Dynamic debt restructuring and evergreening

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April 18, 2014

CIGS Seminar

The Canon Institute for Global Studies

Questions

Q1. Why excess debt stock has a negative and persistent effect on output?

Persistent effect of financial crises:

Reinhart and Reinhart (2010), Reinhart and Rogoff (2009)

- international evidence that financial crises are followed by decade-long slowdown in output growth.

Questions

Q2. Why the lenders often choose to evergreen the debt-ridden borrowers?

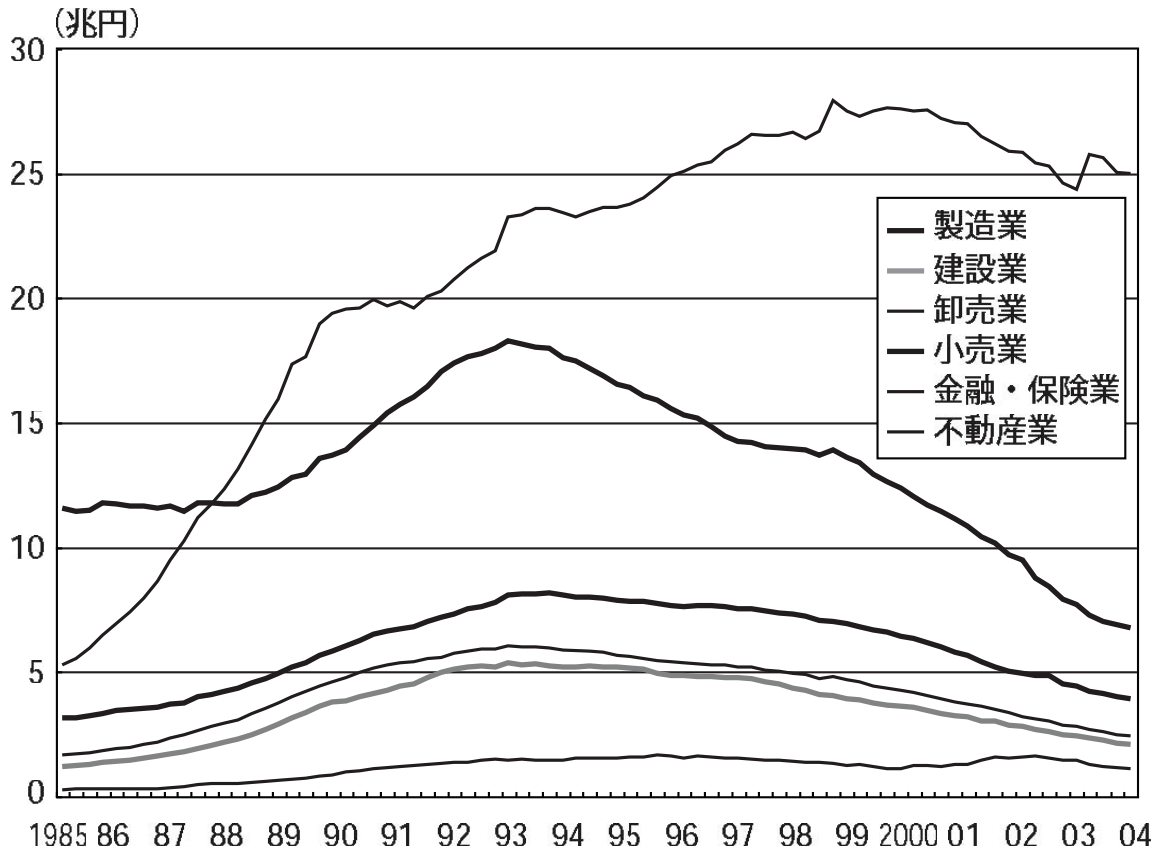


Figure: Amounts Outstanding of Loans for Fixed Investment by Sector

Source: Fukuda, Kasuya and Nakajima (2007)

Questions

Q3. Why the debt restructuring was slow in the 1990s and fast in the 2000s in Japan?

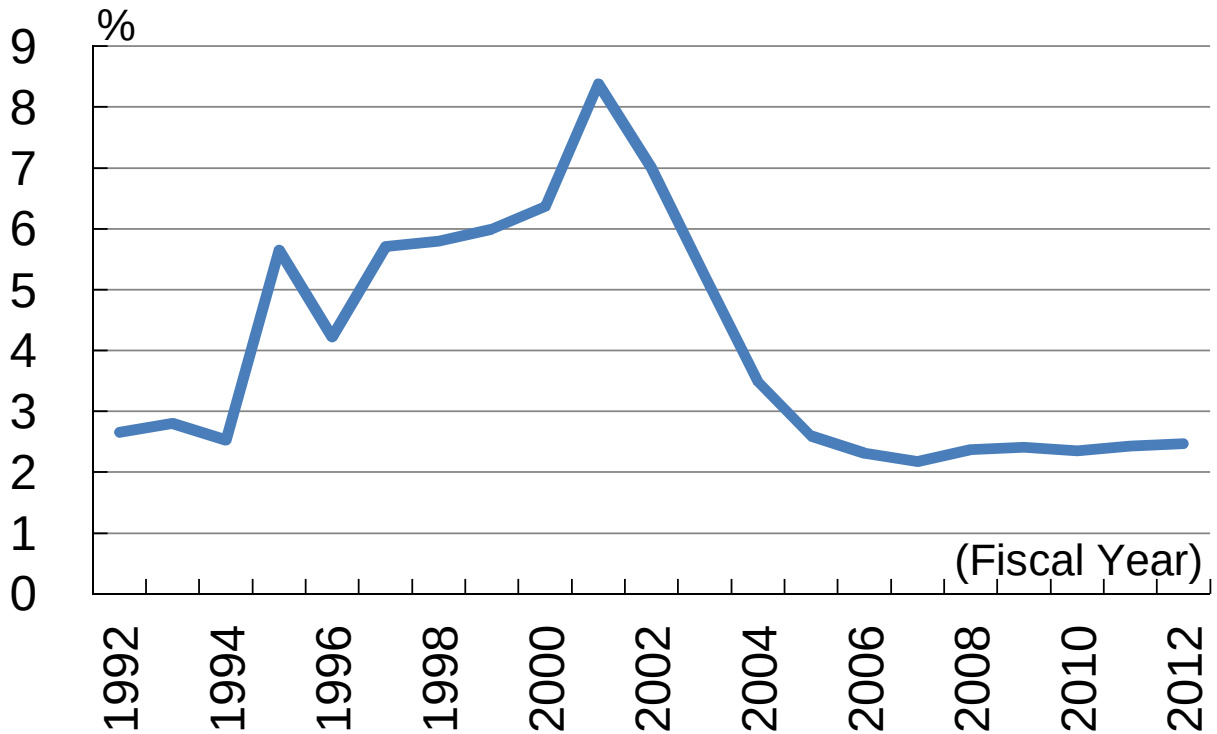


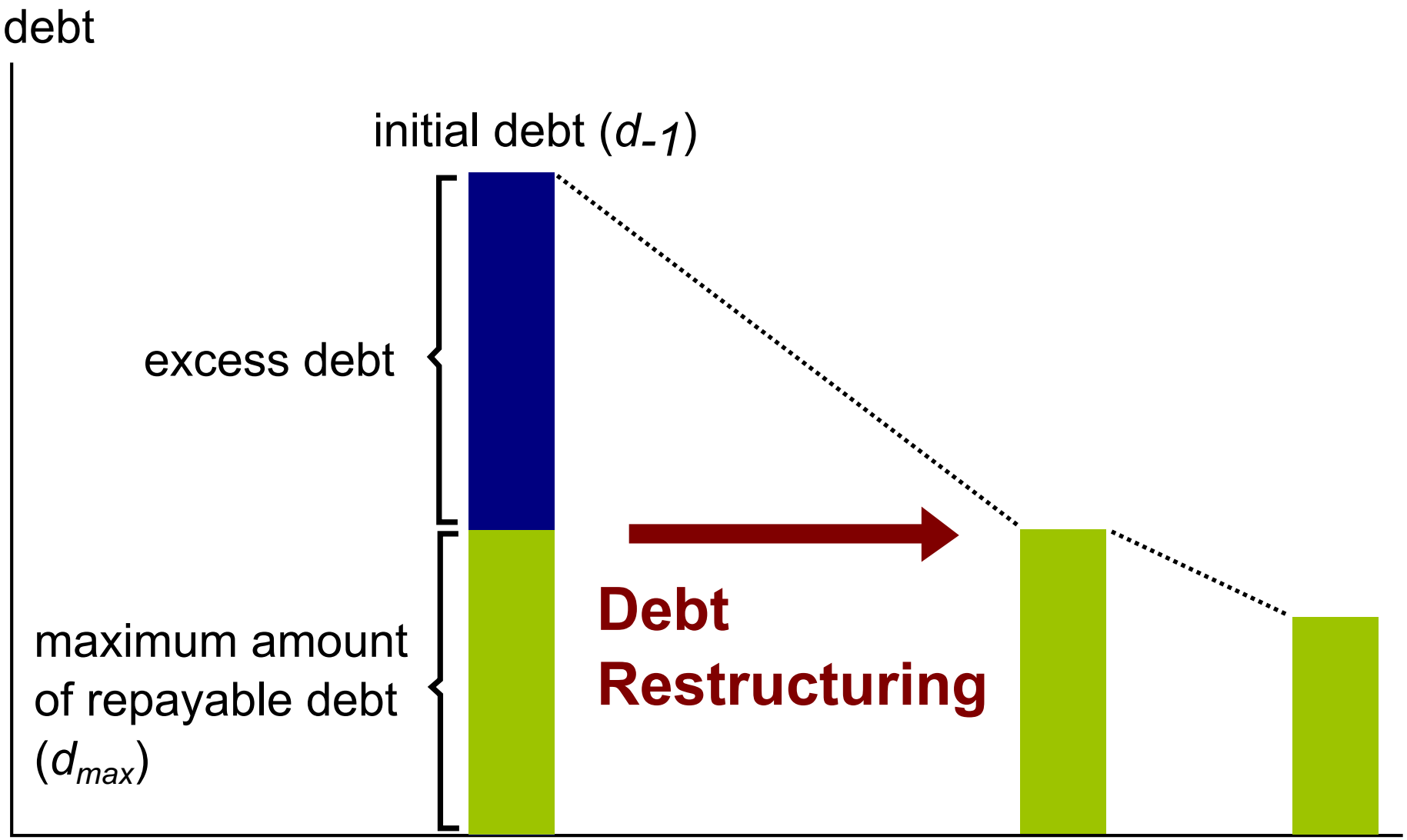
Figure: Outstanding Balance of Non-performing Loans (Ratio to Nominal GDP)

Sources: Financial Services Agency, The Japanese Government, “Status of Non-Performing Loans”; Cabinet Office, Government of Japan, “Annual Report on National Accounts”

Outline of our framework

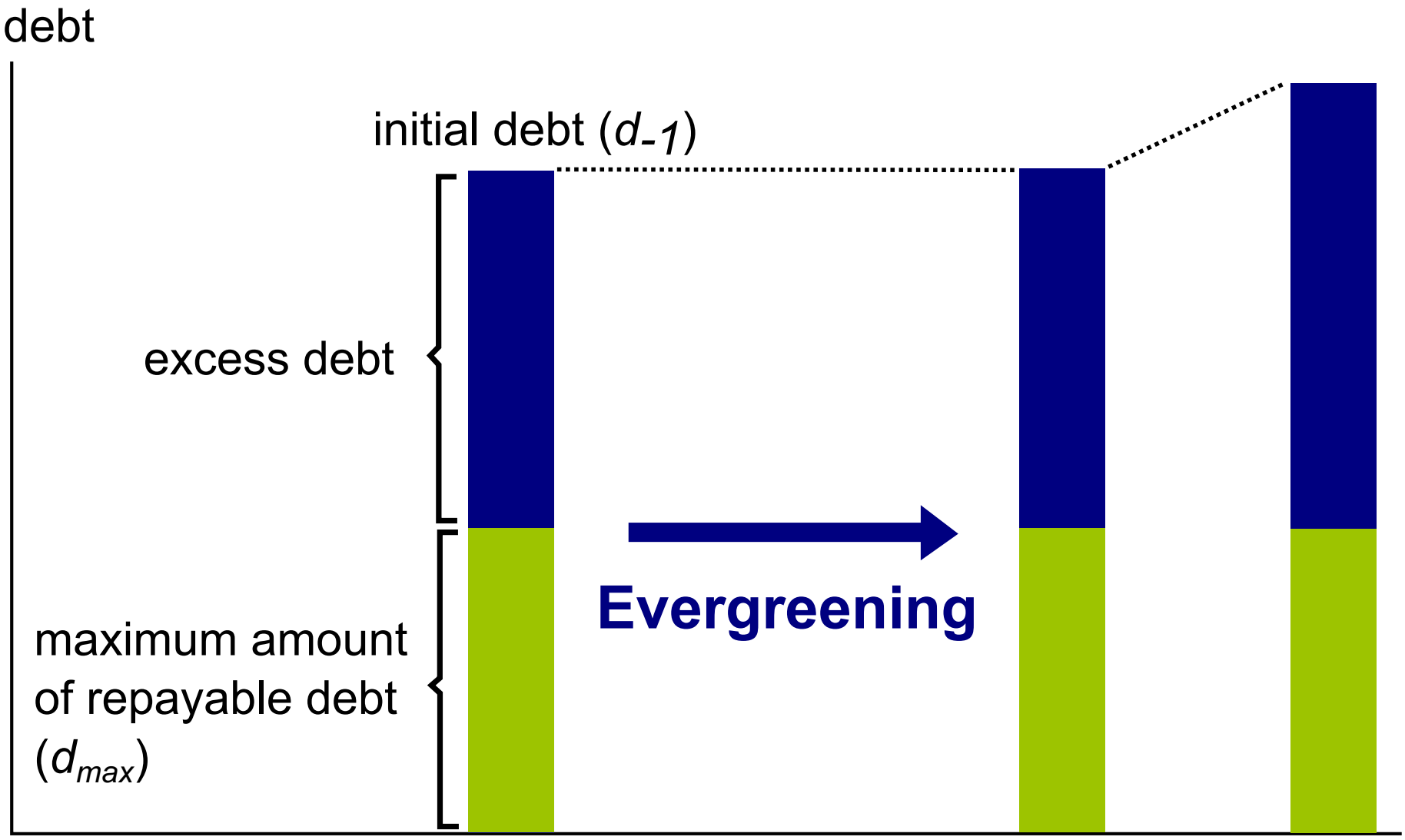
- Endogenous borrowing constraints
  - Constraints are on both short-term (working capital) loans and long-term loans.
  - The value of outside opportunity in defaulting on short-term loans is endogenous.
- Lender can choose either debt restructuring or evergreening for the debt-ridden borrower (firm).
  - There is the maximum amount, d_{max}, of repayable debt.
  - A debt-ridden firm owes the initial debt d_{-1}, where $d_{-1} > d_{max}$.
  - Debt restructuring: Lender forgives the excess debt, $d_{-1} - d_{max}$.
    - Lender commits to the repayment schedule (one-sided lack of commitment).
  - Evergreening: Lender does not forgive $d_{-1} - d_{max}$, and let debt grow.
    - Lender cannot commit to the repayment schedule (two-sided lack of commitment).

Debt Restructuring



Return

Evergreening



The Lender Problem: DR Surplus

other firms	Debt Restructuring Environment (DR Env.)	Evergreening Environment (E Env.)
DR	D^R_{max}	D^E_{max}
Evergreening	D^R_z	D^E_z

Surplus: $\Delta D^R \equiv D^R_{max} - D^R_z, \qquad \Delta D^E \equiv D^E_{max} - D^E_z$

Debt Restructuring and Evergreening

$\Delta D < Cost \longrightarrow$ Evergreening

$\Delta D > Cost \longrightarrow$ DR

DR Env.

$\Delta D^R < Cost \longrightarrow$ Evergreening

$\Delta D^R > Cost \longrightarrow$ DR

E Env.

$\Delta D^E < Cost \longrightarrow$ Evergreening

$\Delta D^E > Cost \longrightarrow$ DR

Summary

- Q1. Why debt stocks have a negative and persistent effect on output?
  - Endogenous borrowing constraints on short-term and long-term loans can generate negative and persistent real effects.
  - Evergreening is more inefficient than debt restructuring.
    - Output is smaller in evergreening than in debt restructuring.

Summary (cont'd)

- Q2. Why the lenders often choose to evergreen the debt-ridden borrowers?
  - The amount of debt to be recovered by debt restructuring may be smaller than the cost of debt restructuring.
  - Due to the general equilibrium effect, the economy can fall into a mixed-strategy equilibrium where both debt restructuring and evergreening coexist for some time periods.
- Q3. Why the debt restructuring was slow in the 1990s and fast in the 2000s in Japan?
  - Government intervention might have changed the parameter of the endogenous borrowing constraints.

Related literature

- Endogenous borrowing constraints are the key to understanding the persistence and amplification of financial crises.
  - Jermann and Quadrini (2012):
- Debt stock and Output:
  - Albuquerque and Hopenhayn (2004)
  - Cooley, Marimon, and Quadrini (2004); Jermann and Quadrini (2006, 2007).
- Low productivity of firms in the process of debt restructuring.
  - Caballero, Hoshi and Kashyap (2008):
    - A cause of the lost decade in Japan is too much lending to zombie firms.
    - But why do banks keep on lending to such firms?
  - Fukuda and Nakamura (2011):
    - A majority of the zombie firms substantially recovered during the 2000s.

1. Introduction
2. Partial equilibrium model
   - Financial contract
   - Examples with $\kappa = 0$ and $\kappa = 1$
   - Dynamics with $0 < \kappa < 1$
3. Debt restructuring and evergreening
4. General equilibrium model
   - Model setting
   - Equilibrium analysis
   - Interpretation of the Lost Decades
5. Conclusion

Set up

The firm's problem with debt stock d_t:

$$V(d_t) = \max \frac{1}{1+r_{t+1}} \left[A^\alpha l_{t+1}^\alpha - w_{t+1} l_{t+1} - b_{t+1} + V(d_{t+1}) \right],$$

$$s.t. \begin{cases} d_t = \frac{1}{1+r_{t+1}}(b_{t+1} + d_{t+1}), & \text{(law of motion)} \\ w_{t+1} l_{t+1} + b_{t+1} \leq \phi A^\alpha l_{t+1}^\alpha + (1-\kappa) V_{t+1}(d_{t+1}), & \text{(borrowing constraint)} \\ w_{t+1} l_{t+1} + b_{t+1} \leq A^\alpha l_{t+1}^\alpha & \text{(limited liability)} \end{cases}$$

- The firm owes d_t to the lender and needs to borrow working capital $w_t l_t$ for wage payment.
  - d_t: debt stock or debt overhang at the end of t.
  - (w_t, r_{t+1}): wage rate and inter-temporal interest rate.
  - $A^\alpha l_t^\alpha$: the firm's revenue in period t.
  - b_t = repayment in period t.

▸ Graph

Enforcement problem

- The firm owes intra-temporal debt, $w_t l_t + b_t$, which is due at t, and inter-temporal debt, d_t, which is due at $t+1$.

	Debt	Repayment
$t-1$	d_{t-1}	
t	$(1+r_t)d_{t-1}$	
	$(1+r_t)d_{t-1} + w_t l_t$	
		$w_t l_t + b_t$
	$d_t = (1+r_t)d_{t-1} - b_t$	
$t+1$	$(1+r_{t+1})d_t$	

Enforcement problem (cont'd)

- After the firm obtains the revenue, it may default on the repayment of $w_t l_t + b_t$.
  - Then the lender seizes a part of the revenue $\phi A^\alpha l_t^\alpha$.
  - Then with probability $1 - \kappa$, the firm is destroyed.
    - In this case, the firm obtains $(1-\phi)A^\alpha l_t^\alpha$ and the lender obtain $\phi A^\alpha l_t^\alpha$.
  - With probability κ, the firm can continue with remaining debt d_t.
    Then, conditional on survival, firm can default on d_t and walk away. But as we assume outside value is zero, it never defaults on d_t.
    - In this case, the firm obtains $(1-\phi)A^\alpha l_t^\alpha + V(d_t)$ and the lender obtain $\phi A^\alpha l_t^\alpha + d_t$.

Enforcement problem (cont'd)

- If the firm does not default, it obtains $A^\alpha l_t^\alpha - w_t l_t - b_t + V(d_t)$.
- If the firm defaults on $w_t l_t + b_t$, its expected payoff is $(1-\phi)A^\alpha l_t^\alpha + \kappa V(d_t)$.
- The borrowing constraint is derived from the no-default condition:

$$A^\alpha l_t^\alpha - w_t l_t - b_t + V(d_t) \geq (1-\phi)A^\alpha l_t^\alpha + \kappa V(d_t),$$

which can be rewritten as

$$w_t l_t + b_t \leq \phi A^\alpha l_t^\alpha + (1-\kappa)V(d_t).$$

Firm's problem with the enforcement constraint

- The firm's problem with debt stock d_t:

$$V(d_t) = \max \frac{1}{1+r_{t+1}} \left[A^\alpha l_{t+1}^\alpha - w_{t+1} l_{t+1} - b_{t+1} + V(d_{t+1}) \right]$$

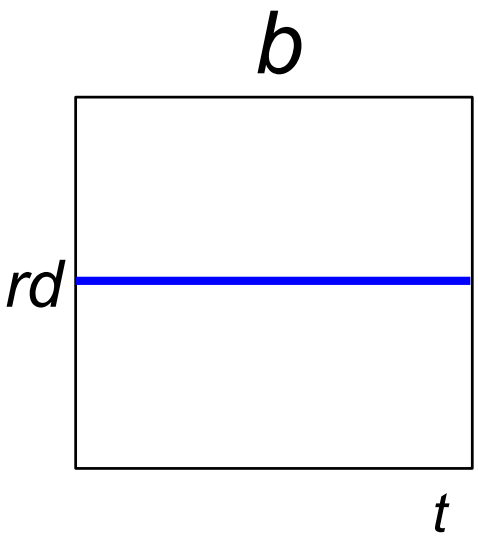
$$s.t. \begin{cases} d_t = \frac{1}{1+r_{t+1}}(b_{t+1} + d_{t+1}), & \text{(LOM)} \\ w_{t+1} l_{t+1} + b_{t+1} \leq \phi A^\alpha l_{t+1}^\alpha + (1-\kappa) V_{t+1}(d_{t+1}) & \text{(BC)} \\ w_{t+1} l_{t+1} + b_{t+1} \leq A^\alpha l_{t+1}^\alpha & \text{(LL)} \end{cases}$$

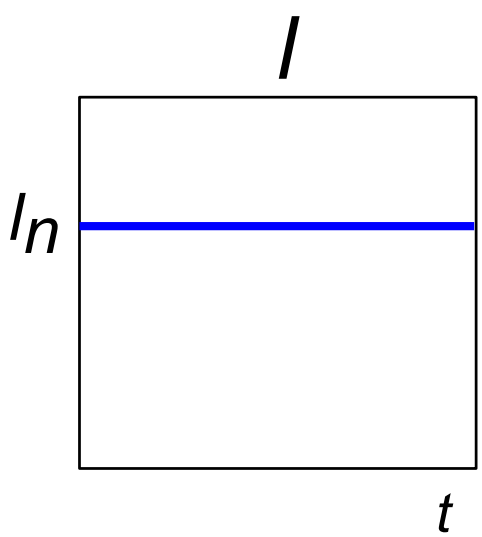
- The example with $\kappa = 1$:

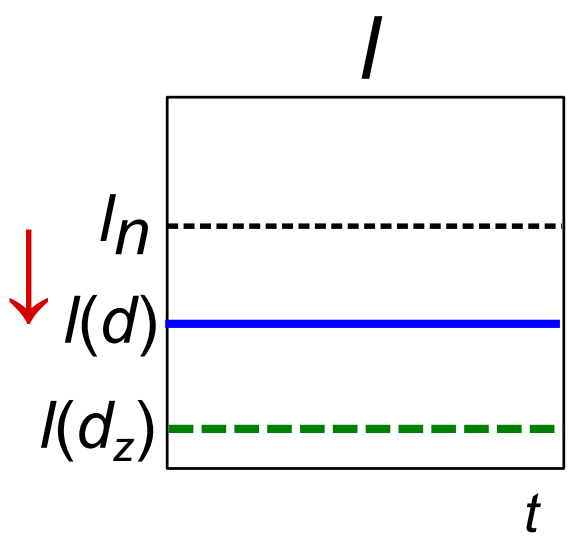
$$V(d_t) = \max \frac{1}{1+r_{t+1}} \left[A^\alpha l_{t+1}^\alpha - w_{t+1} l_{t+1} - b_{t+1} + V(d_{t+1}) \right]$$

$$s.t. \begin{cases} d_t = \frac{1}{1+r_{t+1}}(b_{t+1} + d_{t+1}), & \text{(LOM)} \\ w_{t+1} l_{t+1} + b_{t+1} \leq \phi A^\alpha l_{t+1}^\alpha & \text{(BC)} \\ w_{t+1} l_{t+1} + b_{t+1} \leq A^\alpha l_{t+1}^\alpha & \text{(LL)} \end{cases}$$

Example 1: When prices are time-invariant and $\kappa = 1$ (cont'd)







$d \leq \bar{d}$ $\qquad$ $\bar{d} \leq d \leq d_z$

▸ Appendix

Discussion: Debt stock has a negative effect permanently.

Stark contrast with Carlstrom and Fuerst (1997), and Bernanke, Gertler and Gilchrist (1999), in which financial frictions have little persistence.

Example 2: When prices are time-invariant and $\kappa = 0$

- Model with $\kappa = 0$ is equal to Albuquerque and Hopenhayn (2004): The value of outside opportunity is exogenous, i.e., $\bar{V} = 0$, because the firm can never survive when it defaults on the debt.

- Suppose that $(w_t, r_{t+1}) = (w, r), \quad \forall t$:

$$V(d) = \max_{l,b,d'} \frac{1}{1+r} \left[A^{\alpha} l^{\alpha} - wl - b + V(d') \right]$$

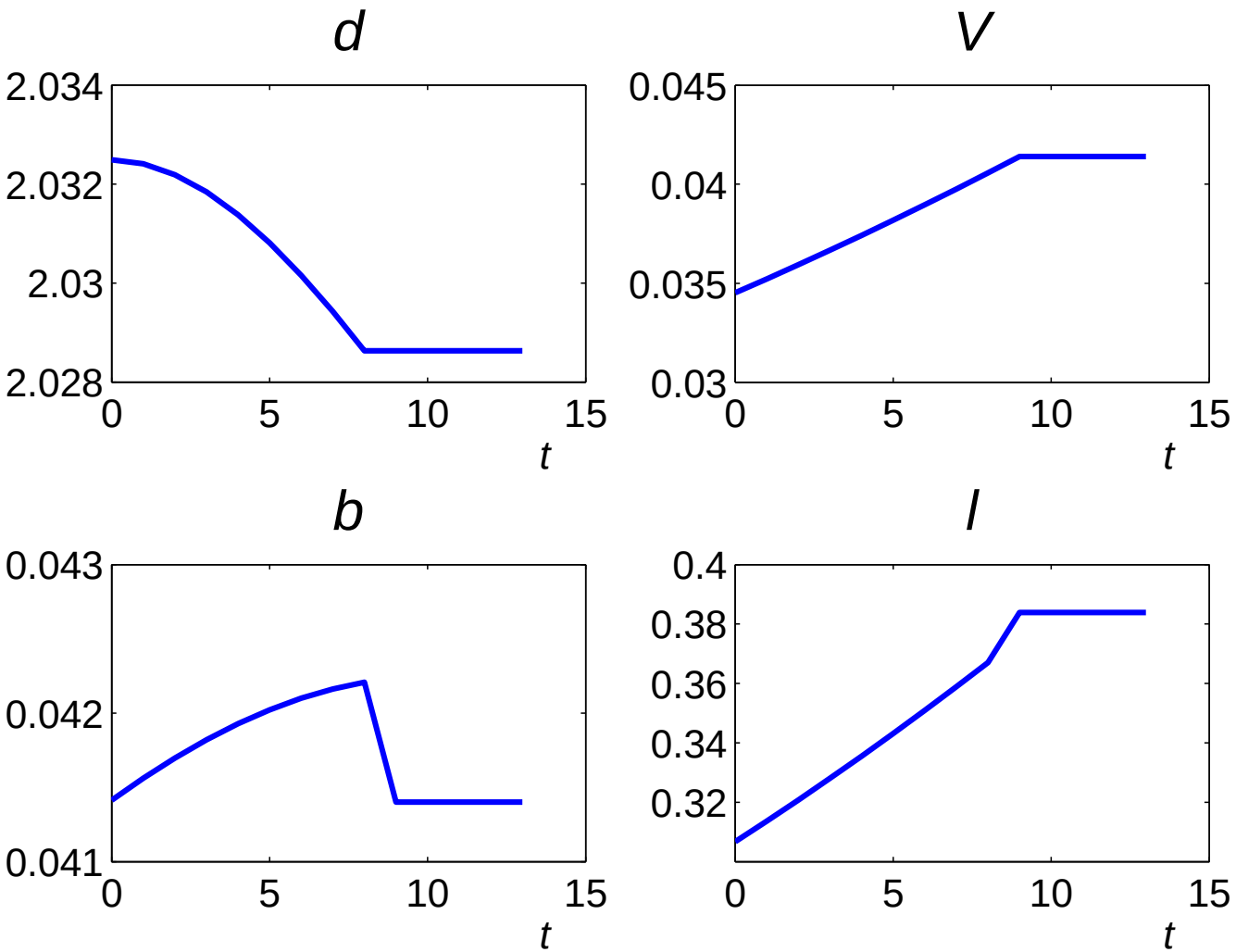
$$s.t. \begin{cases} d = \frac{1}{1+r}(b + d'), & \text{(LOM)} \\ wl + b \leq \phi A^{\alpha} l^{\alpha} + V(d'), & \text{(BC)} \\ wl + b \leq A^{\alpha} l^{\alpha} & \text{(LL)} \end{cases}$$

Numerical experiment: Parameters

- $\alpha = 0.9$: Labor share (Production function)
- $\beta = 0.98$: Discount rate (Utility function)
- $\kappa = 0$: Survival probability
- $\phi = 0.9$: Collateral ratio
- $A = 1$: Productivity

Example 2: When prices are time-invariant and $\kappa = 0$ (cont'd)

Q1. Why debt stocks have a negative and persistent effect on output?



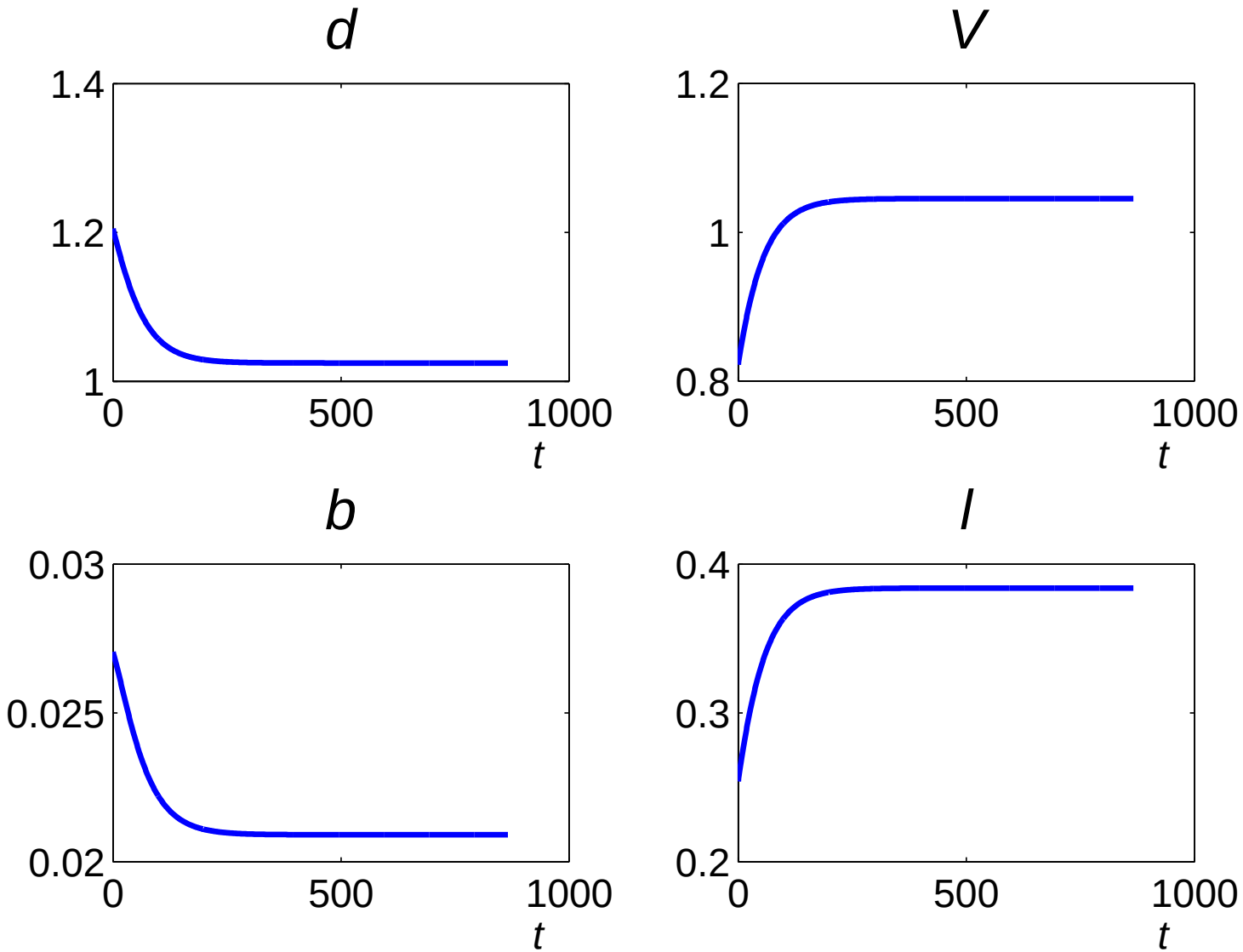
Example 2: When prices are time-invariant and $\kappa = 0$ (cont'd)

Discussion

- When $\kappa = 0$, the economy with large initial debt eventually goes to the efficient equilibrium where $l_t = l_n = \arg\max A^{\alpha} l^{\alpha} - wl$ within finite time.
- This model with $\kappa = 0$ is identical to Albuquerque and Hopenhayn (2004).
- Common feature of our model and Albuquerque and Hopenhayn:
  - Continuation value ($V(d_t)$) affects the borrowing limit.

▸ Appendix

Dynamics of the economy with $0 < \kappa < 1$: $\kappa = 0.98$



Discussion – the value of κ and persistence of debt

- When $\kappa < 1$, the economy with large initial debt eventually goes to the efficient equilibrium where $l_t = l_n = \arg\max A^{\alpha} l^{\alpha} - wl$.
- When $\kappa = 1$, a large initial debt has a negative effect permanently.
- $1 - \kappa$ represents the degree of intervention by outsiders, such as
  - government intervention in the bankruptcy process,
  - creditors' runs on the borrower' assets.

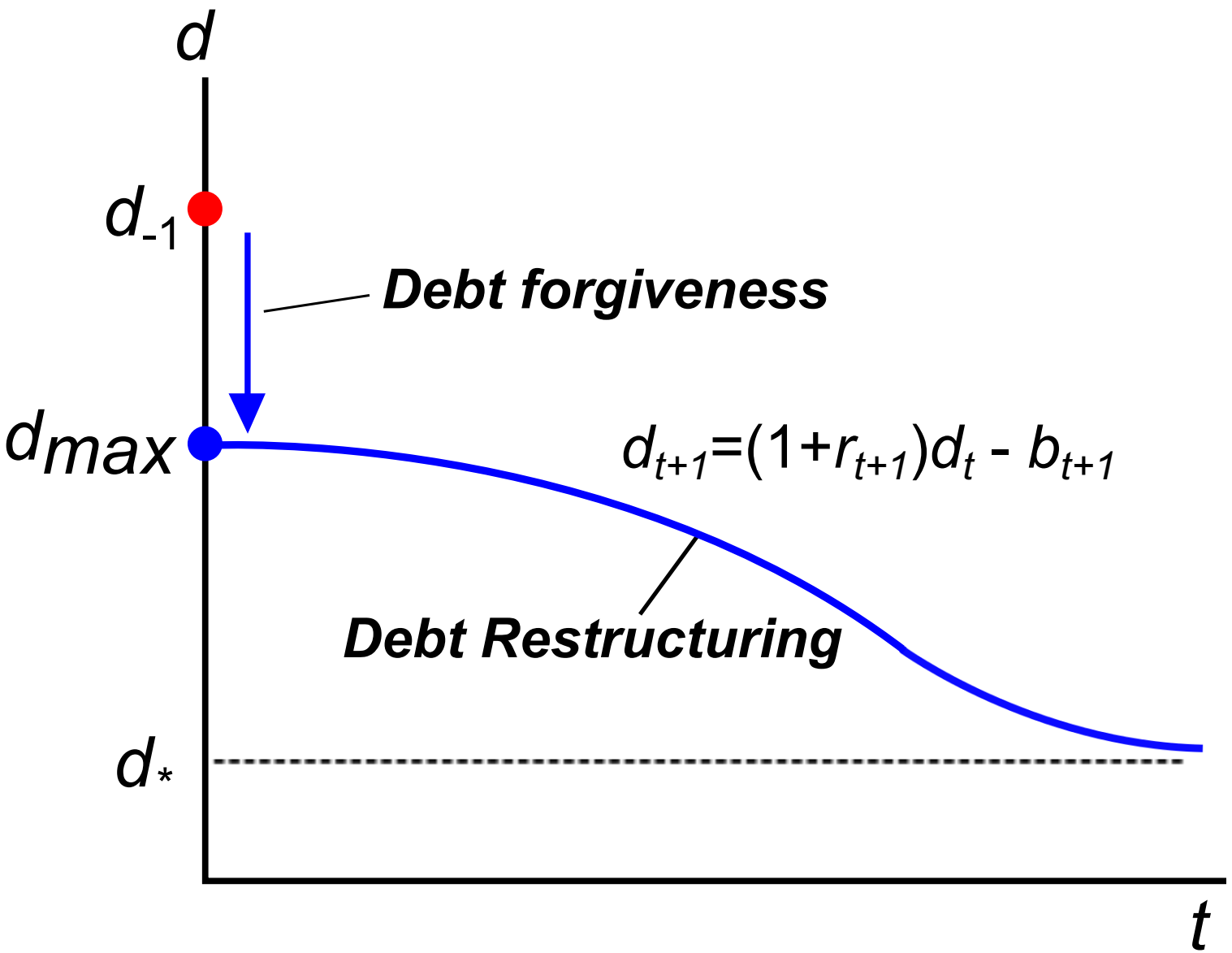
Debt restructuring and evergreening

- Suppose that the initial debt stock, d_{-1}, is larger than d_{max}. Then there are two options for the lenders.
  - Debt restructuring (debt forgiveness): Lender forgives $d_{-1} - d_{max}$.
    - The lender can commit to the repayment schedule $\{b_t^m\}_{t=0}^{\infty}$, where

$$d_{max} = \sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^{t}(1+r_s)} b_t^m,$$

      and $\{b_t^m\}_{t=0}^{\infty}$ satisfies the firm's problem.
    - Debt restructuring = One-sided lack of commitment.
  - Evergreening: The lender does not forgive $d_{-1} - d_{max}$.
    - The lender cannot commit to d_{max} as long as she does not forgive the excess debt.
    - Evergreening = Two-sided lack of commitment.

Debt restructuring



Evergreening

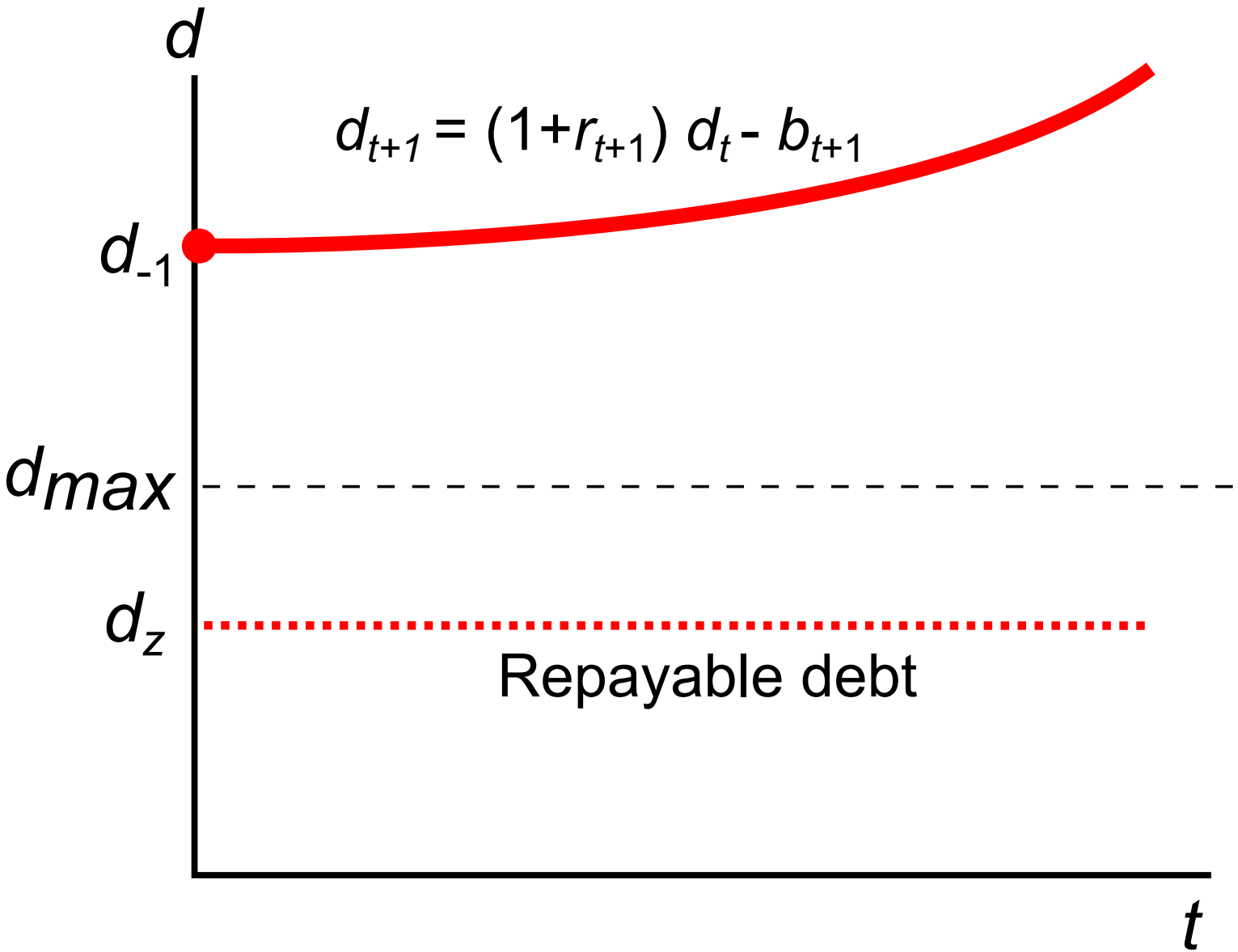
- In evergreening, both the lender and the firm are unable to commit to the repayment path (two-sided lack of commitment).
- The equilibrium is the Markov equilibrium, in which the lender maximizes the repayment b_{zt} period by period:
  Given V_{zt}, the lender solves

$$\begin{aligned} & \max_{l_{zt}} b_{zt} \\ s.t. \quad & w_t l_{zt} + b_{zt} \leq \phi A^{\alpha} l_{zt}^{\alpha} + (1-\kappa) V_{zt} \end{aligned}$$

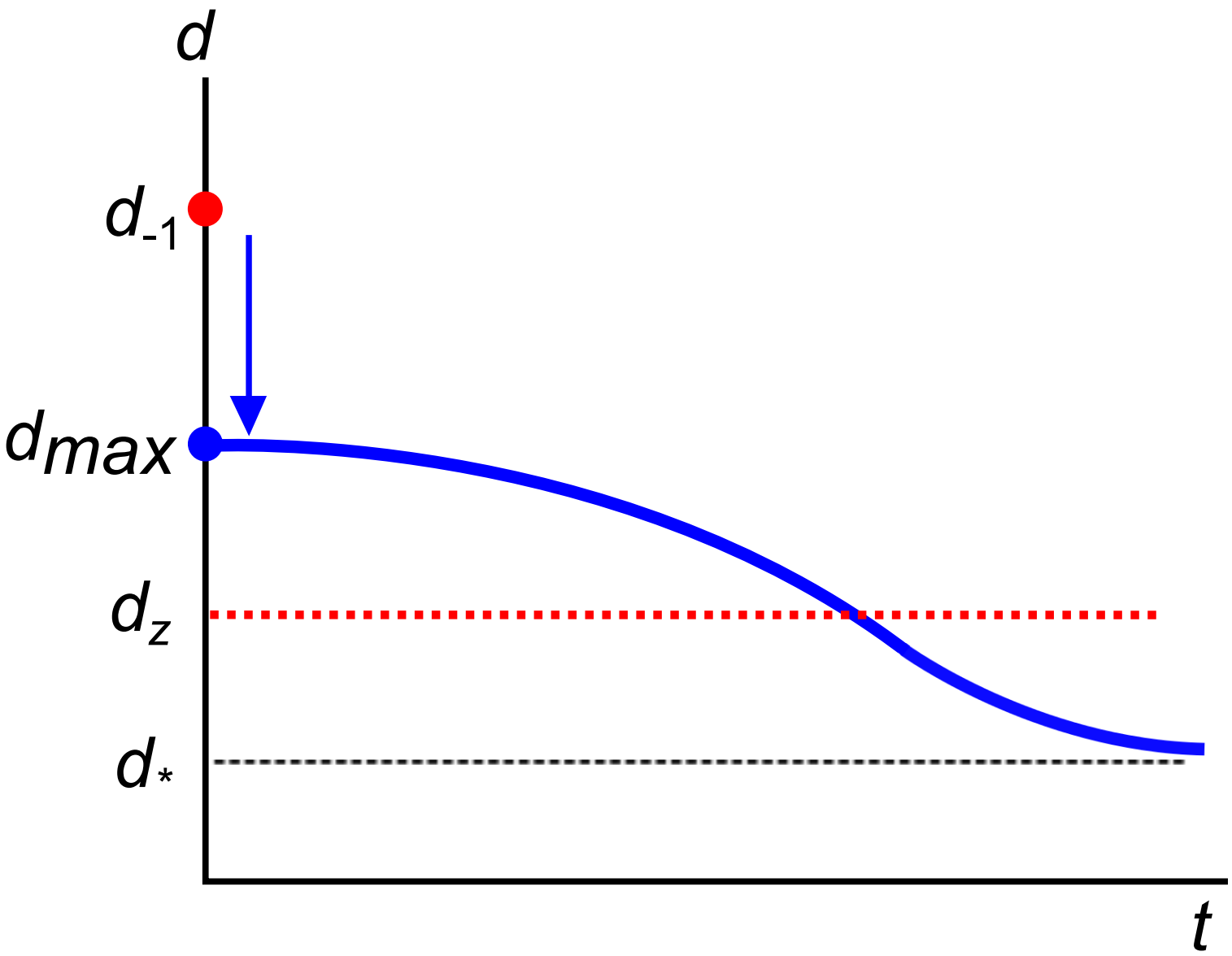
  where

$$V_{zt} = \frac{1}{1+r_{t+1}} \left[A^{\alpha} l_{zt+1}^{\alpha} - w_{t+1} l_{zt+1} - b_{zt+1} + V_{zt+1} \right].$$

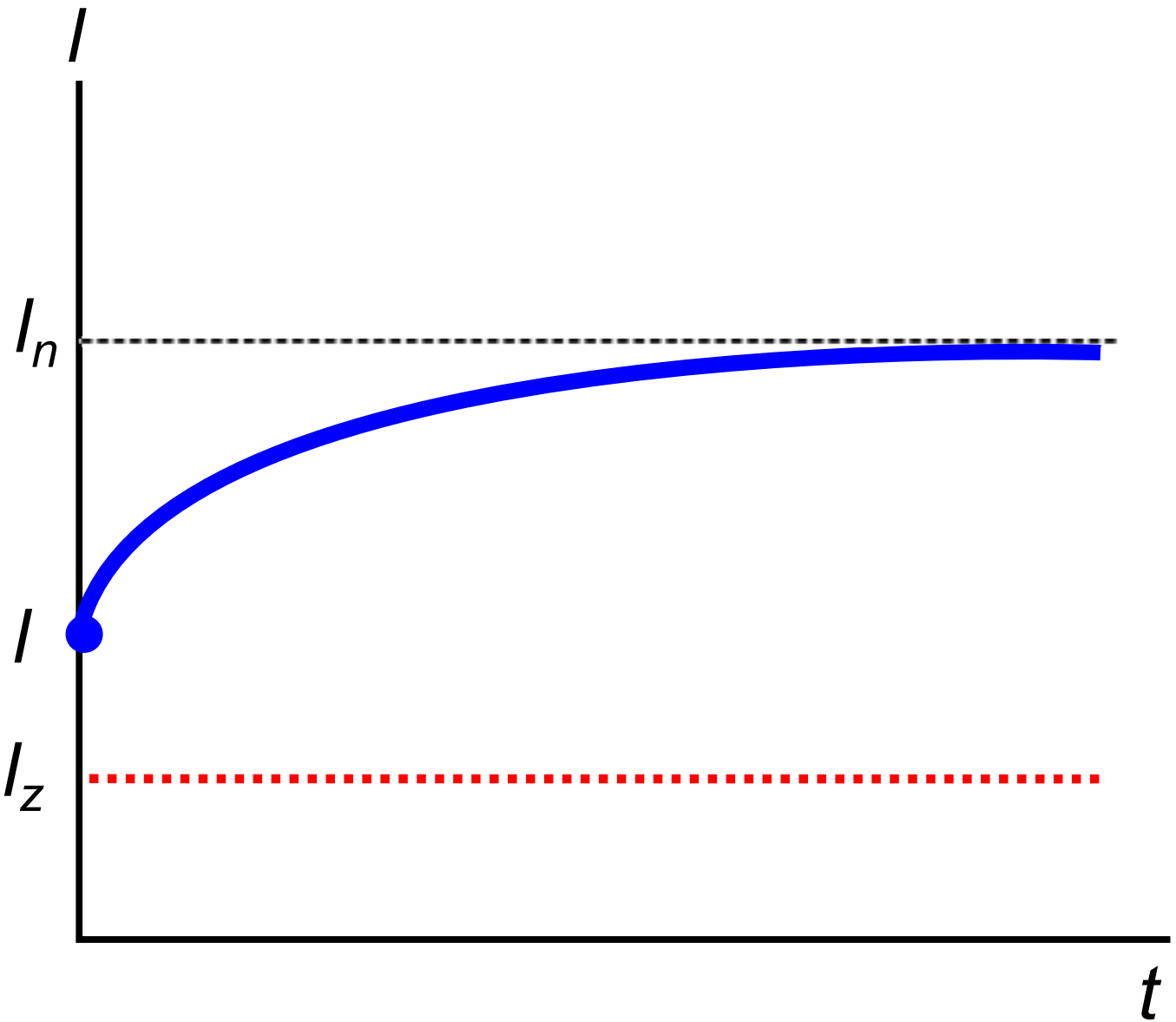
Evergreening (cont'd)



Debt restructuring and evergreening



Debt restructuring and evergreening (cont'd)



Model setting

Economic agents

- Representative household
  - provides labor,
  - owns firms,
  - lends funds to the firms that belong to other households.
- Firms: a continuum with unit measure
  - produce intermediate goods with monopolistic competition,
  - may owe debt stock d_t and borrow working capital $w_t l_t$ for wage payment from other households
- (Competitive final goods producers)

Initial condition

- We assume that the initial debt stocks are exogenously given to firms.

- Debt-ridden firms with measure Z owe a large initial debt stock, $d_{-1} > d_{max}$.

- Normal firms with measure $1 - Z$ owe zero, $d_{-1} = 0$.

▸ Appendix

Gains of debt restructuring

Repayable debt with debt: D, where $D_t \equiv b_t + d_t$.

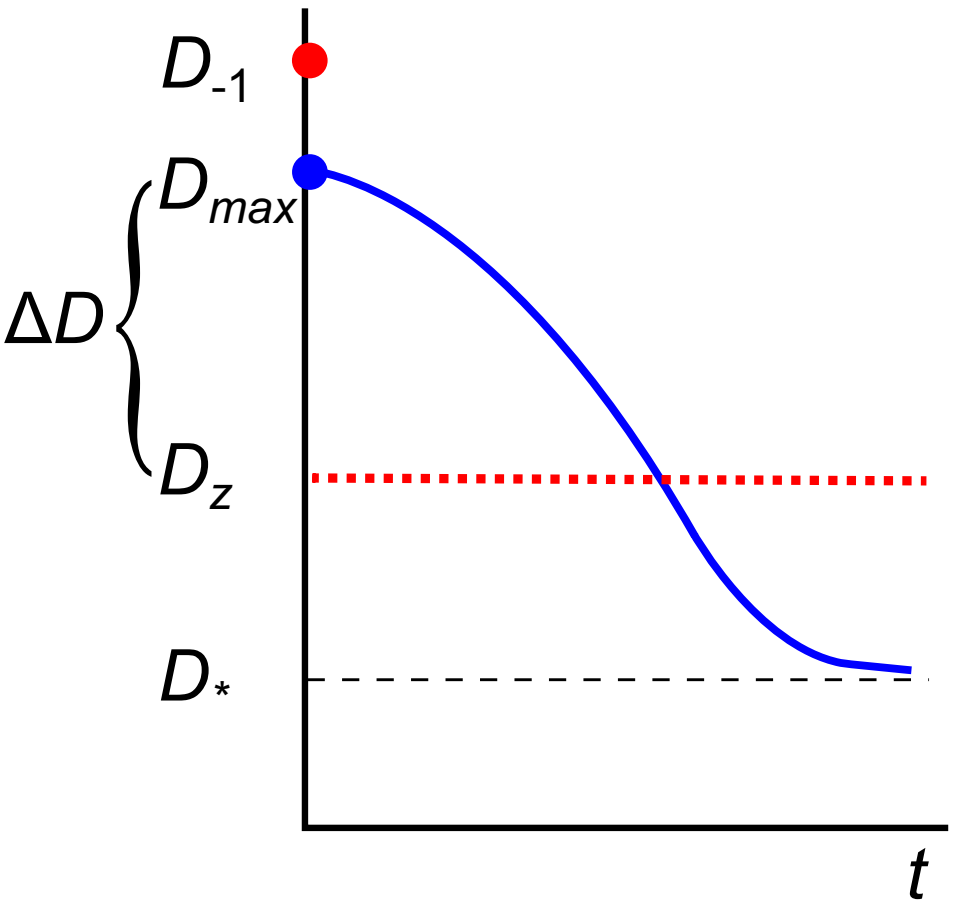
Value of the firm: W, where $W_t \equiv A^{\alpha} l_t^{\alpha} - w_t l_t - b_t + V_t$.

other firms	DR Env.	E Env.
DR	$(D^R_{max},\ W^R)$	$(D^E_{max},\ W^E)$
Evergreening	$(D^R_z,\ W^R_z)$	$(D^E_z,\ W^E_z)$

Lender Surplus: $\Delta D^R = D^R_{max} - D^R_z$, $\Delta D^E = D^E_{max} - D^E_z$

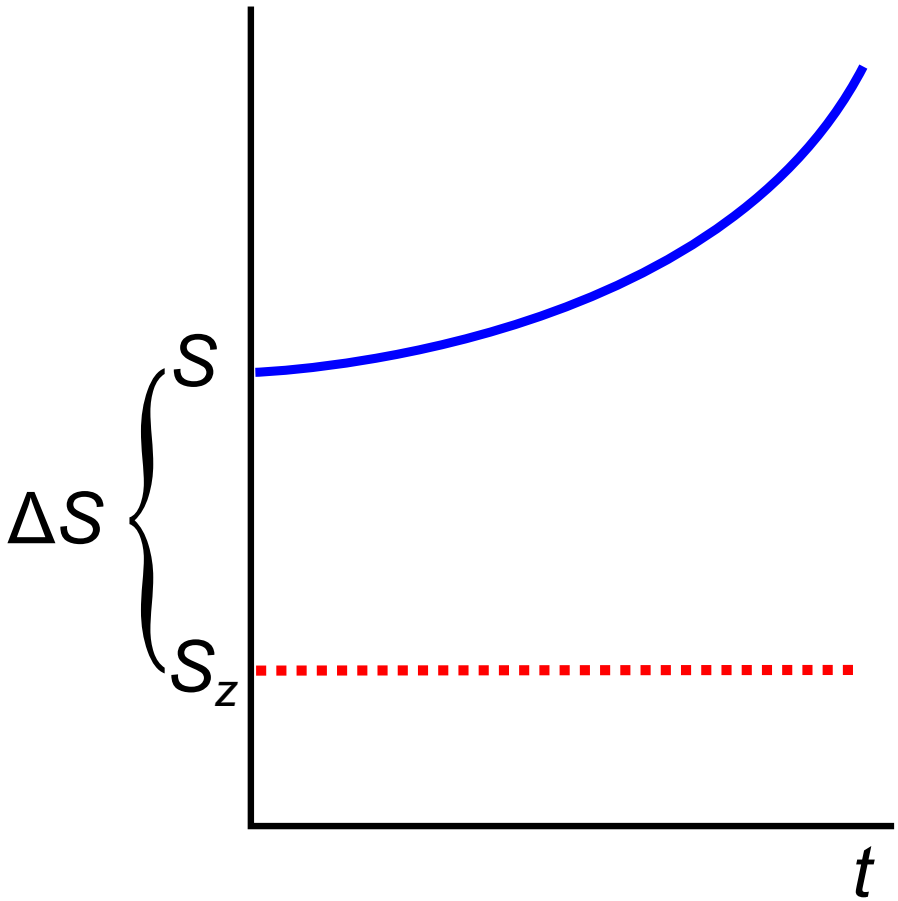
Social Surplus: $\Delta S^R = \Delta D^R + W^R - W^R_z$, $\Delta S^E = \Delta D^E + W^E - W^E_z$

Gains of debt restructuring (cont'd)



Gain for the lender:

$$\Delta D = D_{max} - D_z$$



Gain of social welfare:

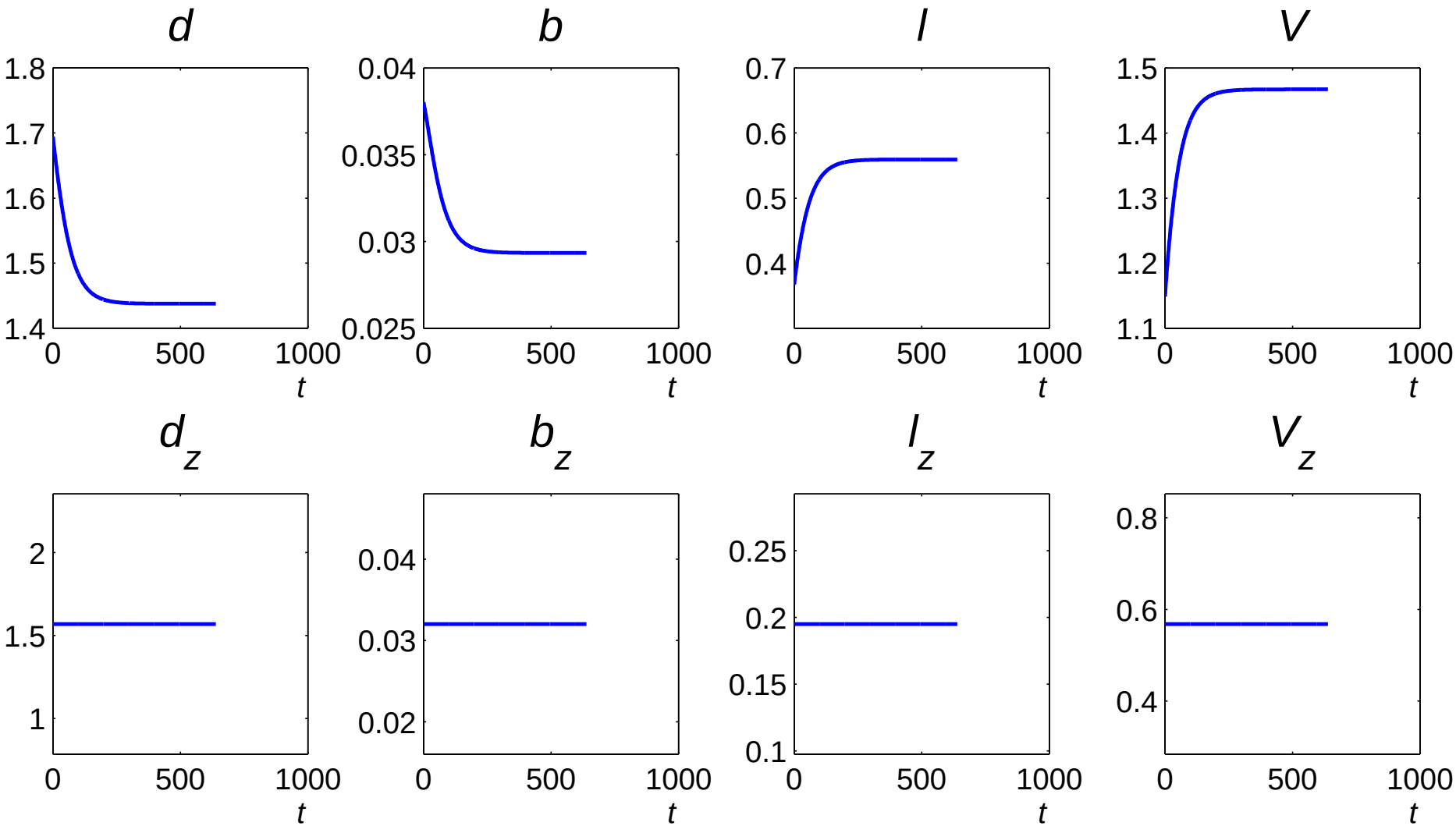
$$\Delta S = D_{max} + W - D_z - W_z$$

Numerical experiment: Parameters

- $\alpha = 0.9$: Labor share (Production function)
- $\beta = 0.98$: Discount rate (Utility function)
- $\kappa = 0.98$ or 0.97 : Survival probability
- $\phi = 0.9$: Collateral ratio
- $A = 1$: Productivity
- $\omega = 0.15$: Debt restructuring cost
- $\gamma = 1.3$: Preference

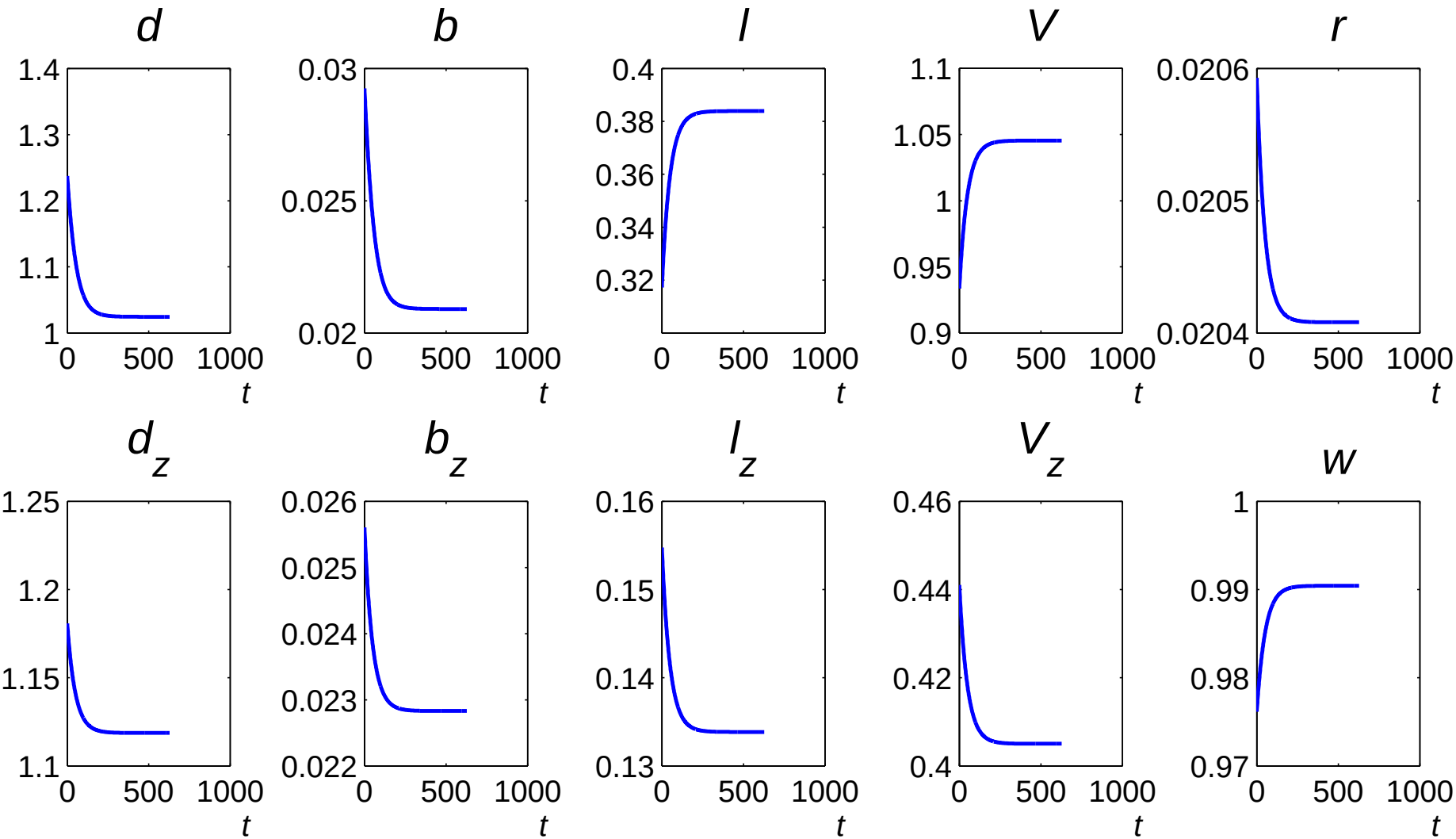
Numerical experiment: Evergreening environment

$$\alpha = 0.9, \quad \phi = 0.9, \quad \kappa = 0.98, \quad Z = 0.5$$

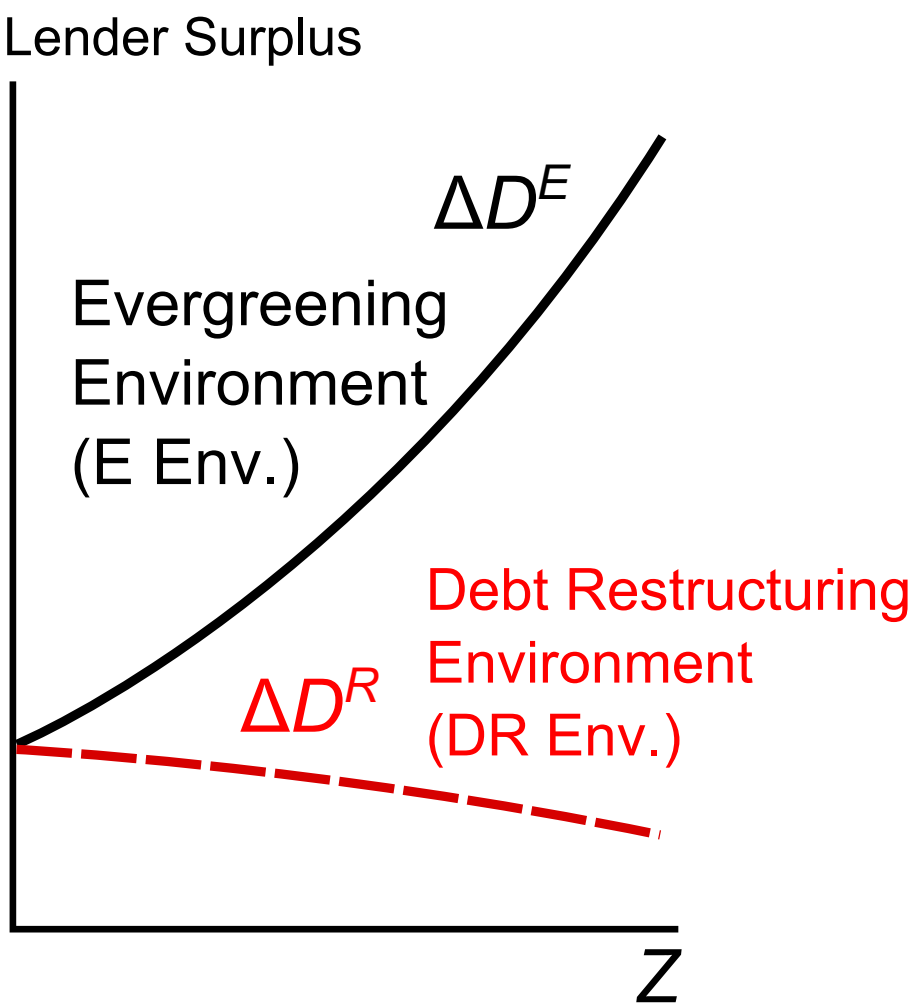


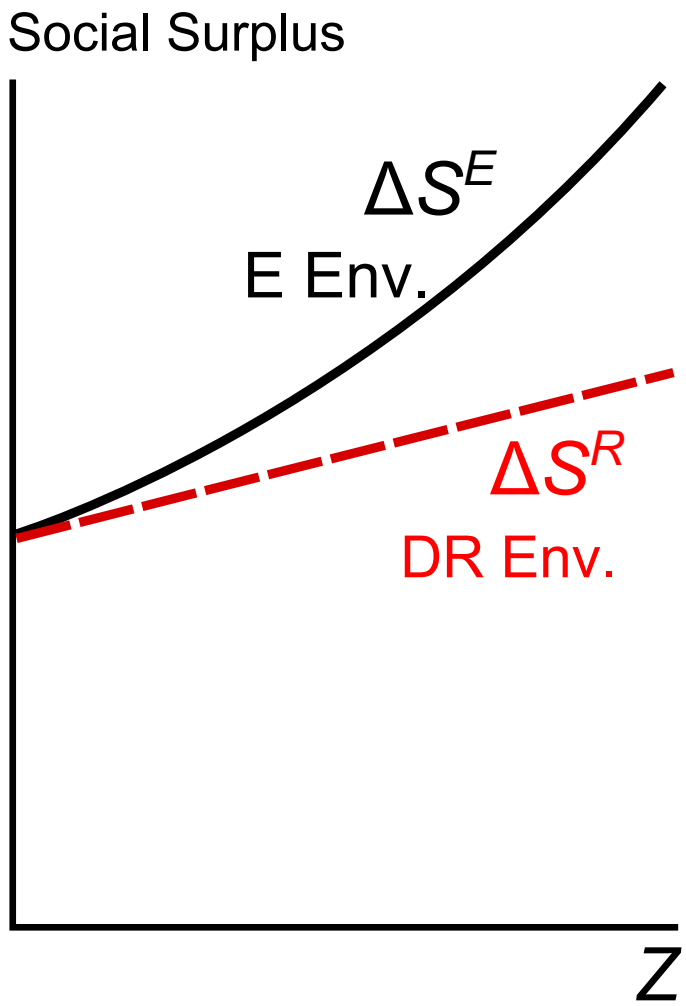
Numerical experiment: Debt restructuring environment

$$\alpha = 0.9, \quad \phi = 0.9, \quad \kappa = 0.98, \quad Z = 0.5$$

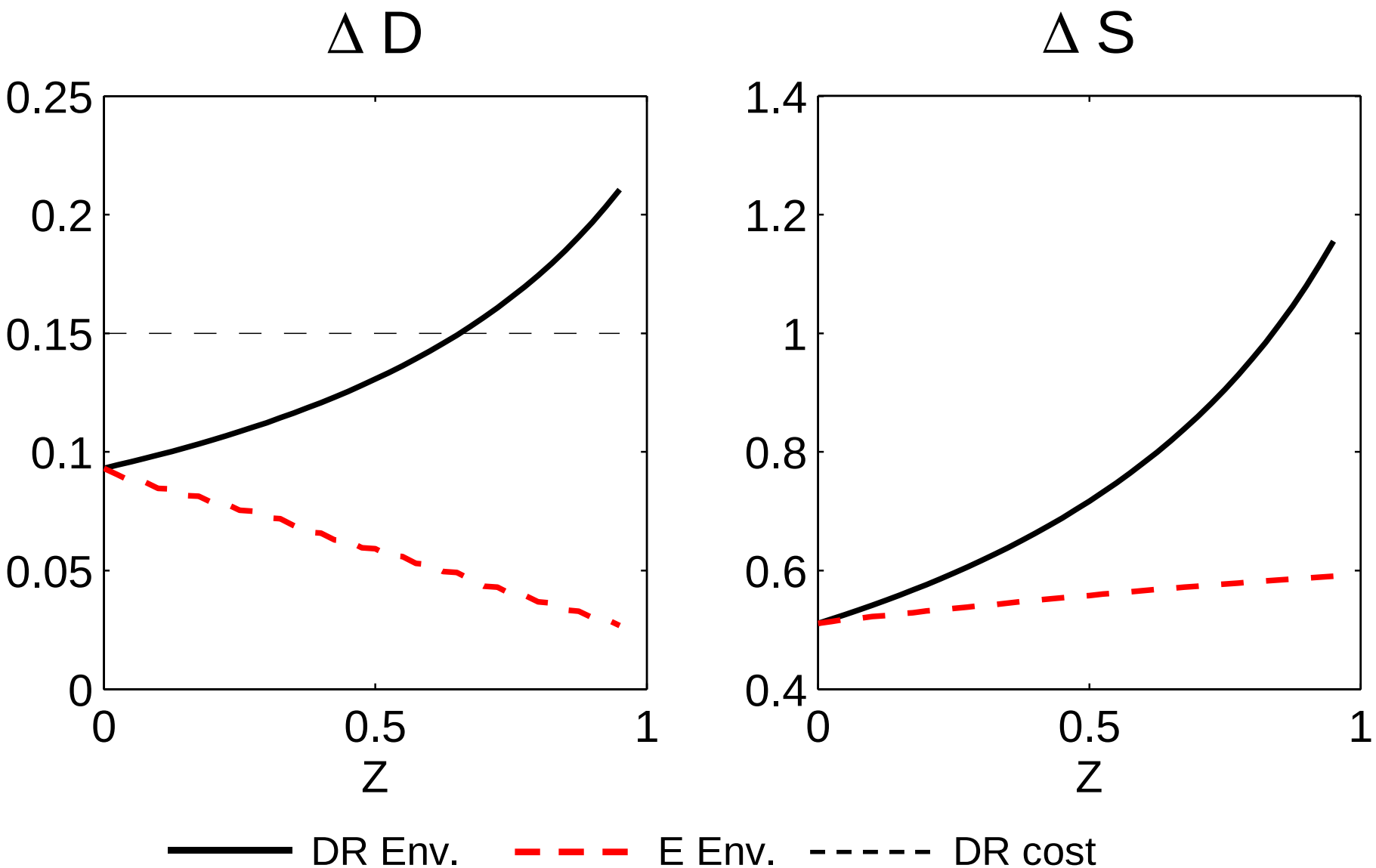


General equilibrium effect



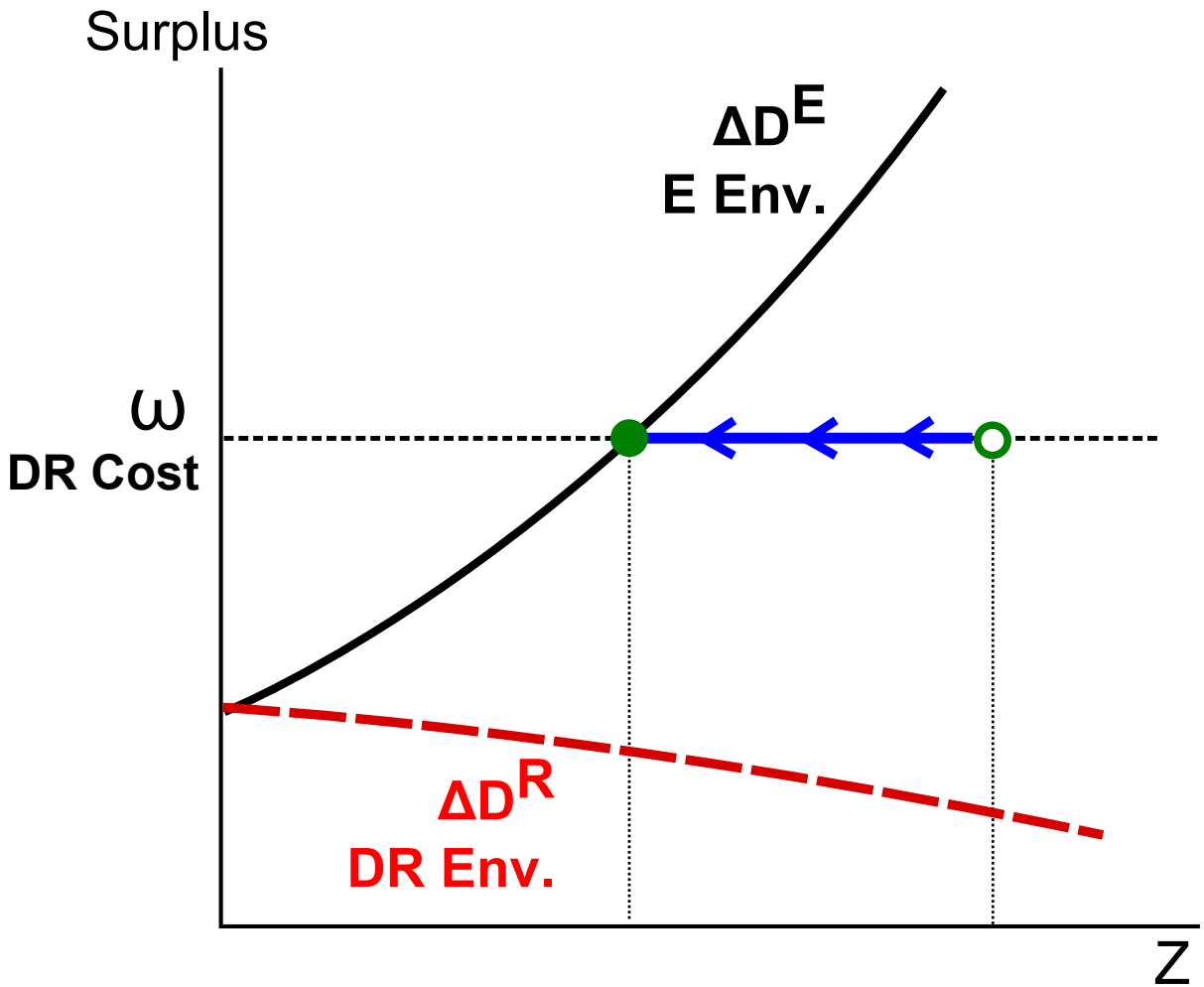


Case of large κ : $\kappa = 0.98,\ \omega = 0.15$

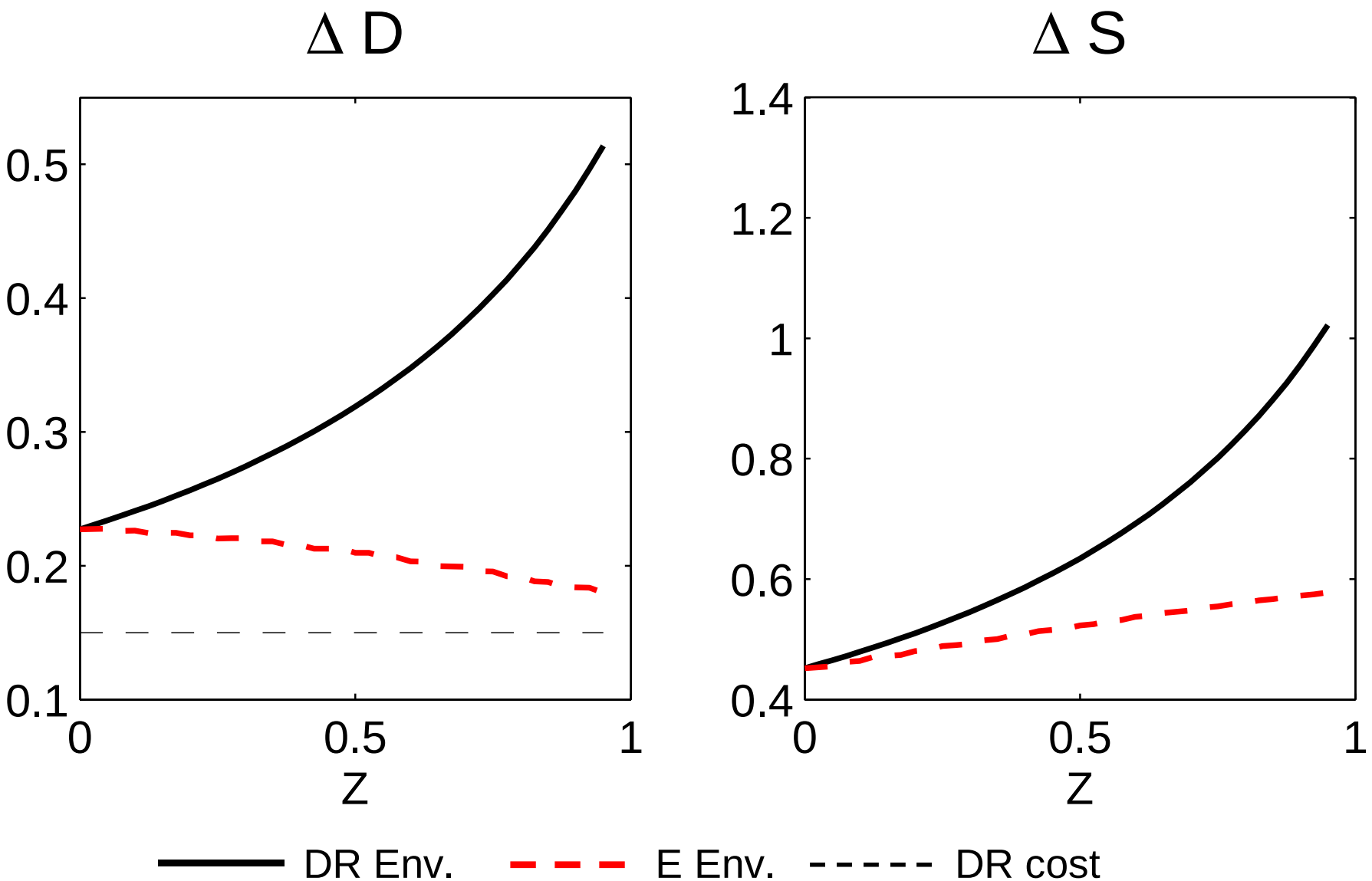


Case of large κ (or High Cost)

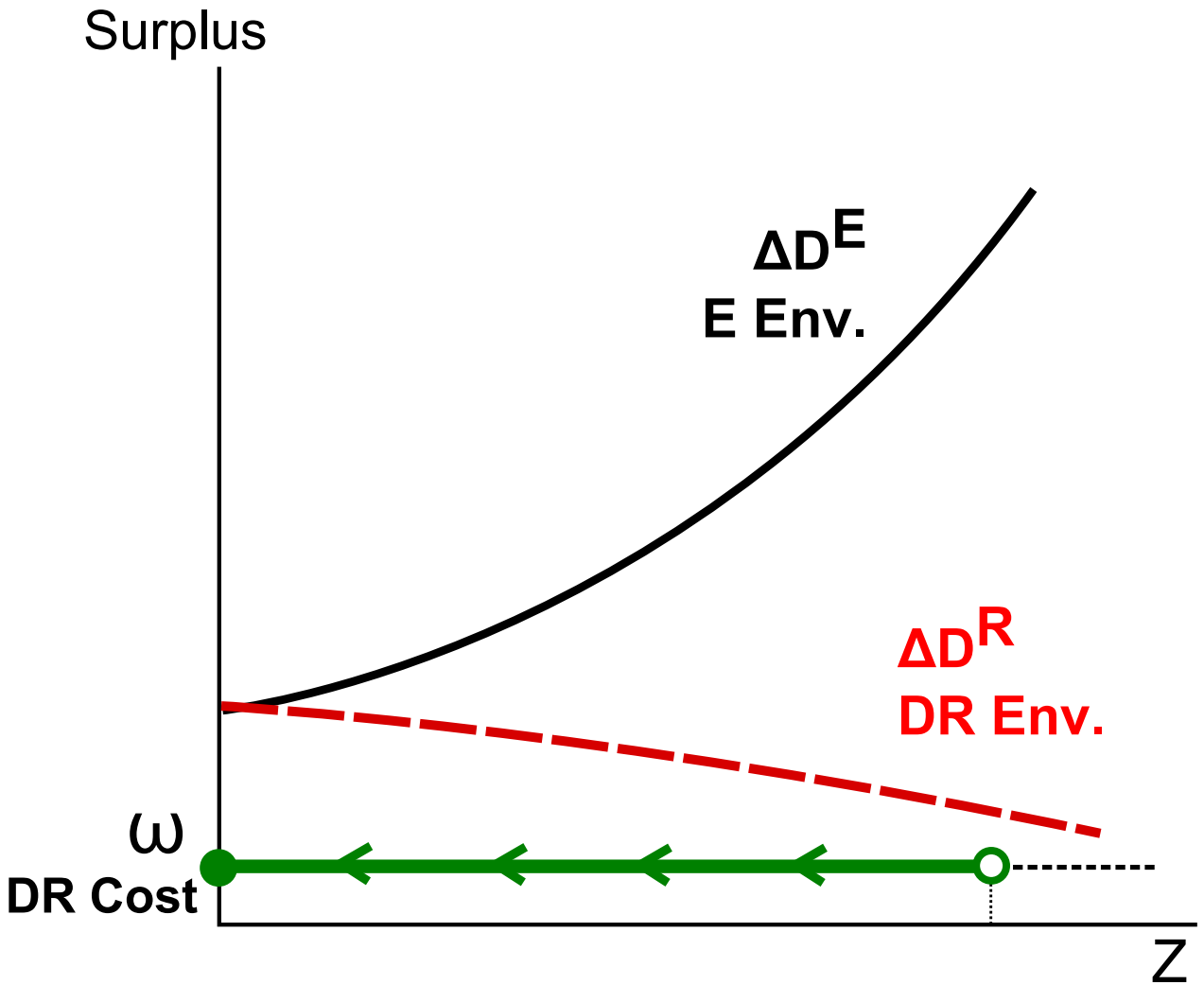
- **Q2. Why the lenders often choose to evergreen the debt-ridden borrowers?**



Case of small κ : $\kappa = 0.97,\ \omega = 0.15$



Case of small κ (or Low Cost)



▸ Middle Cost

Interpretation of Japan's Lost Decades

Policy might have changed the parameter κ in borrowing constraints that affects debt dynamics.

- In the 1990s, government intervention was minimal and few creditors ran on the borrowers: κ was large.
  - Debt repayment is small and evergreening is widespread. Negative effect of debt is persistent.
- In the 2000s, government intervened aggressively and many creditors ran on the borrowers: κ was small.
  - Debt repayment is large and outstanding debt decreased rapidly. Negative effect of debt decays promptly.

Q3. Why the debt restructuring was slow in the 1990s and fast in the 2000s in Japan?

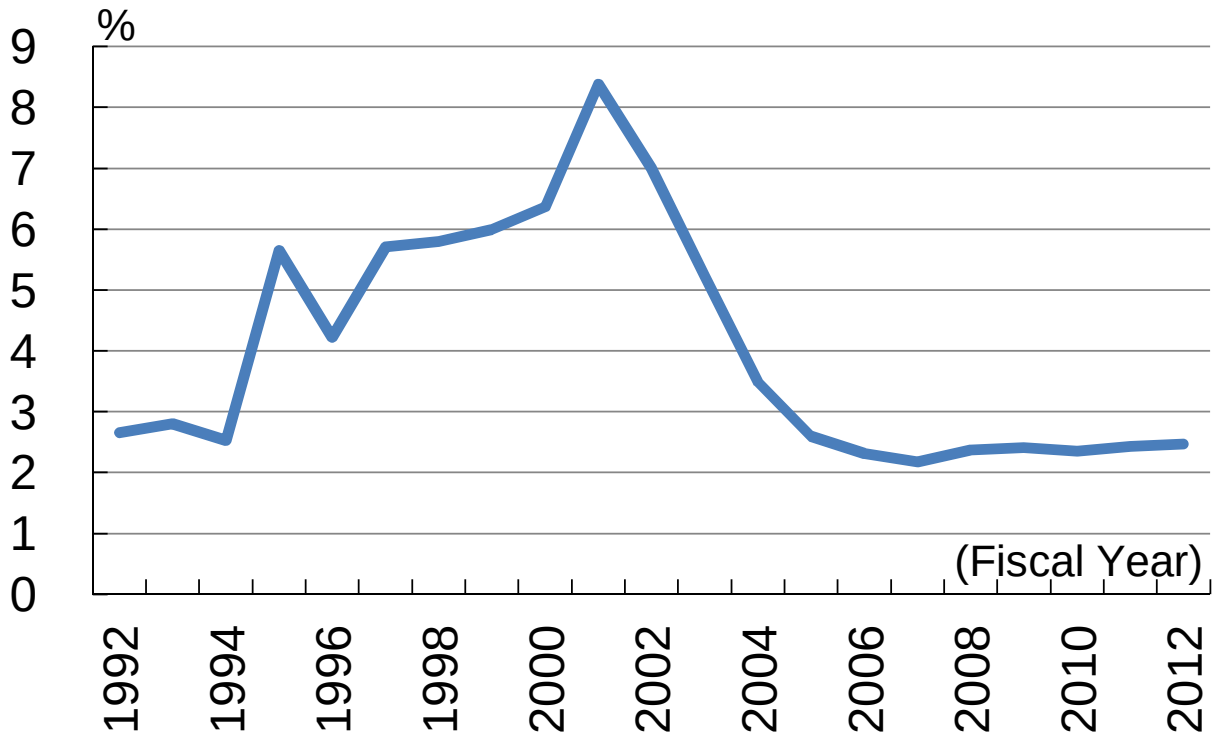


Figure: Outstanding Balance of Non-performing Loans (Ratio to Nominal GDP)

Sources: Financial Services Agency, The Japanese Government, “Status of Non-Performing Loans”; Cabinet Office, Government of Japan, “Annual Report on National Accounts”

Conclusion

- We have analyzed
  - how endogenous borrowing constraints on short-term and long-term loans generate negative and persistent effect;
  - how lenders choose debt restructuring or evergreening.
- With endogenous borrowing constraints, large debt stocks of firms can deteriorate output persistently.
- When debt restructuring is costly, lenders may choose evergreening:
  - Debt restructuring and evergreening may coexist in equilibrium (mixed-strategy equilibrium).
  - Policy may change the endogenous borrowing constraint in such a way that substantial changes in debt dynamics are realized. (Japan's Lost Decade)