Firm Quality Dynamics and the Slippery Slope of Credit Intervention

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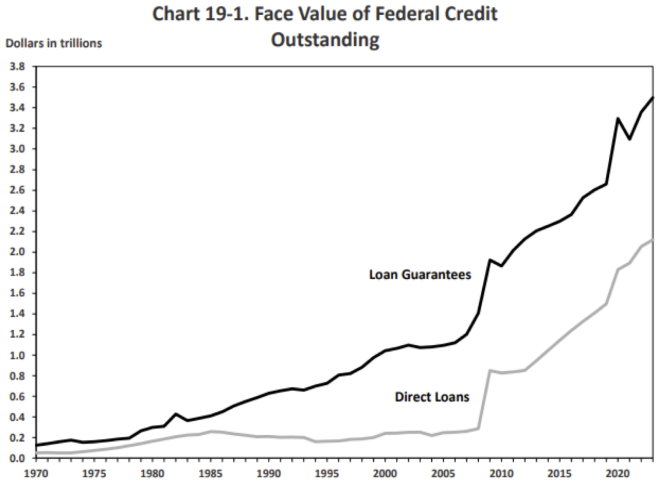
The Rise of Government Credit Intervention



Note: Excludes Fannie & Freddie, deposit insurance, pension benefit guarantee corporation, federal home loan banks

Traditional credit programs
≈ $5 trillion in 2021

Including these other federal credit activities brings total to > $20 trillion

Government Financing Support to Nonfinancial Firms

- Government financing support to nonfinancial firms has become a global phenomenon.
  - United States: corporate bond purchases and paycheck protection programs.
  - Europe: direct grants and tax reductions to nonfinancial firms.
  - China: expansion of local government lending to firms.

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  - China: expansion of local government lending to firms.

- Question: impact on recovery and the long-run dynamics?
  - Quantity: containing output drop and preserving the growth base
  - Quality: dampening the cleansing effects of crises due to less differentiation than private market

  $\rightarrow$ Intertemporal linkage through endogenous quality:

  cumulative quality distortion & increasingly large interventions

  A slippery slope of intervention!

- Main conclusion holds if there is lack of differentiation in either pricing or volume of government financing.

The Model Mechanism

- Firms differ in the productivity of their capital (collateral)
  - Under limited commitment, firms' financing capacity depends on collateral value
  - Financial constraints tighten in crises
  - The cleansing effect: high-quality firms have higher capital value

    $\rightarrow$ higher Tobin's q and higher financing capacity $\rightarrow$ invest more

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- The government may act as an intermediary between investors (HHs) and firms
  - Government has a deep pocket;
  - Government cannot differentiate firms of different productivities due to

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  - Government cannot differentiate firms of different productivities due to

    (1) the lack of information, (2) political constraint, (3) time constraint
- Slippery slope: intervention $\rightarrow$ larger intervention in future crises ...
  - Low quality firms are more subsidized due to the lack of differentiation.
  - Entering future crises, firm quality is lower and begets larger intervention to achieve the same macroeconomic outcome.

Literature and Contributions

- A new type of intervention costs: distortionary effects on capital quality dynamics
  - Government intermediates funding (Bebchuk, Goldstein, 2011; Lucas, 2016)
  - The lack of differentiation of asset/collateral quality in practice (Tamura, Tabakis, 2013; English, Liang, 2020)
  - A black box of deadweight loss is assumed in models of unconventional monetary policy/govt asset or capital purchases (Gertler, Kiyotaki, 2010; Cúrdia, Woodford, 2011; Gertler, Karadi, 2011; Gertler, Kiyotaki, Queralto, 2012; Araújo, Schommer, Woodford, 2015; Del Negro, Eggertsson, Ferrero, Kiyotaki, 2017)

- Credit misallocation and firm dynamics
  - Heterogeneous firms and reallocation/misallocation under financial frictions (Cooley and Quadrini 2001; Eisfeldt, Rampini, 2006; Eberly, Wang, 2008; Gilchrist, Sim, Zakrajšek, 2013; Midrigan, Xu, 2014; Moll, 2014; Fuchs, Green, Papanikolaou, 2016; David, Schmid, Zeke, 2018; Dou, Ji, Tian, Wang, 2020; David, Zeke, 2021; Lanteri, Rampini, 2021)

Literature and Contributions

- Firms' expectations of intervention
  - The literature of expectation of intervention grew after the GFC and focuses on bank risk-taking (Calomiris, 1990; O'Hara, Shaw, 1990; Acharya, Yorulmazer, 2007; Acharya, 2009; Bond, Goldstein, Prescott, 2009; Farhi, Tirole, 2012; Gropp, Gruendl, Guettler, 2013; Acharya, Mora, 2015; Gandhi, Lustig, 2015; Allen, Carletti, Goldstein, Leonello, 2018; Dávila, Walther, 2020)
  - Haddad, Moreira, and Muir (2022) show that firms expect significant Fed support in downturns after the introduction of corporate bond purchase programs.

- Safe asset supply alleviates the distortionary effects of credit intervention
  - High-quality firms' self-insurance $\rightarrow$ intervention $\downarrow$ $\rightarrow$ distortions $\downarrow$
  - Government supply of liquid/safe assets: Woodford, 1990; Aiyagari, McGrattan, 1998; Holmström, Tirole, 1998; Gorton, Lewellen, Metrick, 2012; Krishnamurthy, Vissing-Jorgensen, 2012, 2015; Stein, 2012; Nagel 2016; Gorton, Ordoñez, 2021; Diamond, 2017; Lenel, 2017; Li, 2017; Li, 2019 ...

Outline

1. A Simple Model
2. Results
3. A Richer Model with Quantification
4. Conclusion

Model: Preferences and Technology

- Households: $\mathbb{E}\left[\int_{t=0}^{\infty} e^{-rt} dc_t\right]$
- Firms have different productivity A^j, $j \in \{H, L\}$, with A-K production technology. Total capital

$$K_t = K_t^H + K_t^L$$

- Quality distribution (fraction of H firms):

$$\omega_t = \frac{K_t^H}{K_t^H + K_t^L}$$

- Total output:

$$A^H K_t^H dt + A^L K_t^L dt = \underbrace{\left(A^H \omega_t + A^L (1 - \omega_t)\right)}_{\text{quality affects productivity}} \cdot \underbrace{K_t}_{\text{quantity}} \, dt$$

Model: Firm Investment and Financing

- Invest $x_t^j k_{t-}^j$, get $F(x_t^j)k_{t-}^j$ new capital. Financial constraint:

$$F(x_t^j) \qquad s.t. \qquad x_t^j \leq \chi q_t^j \quad (\chi \in (0,1))$$

- Normal time: idiosyncratic Poisson arrivals for investments. Unconstrained.
  - Investment target from q-theory: $q_t^j F'(\bar{\imath}_{t-}^j) = 1$.

- Crises time (systematic Poisson arrival): firms draws i.i.d. $u_t \sim G(\cdot)$, fraction of capital destroyed, and rebuild their capital via investment:

$$F(x_t^j) \quad s.t. \quad x_t^j \leq \chi q_t^j (1 - u_t)$$

- Financing constract: repayment of 1 is γ_t^j units of capital, worth $\gamma_t^j q_t^j$
  - Private funding $\gamma_t^j = 1/q_t^j$ capital units;

Model: Government Funding Support

- Invest $x_t^j k_{t-}^j$, get $F(x_t^j)k_{t-}^j$ new capital. Financial constraint:

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- Crises time (systematic Poisson arrival): firms draws i.i.d. $u_t \sim G(\cdot)$, fraction of capital destroyed, and rebuild their capital via investment:

$$F(x_t^j + g_t^j) \quad s.t. \quad x_t^j \leq \chi q_t^j (1 - u_t)$$

- Financing constract: repayment of 1 is γ_t^j units of capital, worth $\gamma_t^j q_t^j$
  - Private funding $\gamma_t^j = 1/q_t^j$ capital units; govt funding γ_t (non-discriminatory)
    Repay capital shares (equity), following models of unconventional monetary policy (Gertler, Kiyotaki, 2010; Gertler, Karadi, 2011; Gertler, Kiyotaki, Queralto, 2012; Araújo, Schommer, Woodford, 2015; Del Negro, Eggertsson, Ferrero, Kiyotaki, 2017)

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Equilibrium and Endogenous Capital Valuation

- Capital value evolution, $\frac{dq^j_t}{q^j_{t-}} = \mu^j_{q,t-}dt + \Delta^j_{q,t-}dN_t$, and the valuation equation:

$$r = \frac{A^j}{q^j_{t-}} + \mu^j_{q,t-} - \delta + \underbrace{\lambda_I \frac{\left(q^j_{t-}F(\bar{\iota}^j_{t-}) - \bar{\iota}^j_{t-}\right)}{q^j_{t-}}}_{\text{normal-time investment profit}} + \underbrace{\lambda \frac{\Pi^j_t}{q^j_{t-}}}_{\text{crisis-time investment profit}} - \underbrace{\lambda\left(\mathbb{E}[u]\cdots\right)}_{\text{destruction of capital}}$$

  - $\Pi^j_t = \mathbb{E}_u[\pi(u, q^j_t, \gamma_t)]$, where

$$\pi(u, q^j_t, \gamma_t) = \max_{\{x,\, g\}} q^j_t F\left(x + g\right) - x - q^j_t \gamma_t g$$

Equilibrium and Endogenous Capital Valuation

- Proposition – benchmark economy: constant q^j and $q^H > q^L$
- Proposition: (optimal) constant $\gamma \in [1/q^H, 1/q^L]$: constant q^j and $q^H > q^L$
- Proposition: optimal quality-dependent $\gamma(\omega_t)$: $q_t^j = q^j(\omega_t)$ solved via valuation ODE with endogenous jumps
- Source of inefficiency: the first-best government intervention is to perfectly discriminate firm quality, setting $\gamma^j = 1/q^j$. Thus, the inefficiency comes from too expensive financing to high-quality firms and too cheap financing to high-quality firms.

Crisis Dynamics and Cleansing Effects

- Capital quantity change in crisis under benchmark economy (no government intervention):

$$\Delta^j = \underbrace{\int_0^{\hat{u}^j} F(\bar{\iota}^j) dG(u)}_{\text{unconstrained}} + \underbrace{\int_{\hat{u}^j}^{\upsilon} F(\chi(1-u)q^j) dG(u)}_{\text{constrained}} - \underbrace{\mathbb{E}[u]}_{\text{avg capital destruction}}, \quad j \in \{H, L\}$$

- **Cleansing effects**: type-H firms invest more and decline less in a crisis:

$$\Delta^H > \Delta^L$$

Therefore, average capital quality improves in a crisis.

$$\Delta^\omega = \frac{\omega(1-\omega)}{\omega(1+\Delta^H) + (1-\omega)(1+\Delta^L)} (\Delta^H - \Delta^L) > 0$$

Two mechanisms:

- Unconstrained investment (diff in investment target): $F(\bar{\iota}^H) > F(\bar{\iota}^L)$
- Constrained investment (diff in collateral value): $F(\chi(1-u)q^H) > F(\chi(1-u)q^L)$

Government Interventions, $\gamma \in [1/q^H, 1/q^L]$

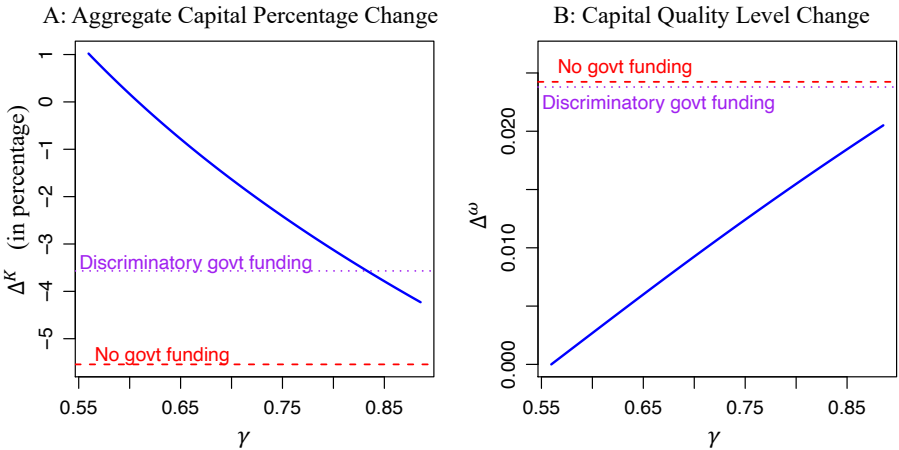
$$\Delta^H = \underbrace{\int_0^{\hat{u}^H} F(\bar{\iota}^H) dG(u)}_{\text{unconstrained}} + \underbrace{\int_{\hat{u}^H}^{\tilde{u}^H} F(\chi(1-u)q^H) dG(u)}_{\text{constrained}} + \underbrace{\int_{\tilde{u}^H}^{\upsilon} F(\chi(1-u)q^H + g^H) dG(u)}_{\text{constrained with govt financing}} - \mathbb{E}[u]$$

$$\Delta^L = \underbrace{\int_0^{\hat{u}^L} F(g^L) dG(u)}_{\text{unconstrained with govt financing}} + \underbrace{\int_{\hat{u}^L}^{\tilde{u}^L} F(g^L) dG(u)}_{\text{unconstrained with govt financing}} + \underbrace{\int_{\tilde{u}^L}^{\upsilon} F(g^L) dG(u)}_{\text{unconstrained with govt financing}} - \mathbb{E}[u]$$

- Proposition: given q^H and q^L, more lenient government intervention (lower γ) saves total capital quantity $w\Delta^H + (1-\omega)\Delta^L$, but dampens cleansing effect Δ^ω.

Quantity vs. Quality Effects of Government Funding in Crises

- Δ^K: change of capital quantity in a crisis.
- Δ^ω: change of capital quality in a crisis.



The Expectation Effect

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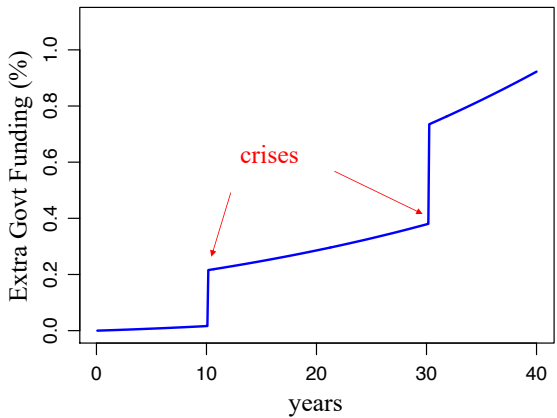
- More lenient government intervention (lower funding cost γ) $\Rightarrow$ higher q^H and q^L, but the gap $q^H - q^L$ shrinks.

Dynamic Distortions and the Slippery Slope of Intervention

1. Intervention $\rightarrow$ the economy exits the crisis with ω_t downward biased

$\rightarrow$ lower ω_{t-} $\rightarrow$ more intervention needed to contain the output drop to a target level.



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Alternative Setup with Credit Intervention and Firm Default

- Liquidity crises as in Holmstrom and Tirole (1998). More financing $\rightarrow$ higher survival probability.
  - If not enough funding, firms will get dissolved with no recovery value.
  - Firms can also strategically default and renegotiate with creditors, recouping β of capital value.
  - Private lenders set endogenous debt limit $\hat{d}_j$ to avoid expected losses.

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- To illustrate generality of the results, we assume:
  - Both types have the same private credit borrowing limit $\bar{d}$.
  - Government can rely on the private sector for pricing, e.g., corporate bond purchase.
  - There are new firm entry and type transition between H and L firms.

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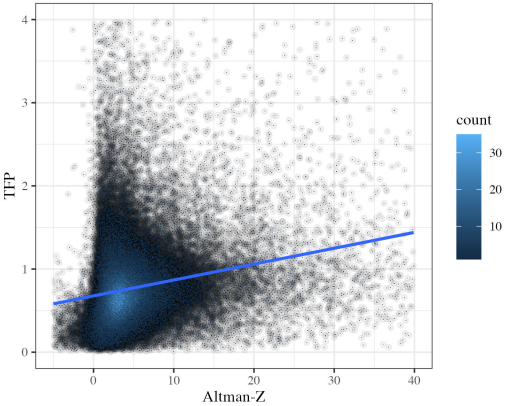
  - Government can rely on the private sector for pricing, e.g., corporate bond purchase.
  - There are new firm entry and type transition between H and L firms.
- Government intervention affects the credit market
  - For firms that are not severely hit (still honor debt): reduce interest rate.
  - For firms that are severely hit (default): augments the endogenous private-sector borrowing limit.

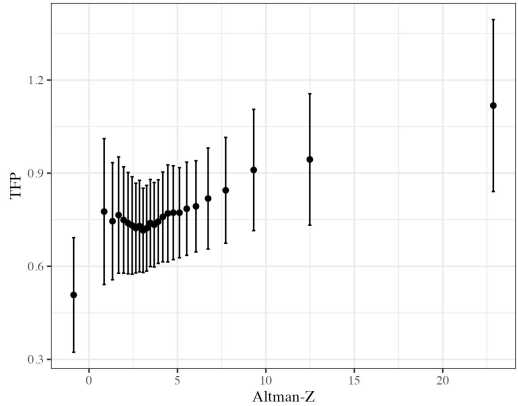
Main Results are the Same Despite Different Setup

- Sources of inefficiency:
  - Lending scale is $\bar{g}k$, proportional to firm size, but not quality.
  - Low-quality firm survival is improved by more, because high-quality firms borrow more from private sector and marginal survival improvement is lower per dollar financing.
  - However, high-quality firm survival is much more valuable.
- Main result 1: crises feature cleansing effects.
- Main result 2: government intervention dampens cleansing so there is a quality-quantity tradeoff.
- Main result 3: slippery slope of government intervention.

Can Government Observe Credit Quality and Infer Firm Quality?

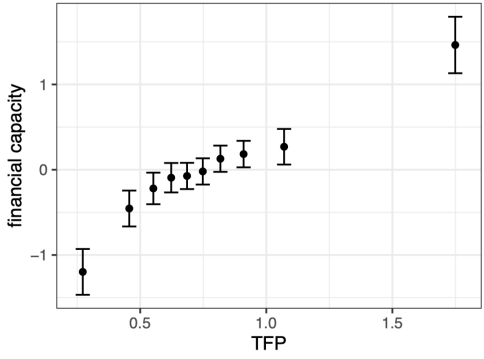
- In reality, credit quality (credit rating, proxied by a continuously Altman-Z score) is imperfectly correlated with firm quality (TFP).
- Government cannot credibly infer firm quality from credit rating.



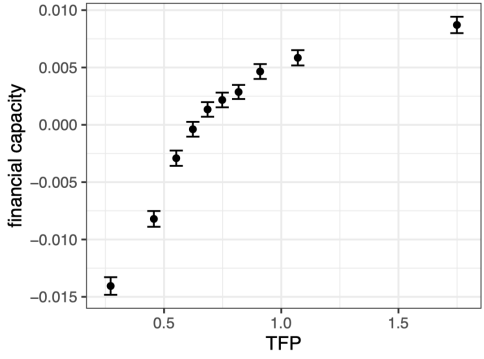


Do High-Quality Firms Have Higher Financing Capacity?

- We use financial constraint indexes, Kaplan and Zingales (1997) (KZ) and Whited and Wu (2006) (WW).
- Financial constraint = financial need (proxied by Q) − financial capacity



(a) −KZ index residualized by average Q



(b) −WW index residualized by average Q

Model Setup

- In a crisis, absent from moral hazard, firms maximize expected value,

$$x_t^j(\zeta) = \arg \max_{0 \le x \le \bar{d}+\bar{g}} F(x+\zeta) \left[q_t^j - (1 + r_t^j(\zeta, x))x \right] .$$

  where $F(\cdot)$ is the survival probability that depends on investment x and idiosyncratic draws of ζ.

- Endogenous interest rate from the break-even condition (competitive credit market),

$$F(x+\zeta)(1 + r_t^j(\zeta, x))x = x .$$

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$$F(x+\zeta)(1 + r_t^j(\zeta, x))x = x .$$

- Firms compare default value β with continuation value $q_t^j - (1 + r_t^j(\zeta, x))x$ for continuation decision. Cutoff strategy based on ζ, with cutoff $\underline{\zeta}_t^j$.

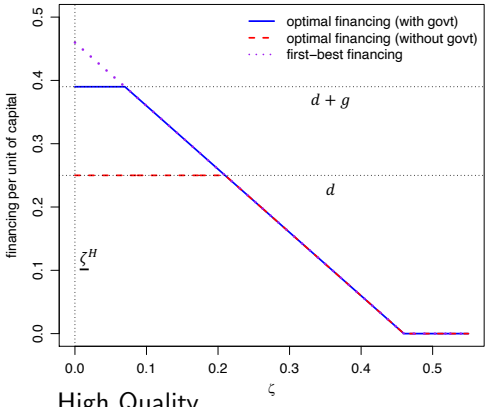
- For the default scenario, private investors specify an endogenous debt limit $\hat{d}_t^j(\zeta)$ to avoid losses,

$$\hat{d}_t^j(\zeta) = F(\hat{d}_t^j(\zeta) + \zeta + \bar{g})(q_t^j - \beta)$$

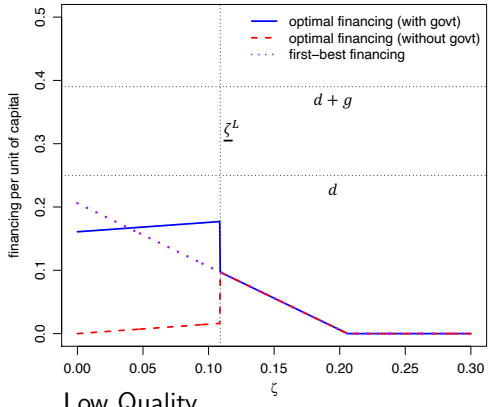
Model Solution and Sources of Inefficiency

- Total optimal financing of firm j is

$$x_t^j(\zeta) = \underbrace{\mathbf{1}_{\zeta \geq \underline{\zeta}_t^j} \min\{(\bar{\zeta}_t^j - \zeta)^+, \bar{d} + \bar{g}\}}_{\text{no default}} + \underbrace{\mathbf{1}_{\zeta < \underline{\zeta}_t^j} \left(\min\{\hat{d}_t^j(\zeta), \bar{d}\} + \bar{g}\right)}_{\text{default}}.$$



High Quality



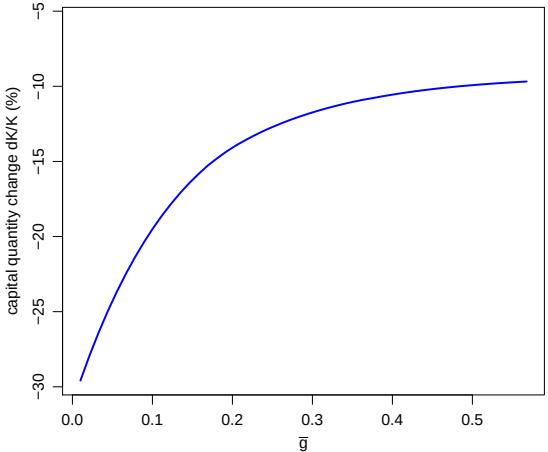
Low Quality

Model Calibration

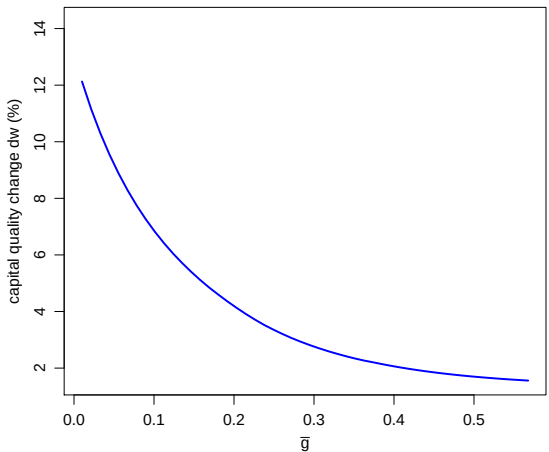
Parameter	Description	Value	Target
ϕ_0	Investment adjustment cost	10	avg investment/output ratio
λ_F	survival rate	3	avg GDP drop in crises
l_ζ	average value of ζ	0.16	increase of survival rate by govt intervention
λ	crisis frequency	0.06	crisis frequency in the data
β	moral hazard	0.7	average creditor recovery
δ	capital depreciation rate	0.2	depreciation plus exit rate
r	real discount rate	0.06	real bond return plus equity premium
A^H	productivity of H firms	0.6	average output to capital ratio
A^L	productivity of L firms	0.2	TFP inter-quartile ratio
η	entry rate of new firms	0.062	entry rate in the data
$\bar{d}$	private-sector debt capacity	0.25	total private-sector debt/GDP ratio
$\bar{g}$	government credit support	0.15	total govt+Fed support during COVID-19

Crises Cleansing Effects and the Quality-Quantity Tradeoff

- Quantity v.s. Quality tradeoff.



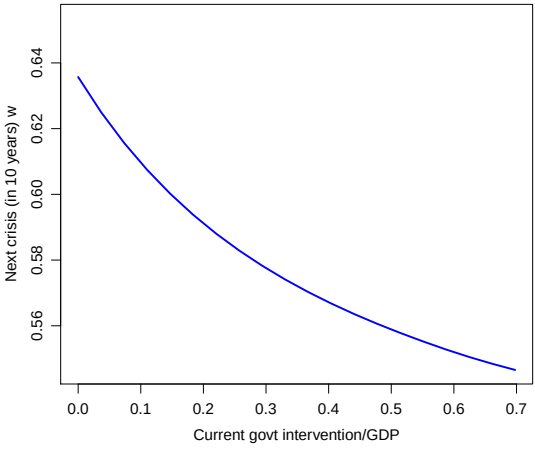
(e) capital quantity change $\Delta K_t/K_t$



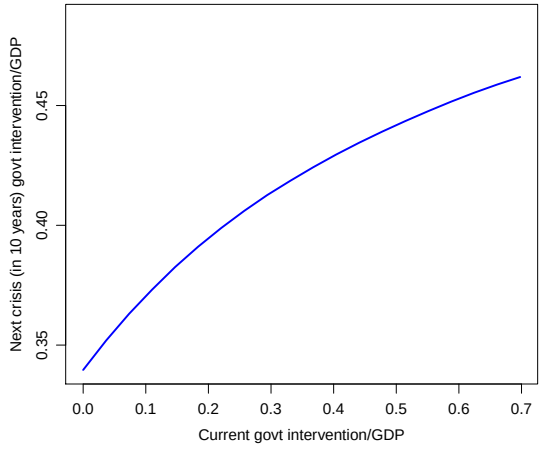
(f) capital quality change $\Delta\omega_t$

The Slippery Slope of Credit Interventions

- On average, every \$1 lending in the current crisis begets 16 cents extra in the next crisis, to achieve the same output drop.



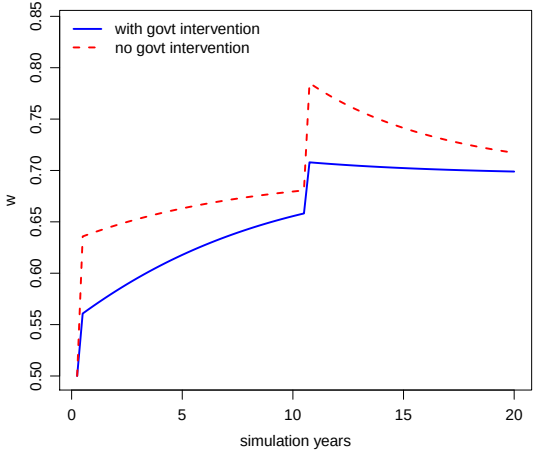
(g) Firm quality ω in the next crisis



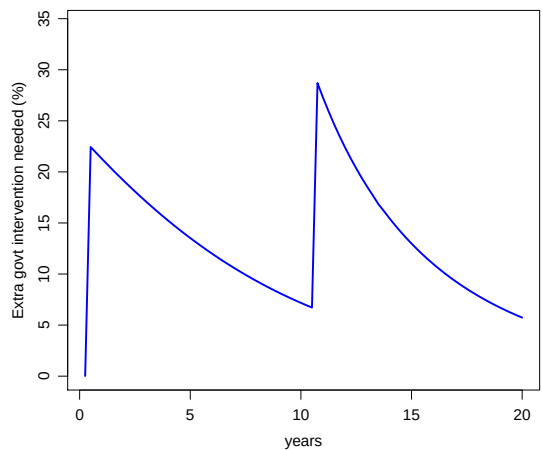
(h) Required intervention in the next crisis

The Slippery Slope of Credit Interventions

- Even with firm entry, the impact on quality is significant for next crisis.



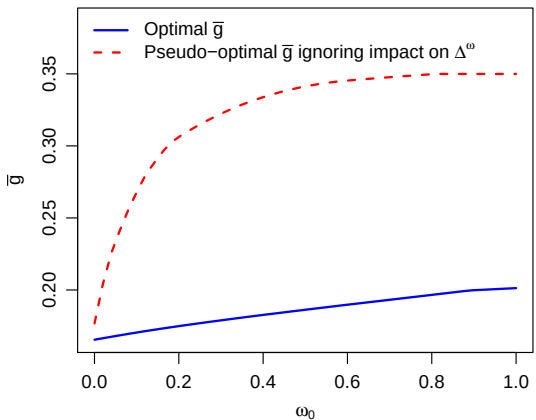
(a) Firm quality ω

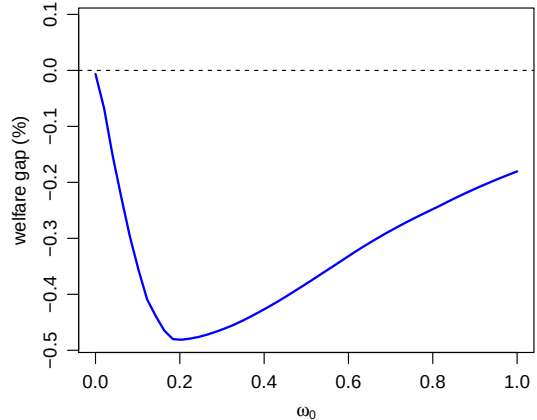


(b) Extra intervention needed

Welfare

- If the government ignores the impact of intervention on firm quality (assuming Δw_t not affected), then the "pseudo-optimal" policy is about 80% larger than the actual optimal policy, causing a welfare loss of about -0.3%.





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Conclusion

- Government as a financial intermediary in crises that **supplements funding capacity** but **lacks differentiation**.
- Tradeoff: quantity K vs. quality ω
- Intervention has a slippery slope (still welfare improving):
  - Interventions & expectation of interventions $\rightarrow \omega_{t-} \downarrow \rightarrow$ crisis: larger interventions ...
- This slippery slope calls for cautionary design of government programs, not "whatever it takes". Ignoring the effect causes policy 80% larger than optimal and welfare loss of 0.3%.


Wheee!
It's fun in
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