ρ)
  3. Internal calibration of remaining parameters to match U.S. economy moments: $(\sigma_\varepsilon, \nu, i^{reg}, \beta, \psi, \phi, \rho_\zeta, \sigma_\zeta)$ ▸ details

Direct estimation of R&D parameters

- Firm i that wants to increase its productivity from $z_{i,s,t}$ to $z_{i,s,t+1}$ must spend

$$\mathrm{R\&D}_{i,s,t} = \phi_t \times \left(\frac{z_{i,s,t+1}}{z_{i,s,t}^{1-\rho} (x_{s,t}^{*})^{\rho}} \right)^{\kappa},$$

where $x_{s,t}^{*}$ is average productivity of industry s, ρ **is learning weight**, κ **is cost curvature**, ϕ_t is common scale

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- Rearranging terms & taking logs,

$$\log z_{i,s,t+1} - \log z_{i,s,t} = \frac{1}{\kappa} \cdot \left(\log \mathrm{R\&D}_{i,s,t} + \log \phi_t\right) + \rho \cdot \log \frac{x_{s,t}^{*}}{z_{i,s,t}}.$$

Empirical specification & identification

The empirical specification uses predetermined productivity terms and time fixed effects

$$\log z_{i,s,t+1} - \log z_{i,s,t-1} = \alpha_t + \beta_1 \log \mathrm{R\&D}_{i,s,t} + \beta_2 \log \frac{x^*_{s,t-1}}{z_{i,s,t-1}} + u_{i,s,t}$$

- **Endogeneity concern**: $\mathrm{R\&D}$ correlated with unobservables (e.g. expected growth)

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- IV approach: state-level R&D tax credits (Wilson, 2009; Bloom et al., 2013)
- **First stage**: higher credits $\Rightarrow$ higher reported firm R&D; F-stat $\approx$ 15–20

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- **Data:** annual Compustat, sample: 1982–2023; obtain firm-level TFP estimates

Results: $\hat{\beta}_1 = 0.33^{***}$, $\hat{\beta}_2 = 0.30^{***} \Rightarrow \hat{\kappa} \approx 1/\hat{\beta}_1 \approx 3, \quad \hat{\rho} \approx 0.30$

- Robustness: (i) industry–time FE (absorbing $w_{s,t}$), (ii) alternative TFP measure, (iii) economy-wide learning $x^*_t \Rightarrow \beta_1 \in [0.33, 0.49]$, $\beta_2 \in [0.30, 0.41]$

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Impact of soft credit on balanced growth path

PD ϵ | Policy Functions | other soft credit

- **Hard Credit:** $i^{reg} = \omega$; **Evergreening:** $i^{reg} < \omega$

Moment	Hard Credit	Evergreening
Subs. firm rate	**0.00**	**5.95**
i, %	**2.00**	**1.79**
Exit rate	9.77	4.99
ε^*	1.03	1.02
GDP growth	2.23	2.00
$\sigma(G_Y)$	3.12	2.44
Spread, %	3.75	1.97
K/Y ratio	2.04	2.36
Wage	0.76	0.82
CEV wrt HC	0.00	4.81

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- Soft credit reduces firm exit and average prod. of incumbents ε^* ...

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- ... relative to hard credit economy, this reduces GDP growth & volatility

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- Interperiod spreads decline which raises capital investment all else equal.

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- Evergreening distorts labor decision, raises wages, reduces incentives to invest

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- Growth effect dominates, soft credit reduces welfare

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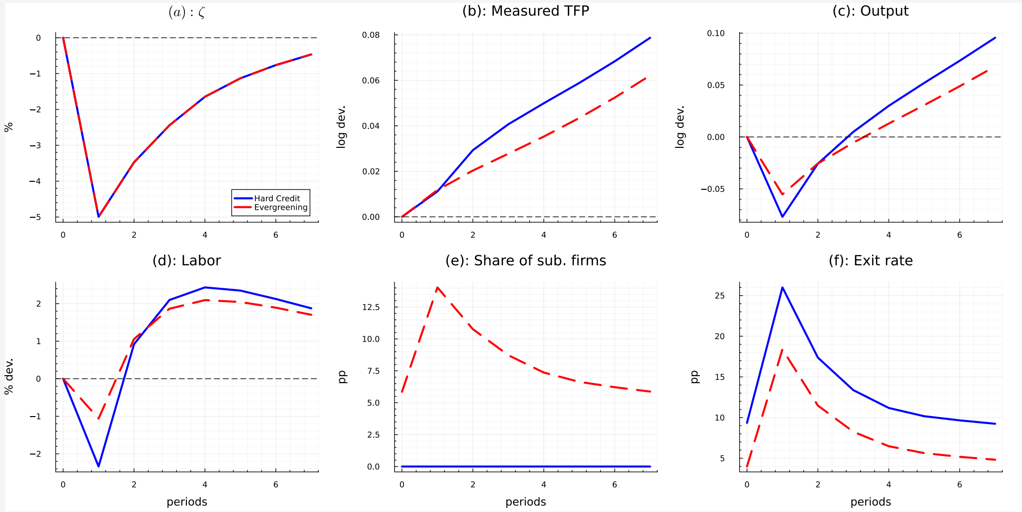
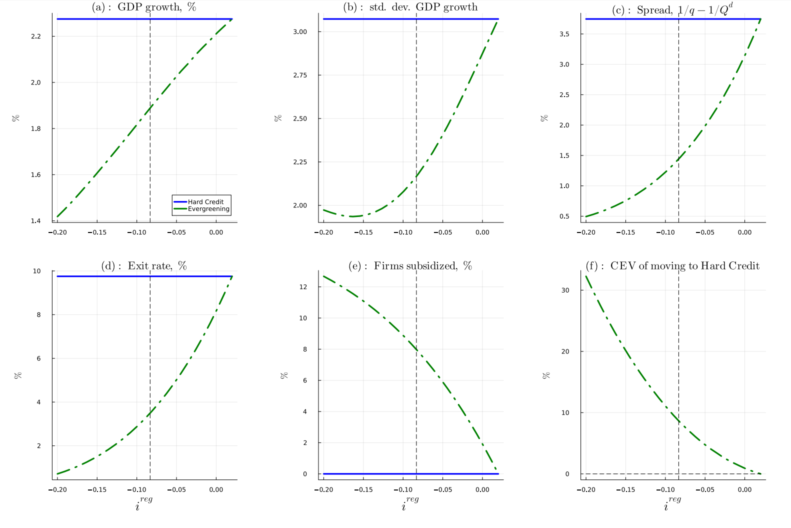
Soft credit moderates recessions [IRF to capital quality shock]

▸ all economies

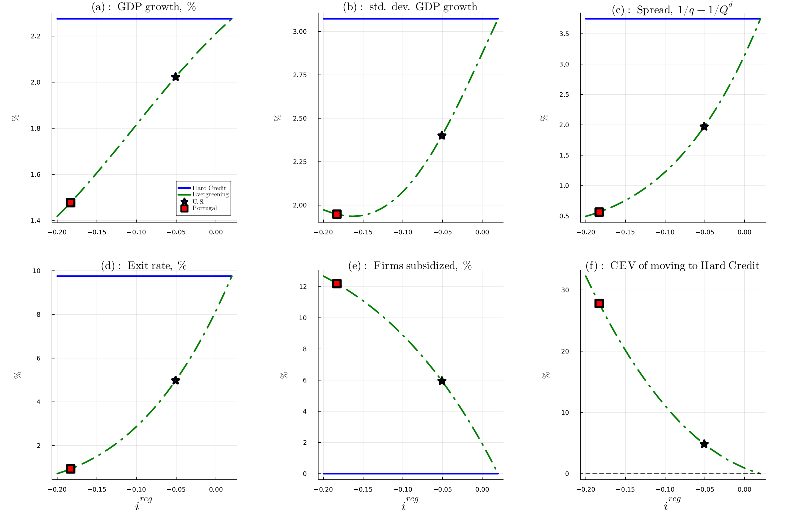


Comparative statics w.r.t. i^{reg}

▸ other policies ▸ misallocation



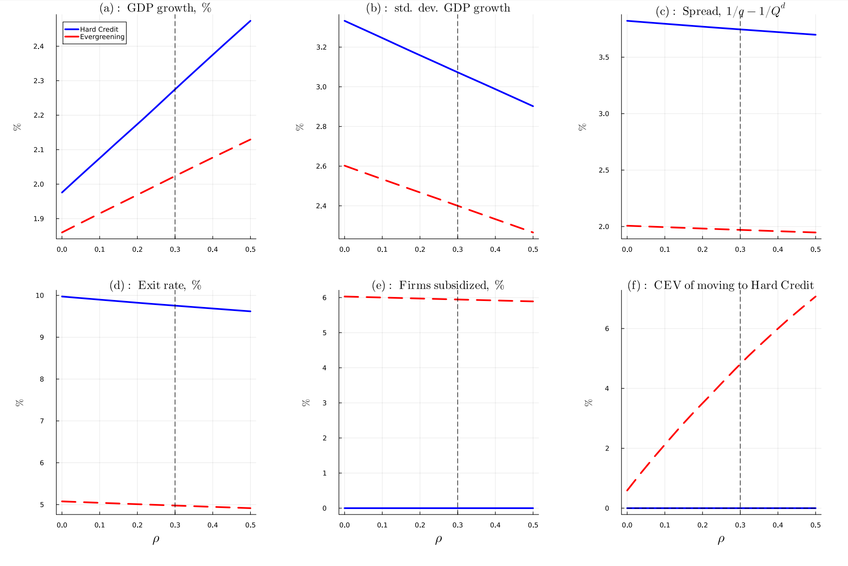
Portugal vs. the US



Zombie share of 11.7% for Portugal estimated using the dataset of Albuquerque & Iyer (2024).

Welfare effects of soft credit depend on ρ

▸ all policies



Conclusion

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- **Key channel**: soft credit allows low-productivity firms to survive longer, affecting other firms via innovation externalities and congestion in input markets
- This stabilizes the economy in the short run, but slows down long-run growth.
- **Work in progress:** (i) planner problem, (ii) monetary policy, (iii) recursive preferences, (iv) endogenous entry

APPENDIX

Evergreening

back

- Banks may have incentives to keep distressed firms alive by rolling over credit
- Typically associated with aftermath of crises $\rightarrow$ Japan in 1990s, Eurozone in 2010s
  - **But**: also prevalent among US banks recently [Faria-e-Castro, Paul, and Sanchez, 2024]
- Literature mostly empirical; welfare implications not clear
  - $\uparrow$ prevents firm exit, stabilizes employment [Kashyap, Rajan & Stein, 2002]
    - does it make recessions less severe? $\Rightarrow$ need a business cycle model
  - $\downarrow$ linked to zombie lending [Caballero, Kashyap & Hoshi, 2008]
    - does it have long-run implications for productivity? $\Rightarrow$ need a growth model
- Similarly, renegotiation (Chapter 11) allows for ex-post restructuring of debt

Representative Household

▸ Back

- Representative household maximizes PDV of period utility with discount factor β

$$u(C_t, N_t) = \frac{C_t^{1-\sigma}\left[1 + (\sigma - 1)\chi \frac{N_t^{1+\varphi}}{1+\varphi}\right]}{1-\sigma}$$

- King, Plosser & Rebelo (1988) preferences required for balanced growth with constant hours
- Budget constraint:

$$C_t + Q_t^d D_{t+1} = w_t N_t + D_t + \Psi_t$$

- Ψ_t are firm and intermediary profits
- Standard optimality conditions

Intraperiod firm decisions

Back

- Binding working capital constraint $\Rightarrow$ closed-form solutions for (n, ℓ)
- Operating profits linear in (z, ε):

$$\max_{n,\ell \geq wn} (z\varepsilon)^{1-\eta}(\zeta k)^{\alpha} n^{\eta} - wn + \ell - (1+i)\ell \equiv \varepsilon \cdot z \cdot \pi(k, \zeta; w, i)$$

- Distress iff

$$V^{p}(s, \varepsilon) < 0 \Leftrightarrow \varepsilon < \bar{\varepsilon}$$

where

$$\bar{\varepsilon} = \frac{b + \nu - (1-\delta)\zeta k - V_1(s)}{z\pi(k, \zeta; w, i)} = \text{distress threshold}$$

- Distress implies exit in the hard credit economy

Intraperiod equilibrium w/. evergreening

▸ Back

Define the following objects:

1. $i^{\max}(s, \varepsilon)$: max rate for which firm does not default

$$i^{\max}(s, \varepsilon) = \max\{i : \bar{\varepsilon}(s; i) = \varepsilon\}$$

2. $i^{\min}(s, \varepsilon)$: min rate for which lender is indifferent between lending or liquidating

$$i^{\min}(s, \varepsilon) = \min\{i : W_0(s, \varepsilon; i) = (1 - \lambda)\zeta k\}$$

Intraperiod equilibrium w/. evergreening

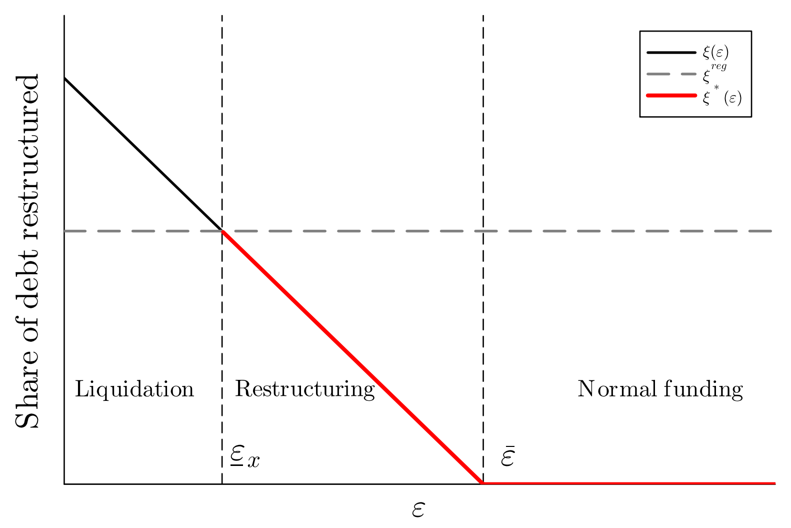
Back

The intraperiod equilibrium can be characterized in terms of a distress threshold $\bar{\varepsilon}(s)$ and a liquidation threshold $\underline{\varepsilon}_z(s)$ for idiosyncratic productivity:

1. If $\varepsilon > \bar{\varepsilon}(s)$, the firm is in the normal funding region and $i = \omega$ (not distressed)
2. If $\varepsilon \in [\underline{\varepsilon}_z(s), \bar{\varepsilon}(s)]$, the firm is the evergreening region and $i \in [i^{reg}, \omega)$ (distressed)
3. If $\varepsilon < \underline{\varepsilon}_z(s)$, the firm is liquidated.

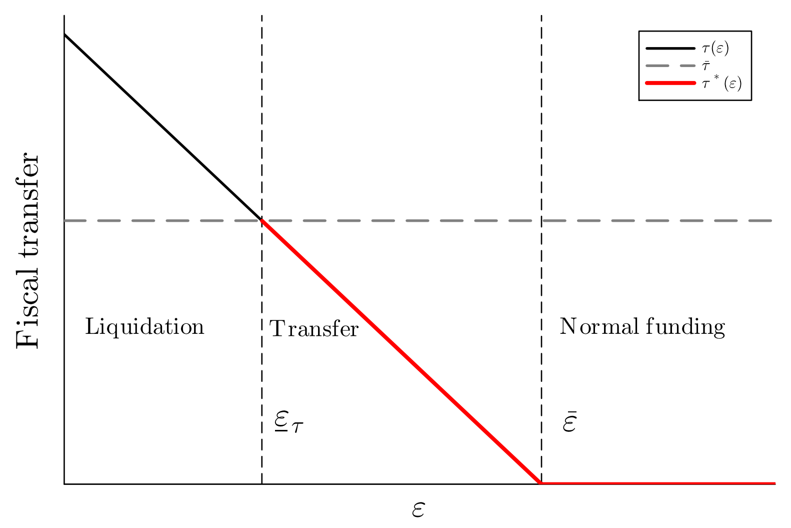
Intraperiod equilibrium w/. restructuring

back
Details



Intraperiod equilibrium w/. fiscal transfers

back



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1. If $\varepsilon > \bar{\varepsilon}(s)$, the firm is in the normal funding region (not distressed)
2. If $\varepsilon \in [\underline{\varepsilon}_x(s), \bar{\varepsilon}(s)]$, the firm is the restructuring region and $x \in (0, \xi^{reg}]$ (distressed)
3. If $\varepsilon < \underline{\varepsilon}_x(s)$, the firm is liquidated.

Equilibrium

back

A competitive equilibrium is a sequence of allocations $(C_t, N_t, D_{t+1}, z_{t+1}, k_{t+1}, b_{t+1}, n_t, \ell_t)$, prices (w_t, q_t, i_t), and thresholds for liquidation and distress $(\underline{\varepsilon}_t, \bar{\varepsilon}_t)$, such that for all t:

1. Households optimize over (C_t, N_t, D_{t+1}), taking prices and the distribution of firms as given
2. Firms optimize over $(n_t, \ell_t, z_{t+1}, k_{t+1}, b_{t+1})$, taking prices, lending policies, and thresholds as given
3. Lenders optimize over (q_t, i_t, ξ_t)
4. Thresholds $(\underline{\varepsilon}_t, \bar{\varepsilon}_t)$ satisfy the firm's indifference conditions implied by optimal lending contracts.
5. The labor, goods, deposit, intraperiod debt, and interperiod debt markets clear.

Balanced growth path

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- A BGP exists with detrending factor

$$z_t^{\frac{1-\eta}{1-\alpha}}$$

- We solve for a detrended version of the model, where all quantities are detrended:

$$x_t = \tilde{x}_t \cdot z_t^{\frac{1-\eta}{1-\alpha}}$$

- Letting $G_z \equiv z_{t+1}/z_t$, all real quantities in the economy grow at gross rate

$$G_z^{\frac{1-\eta}{1-\alpha}}$$

External calibration

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Parameter	Description	Value	Target/Reason
σ	Inverse EIS	1.5	-
φ	Inv. Frisch elasticity	1	Standard
α	Capital share	$0.36 \times \psi$	Standard
η	Labor share	$0.64 \times \psi$	Standard
δ	Depreciation rate	0.08	Standard
θ	Collateral constraint	1	Debt to fixed-assets of 1 (FPS, 2024)
λ	Loss given default	0.35	Y-14 data
ω	Lending cost	0.02	2% annual (Gilchrist & Zakrajsek, 2012)

Internally calibrated parameters and shocks

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Parameter	Description	Value	Moment	Source	Data	Model
σ_ε	Variance of prod.	0.192	TFP of exiting/continuing firms	Lee & Mukoyama (2015)	0.65	0.65
ν	Fixed cost	0.012	Exit/default rate	Crane et al. (2022)	5.0%	5.0%
i^{reg}	Lower bound int. rate	-0.051	Credit spread	Y-14 data	2.0%	2.0%
β	Discount factor	0.995	Real interest rate	U.S. data	3.0%	3.0%
ψ	Returns to scale	0.864	EBITDA/Value Added	Compustat	42.2%	41.6%
$\tilde{\phi}$	Level cost of R&D	0.171	GDP pc growth	U.S. data	2%	2%
ρ_ζ	Capital quality persistence	0.685	GDP growth rate	U.S. data	0.044	0.041
σ_ζ	Capital quality volatility	0.020	GDP growth rate	U.S. data	0.023	0.024

Probability distribution function of idiosyncratic productivity

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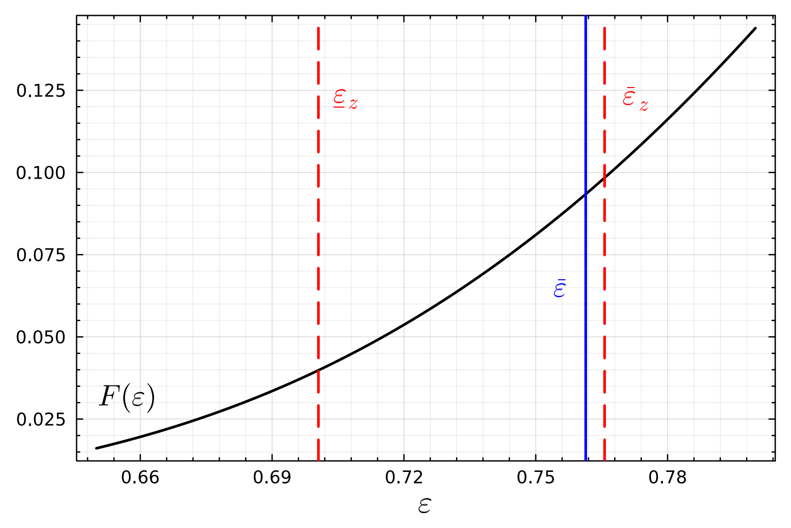

Firm policy functions for physical capital and R&D

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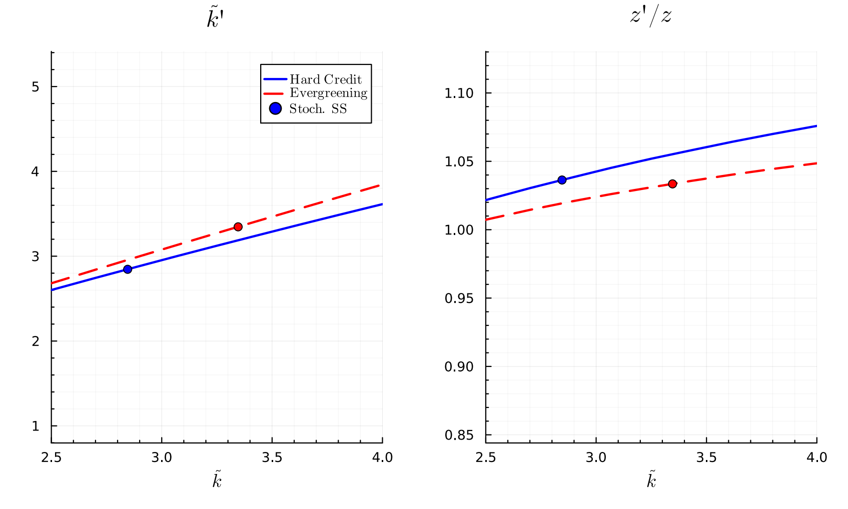

Impact of soft credit on balanced growth path

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Moment	Hard Credit	Evergreening	Restructuring	Transfer
Subs. firm rate	0.00	5.95	5.96	5.96
Exit rate	9.77	4.99	4.92	4.94
ε^*	1.03	1.02	1.02	1.02
GDP growth	2.23	2.00	2.08	2.09
$\sigma(G_Y)$	3.12	2.44	2.54	2.54
$\sigma(G_C)$	2.42	2.37	2.40	2.39
$\sigma(\log N)$	1.92	1.59	1.69	1.60
Spread, %	3.75	1.97	1.96	1.96
i, %	2.00	1.79	2.00	2.00
K/Y ratio	2.04	2.36	2.36	2.36
Wage	0.76	0.82	0.82	0.82
CEV wrt HC	0.00	4.81	2.02	2.05

Capital quality shock: all economies

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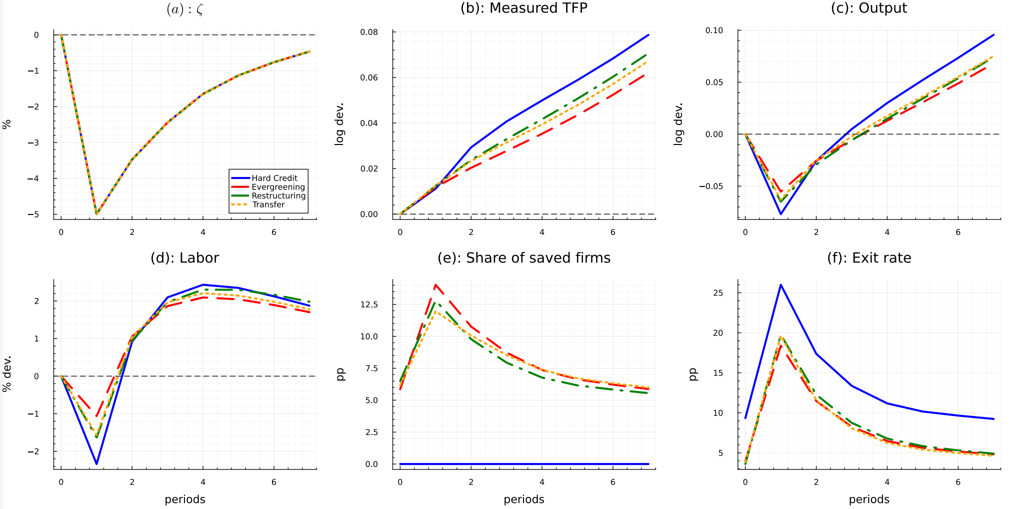

Comparative statics w.r.t. i^{reg}, ξ^{reg}, $\bar{\tau}$

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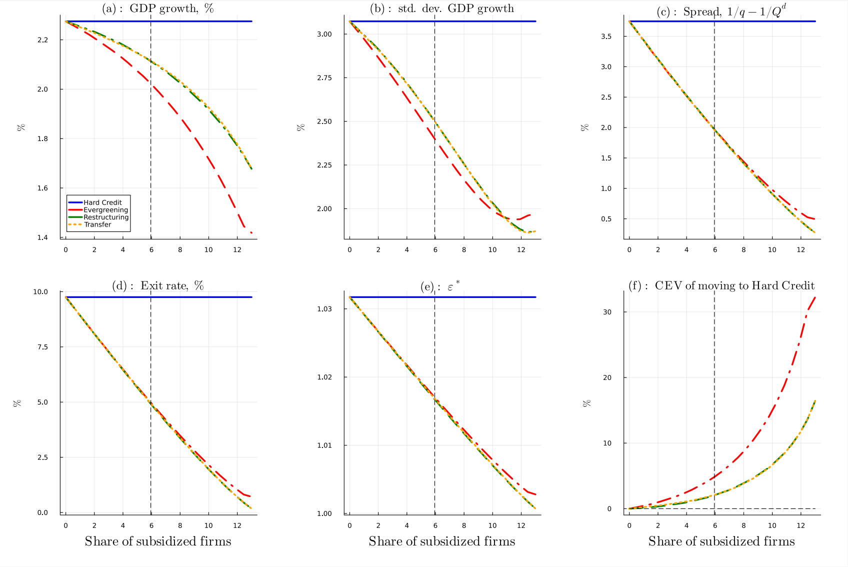

Evergreening vs. Restructuring/Transfers

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- For the same % of subsidized firms, evergreening provides more stabilization but reduces growth by more
  - Evergreened firms benefit from lower i
  - This raises their labor demand
- Low productivity firms demand relatively more labor
- Evergreening generates **static misallocation**
- Restructuring and transfers do not distort static labor choice

Comparative statics w.r.t. ρ, all policies

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