

# Sovereign Debt and Structural Reforms

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# The Debt Dilemma

- The Great Recession hit some Euro countries hard (Portugal, Ireland, Italy, Greece, Spain).
- Natural policy response to a negative income shock:
  - ① Borrow against future (higher) income to achieve consumption smoothing.
  - ② Introduce structural reforms to spur growth and speed up recovery
- Problem: sovereign debt contracts are hard to enforce
  - Additional debt issuance increases default risk premia
  - Incentives to reform might be affected by debt burden

# Building Blocks of the Theory

- A sovereign country has fallen in a recession.
- Recovery can be accelerated by costly structural reforms.
- Debt repayment is subject to limited enforcement.
- Debt renegotiation can avert (mitigate) the cost of default.
- Stochastic default costs determine the terms of renegotiation
  - e.g., internal politics, international sympathy, value of trade  
see evidence in Sturzenegger&Zettelmeyer (JIMF2011), Reinhart&Trebesch (JEEA2016).

# Questions

- Study interaction of three frictions in a dynamic model:
  - ① Limited commitment (debt can be reneged on)
  - ② Moral hazard (reform effort is not verifiable)
  - ③ Incomplete markets (no state-contingent debt)
- Under what conditions does the market equilibrium attain/fail to attain efficiency?
- Quantitative questions:
  - ① How large are the potential welfare gains from
    - GDP-linked bonds?
    - Verifiable effort?
    - Commitment to repay debt?
  - ② Would ruling out renegotiation improve welfare?

## Environment: Technology

- Stochastic aggregate endowments,  
 $w \in [\underline{w}, \bar{w}]$  (“recession” and “recovery”).
- A two-state Markov switching regime
  - $p_t \in [\underline{p}, \bar{p}] \subseteq [0, 1]$  is the (endogenous) probability of leaving the low state ( $\underline{w}$ );
  - “recovery” is an absorbing state with commitment to repay (relaxed later).

## Environment: Preferences

- Representative infinitely-lived agent with preferences:

$$E_0 \sum \beta^t [u(c_t) - \phi_t I_{\{\text{default in } t\}} - X(p_t)].$$

- $X$  is the utility cost of reform, assumed to be an increasing convex function of the probability of recovery:  
 $X'(p) > 0$ ,  $X''(p) > 0$ .
- In normal times,  $X = 0$ .

## (First-Best) Pareto Optimum

- Consider a *planner* who has access to a savings technology with return  $R = 1/\beta$ .
- Maximize agent's utility subject to lifetime budget constraint
  - expected PV of income equals expected PV of consumption.
- Assume that the planner can dictate both consumption and effort choice,
- The optimal allocation:
  - 1 Constant consumption sequence
  - 2 Constant reform effort during recession.
- Note that if  $R < 1/\beta$ , the planner frontloads consumption and backloads effort.

# Markets

- A benevolent government issues one-period *discount bonds*  $b'$ , i.e., claims to one unit of next-period consumption.
- The bond price is denoted by  $Q$ .
- Small open economy:
  - Bonds are purchased by risk neutral foreign investors;
  - Risk-free world interest rate:  $R$ .

# Default and Renegotiation in Recession I

- Every period, the government decides whether to *honor* the outstanding debt, repudiate it (“inexcusable default”), or renegotiate it.
- Default is subject to a stochastic (i.i.d.) cost,  $\phi$ , drawn from a p.d.f.  $f(\phi)$  (c.d.f.  $F(\phi)$ ).
- The realization of the default cost is common knowledge.
- The government decides whether to honor after observing the realization of  $\phi$ .

## Default and Renegotiation in Recession II

- Whenever the default threat is credible, creditors make a **take-it-or-leave-it renegotiation** offer.
- The offer keeps the government indifferent between defaulting and honoring the renegotiated debt level.
- No cost is due under renegotiation (for simplicity).
- When the risk of renegotiation is positive,  $Q < 1/R$ .

# Equilibrium Concept: Markov Equilibrium

- Focus on Markov equilibria
  - Equilibrium functions only depend on payoff-relevant state variables, i.e.,  $b$  and  $\phi$ .
  - Rules out reputational equilibria (e.g. equilibria conditional on effort previous period)
    - Direct default cost vs. reputation (B&R 2015).
  - Captures assumption that the market cannot commit to punish sovereign for past behavior.

## Value Functions

- In recession

$$V(b, \phi) = \max \{ W(b), W(0) - \phi \},$$

where

$$W(b) = \max_{b' \in [\underline{b}, \bar{b}]} \{ u(Q(b') \times b' + \underline{w} - b) + Z(b') \}$$

$$Z(b') = \max_{p \in [\underline{p}, \bar{p}]} \left\{ -X(p) + \beta \left[ \begin{array}{c} p \bar{V}(b') \\ + (1-p) E_{\phi'} [V(b', \phi')] \end{array} \right] \right\}$$

- In recovery the economy achieves the first-best allocation with constant consumption if  $\beta R = 1$ ,

$$\bar{V}(b') = \frac{u(\bar{w} - b'(1 - R^{-1}))}{1 - \beta}.$$

## Renegotiation Threshold

- Define  $\hat{b}(\phi)$  as the renegotiated debt that keeps the sovereign indifferent between repaying  $\hat{b}(\phi)$  and outright default:

$$W(\hat{b}(\phi)) = W(0) - \phi.$$

- Given the realization of  $\phi$  the sovereign will threaten to default if  $b > \hat{b}(\phi)$ .
- Or, identically,  $\exists \Phi(b)$  such that the sovereign will threaten to default if  $\phi < \Phi(b)$ .
- Debt overhang:  
When  $b' > \hat{b}(\phi_{\max})$  then debt is renegotiated for sure in a future recession!

# Competitive equilibrium

- Characterize equilibrium in three steps
  - Optimal reform effort
  - Equilibrium bond price
  - Conditional Euler equation for consumption

## Reform Effort

- Recall timing: the government chooses  $b'$  first, and then  $p$ .
- Investors have rational expectations over  $p$ .
- The reform effort solves:

$$\Psi(b') = \arg \max_{p \in [\underline{p}, \bar{p}]} \left\{ -X(p) + \beta \left[ \begin{array}{l} p \bar{V}(b') \\ + (1-p) E_{\phi'}[V(b', \phi')] \end{array} \right] \right\}.$$

- The first order condition yields:

$$\underbrace{X'(\Psi(b'))}_{\text{Marg. cost reform.}} = \beta \underbrace{\left[ \bar{V}(b') - \left[ \begin{array}{l} [1 - F(\Phi(b'))] W(b') \\ + \int_0^{\Phi(b')} W(\hat{b}(\phi')) dF(\phi') \end{array} \right] \right]}_{\text{Exp. benefit of leaving the rec.}}.$$

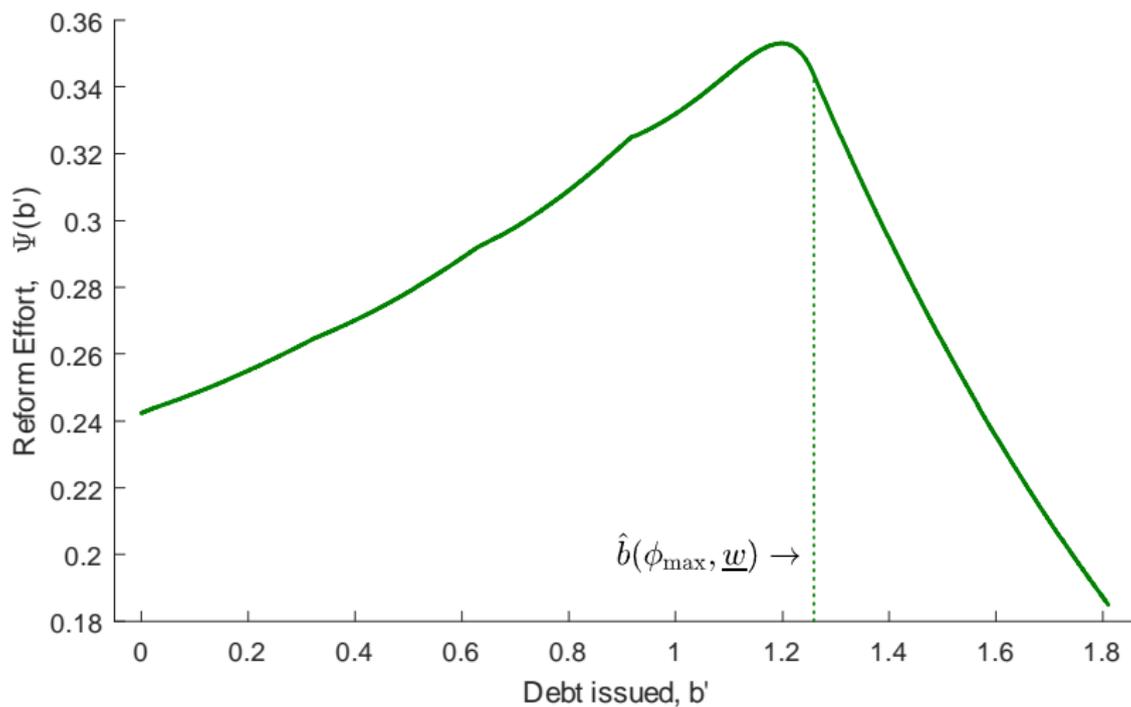


Figure: Reform effort function

## Equilibrium Debt Price

- Since investors are risk neutral, the expected rate of return on the sovereign debt must equal  $R$

$$Q(b') b' = \frac{1}{R} \Psi(b') b' + \frac{1}{R} (1 - \Psi(b')) \underbrace{\Pi(b')}_{\text{Exp. repayment in rec.}}$$

$$\begin{aligned} \Pi(b') &= \underbrace{(1 - F(\Phi(b')))}_{\text{Probability full repayment}} \times b' \\ &+ \underbrace{\int_0^{\Phi(b')} \hat{b}(\phi') dF(\phi')}_{\text{Exp. debt recovery under reneq. } (\phi' < \Phi(b'))} \end{aligned}$$

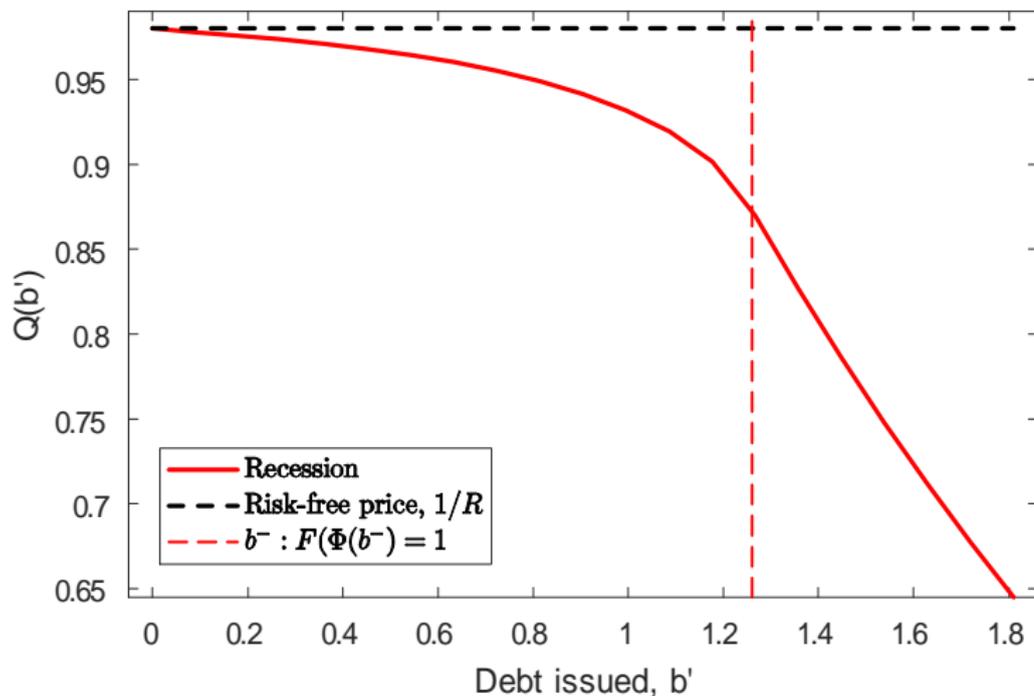


Figure: Bond price function  $Q(b)$  in recession.

## Conditional Euler Equation

- Conditional on no renegotiation ( $H$ ="honor debt") in the future, a version of the Euler equation (CEE) holds:

$$\beta R \times E \left[ \frac{u'(c')}{u'(c)} | H \right] = 1 + \frac{\Psi'(b')}{\Pr(H|b')} [b' - \Pi(b')] .$$

- In case of future renegotiation, consumption increases (relative to case when debt is honored)
- The standard incomplete markets Euler equation applies:
  - without limited commitment ( $\Pi(b') = b'$ ) and,
  - no moral hazard ( $\Psi'(b') = 0$ ).

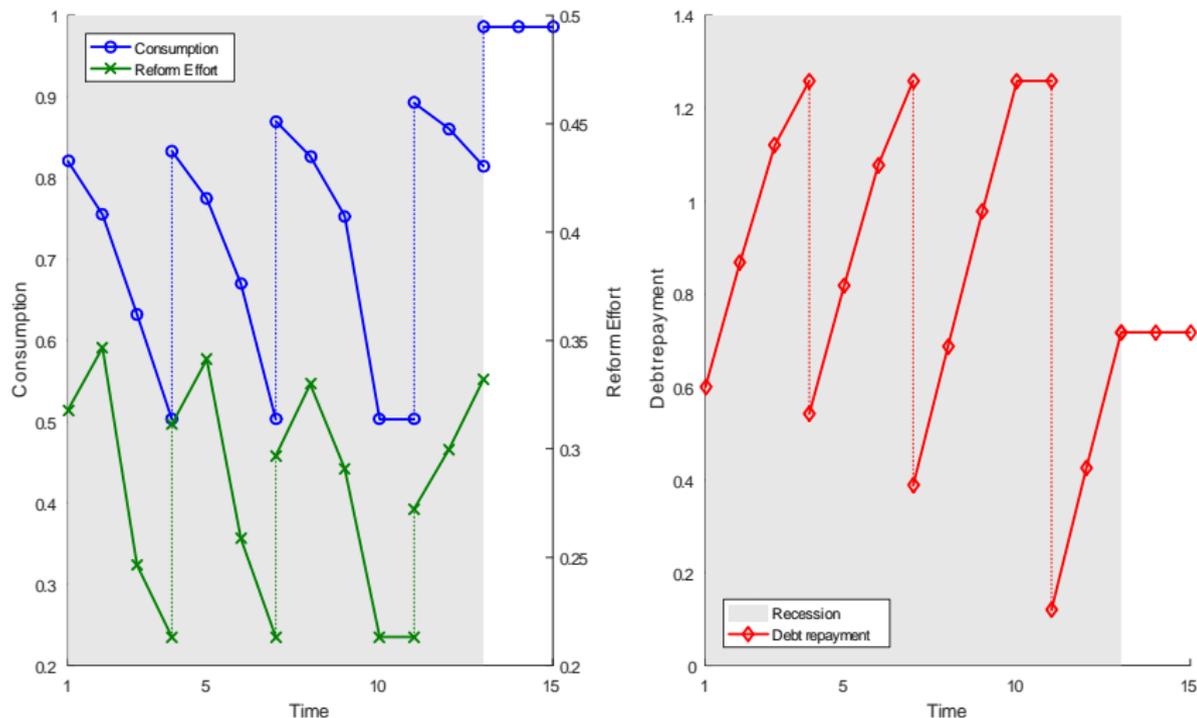


Figure: Simulation of consumption, effort, and debt for  $\beta R = 1$ .

## GDP-linked Debt

- We have exogenously assumed that the interest rate on debt is the same irrespectively of the income shock realization (in the literature, "non-state-contingent debt")
- The analysis can be extended to allow for GDP-linked debt.
- Market for GDP-linked debt cannot restore efficiency.
  - Culprit: moral hazard problem and limited commitment.
- Key insight: state-contingent debt is of limited use in recession
  - State-contingent debt would allow the country to insure against the continuation of the recession
  - However, insurance mitigates incentives to reform

# Comparison to Allocations with Less Frictions

- First-best allocation (without frictions).
- Limited commitment
  - w/o moral hazard (verifiable effort)
  - with moral hazard (non-verifiable effort)
- Implementation of the allocation with verifiable effort:
  - Assistance program of an institution (i.e., the IMF) that can verify effort provision.

# Recurrent Recessions

- Extend limited commitment to the recovery state
- Exogenous (low) probability of falling back into recession
- $\beta R < 1$  (to have a stationary debt distribution)
- Market equilibrium:
  - during normal times debt (wealth) tends to a target level
  - during recessions debt increases

## Parameters calibrated externally

- A period corresponds to one year
- Recession causes a 40% income fall (Greece 2007-13, output loss relative to trend)
- Probability of falling back into a recession: 1%
- Annual real gross interest rate:  $R = 1.02$
- CRRA-utility with risk aversion of 2
- Effort cost is iso-elastic:  $X(p) = \xi \times p^{1+\varphi}$
- Assume that  $\bar{\phi} - \phi$  is distributed exponential, with truncation point  $\bar{\phi}$  and rate parameter  $\eta$ .

# Targeted Moments

| Target  | Data  | Model | Par.         | Value |
|---|-------|-------|--------------|-------|
| Average debt:<br>(% GDP, GIIPS, 1950-2015)                            | 54.9% | 53.7% | $\beta$      | 0.972 |
| Bond spread:<br>(GIIPS, at 100% debt-output ratio, 2008-2012)         | 4.04% | 3.99% | $\eta$       | 1.804 |
| Maximum debt level:<br>(% of normal output, Collard et al. 2015)      | 178%  | 176%  | $\bar{\phi}$ | 2.134 |
| Expected recession duration:<br>(at max. reform effort, years)        | 5     | 4.95  | $\varphi$    | 14.24 |
| Expected recession duration:<br>(at the debt limit $\bar{b}$ , years) | 10    | 9.99  | $\zeta$      | 14.55 |

## Non-Targeted Moments

- Calibration yields an average bond spread of 3%, in line with data for GIIPS-vs-Germany 1992-2015 (2.5%).
- Renegotiation probability is 6.5%, in line with Tomz and Wright (2013).
- Average haircut conditional on renegotiation is 41%, in line with Tomz and Wright (2013).
- Variation in haircuts is in line with Cruces and Trebesch (2013).
- Average debt relief (market value) 21%, in line with Reinhart and Trebesch (2016).
- Debt-GDP ratio's are higher in renegotiation periods (89.7%) compared to the average debt-GDP ratio (53.7%), in line with Asonuma and Trebesch (2016).

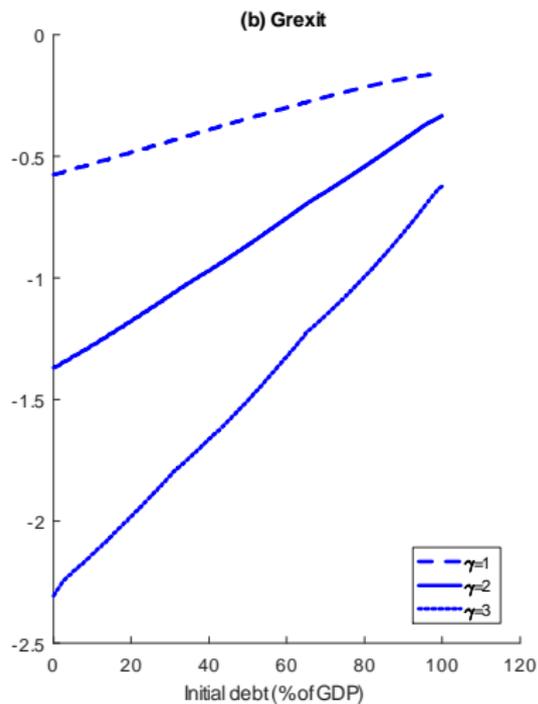
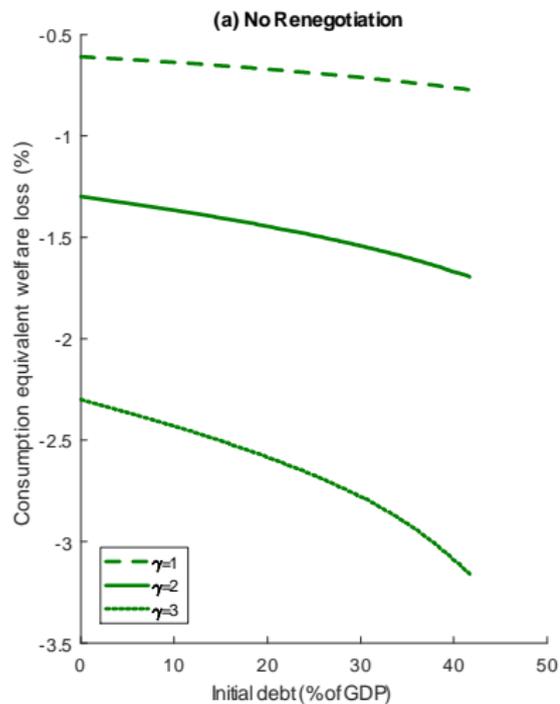
## Quantitative Welfare Effects

- Compute welfare gain of going from benchmark economy (competitive equilibrium) to an alternative economy, measured as equivalent variation (in % of consumption).
  - Evaluated at 100% debt-GDP ratio during recession

| Experiment      | Total | Debt Equivalent (% of Rec. GDP) |
|-----------------|-------|---------------------------------|
| GDP-linked Debt | 0.9   | 34                              |
| No moral hazard | 3.0   | 113                             |
| First Best      | 13.2  | 580                             |

# Ruling Out Renegotiation

- Experiments:
  - ① Disallow renegotiation (New York versus Argentina)
    - Either honor debt or outright default (Arellano, 2008)
  - ② Assistance program, but commit to punish any deviation (debt renegotiation or reforms) with termination of contract
    - Grexit: Debt guarantee, but no further borrowing.
- Effects:
  - default occurs in equilibrium
  - larger default premium
  - less borrowing (and less risk sharing) in equilibrium



# Summary I

- A simple model of sovereign debt and structural reforms to evaluate the welfare effect of different policies.
- The model is tractable: analytical characterization of the stochastic equilibrium, including CEE, the equilibrium price of debt and the probability of renegotiation.
- equilibrium outcome: an “unlucky” borrower (recession drags on) will eventually enter the debt overhang region.

## Summary II

- An efficient assistance program requires:
  - **budget support** (i.e., loans) during recession followed by settling the sovereign country with a (large) debt on market terms upon recovery;
  - & **monitoring of reform** effort;
  - & **fiscal austerity**.
- When faced by a *credible* default threat, the “agency” gives in and sweetens the deal: higher consumption, lower reform effort.
  - no Grexit.

## Summary III

- Time consistent? Yes, our model incorporates that a large debt increases the probability that Greece does not repay after recovering.
- The model is quantitatively consistent with realistic (high) debt, plausible default premium, and with the empirical haircuts after renegotiation

## Related Literature

- Model is related to Bulow&Rogoff (1989)
  - Renegotiation entails no cost;
  - (Potential) default cost defines threat point for renegotiation;
  - Repeated renegotiation is equilibrium outcome.
- Add to B&R: risk aversion, a borrowing motive (consumption smoothing in recess.), reform effort, and quantitative analysis
- Quantitative models with costly default and renegotiation
  - Aguiar and Gopinath (2006), Arellano (2008), etc.
- Models of sovereign debt restructuring
  - Ex-post inefficient restructuring improves incentives to honor debt, e.g., Yue (2011), Benjamin&Wright (2008), Bolton&Jeanne (2007), DAVIS (2016), Amador&al. (2015).
  - Debt affects incentives to undertake productive investments: Krugman (1988), Atkeson (1991).

# A Planning Problem

- A dynamic principle-agent problem with one-sided commitment.
- Planner faces the same limited enforcement constraint as the market, but
  - ... can commit to future policies
  - ... can make state-contingent promises.
- There is a limit to the punishment that the planner can inflict to the agent
  - → send her to the market equilibrium.
- Promised utility approach, following Thomas and Worrall (1988).

## Two cases

- 1 Planner cannot verify reform effort (as can markets).
- 2 Planner can verify reform effort.

# Constrained Optimum with Limited Commitment and Moral Hazard

$$P(v) = \max_{\{\bar{\omega}_\phi, \underline{\omega}_\phi, c_\phi, p_\phi\}} \int_{\mathbb{X}} \left[ \underline{w} - c_\phi + \frac{1}{R} \begin{pmatrix} p_\phi \bar{P}(\bar{\omega}_\phi) \\ + (1 - p_\phi) P(\underline{\omega}_\phi) \end{pmatrix} \right] dF(\phi)$$

subject to

$$\int_{\mathbb{X}} \left( u(c_\phi) - X(p_\phi) + \beta \left( (1 - p_\phi) \underline{\omega}_\phi + p_\phi \bar{\omega}_\phi \right) \right) dF(\phi) = v \quad (\text{PKC})$$

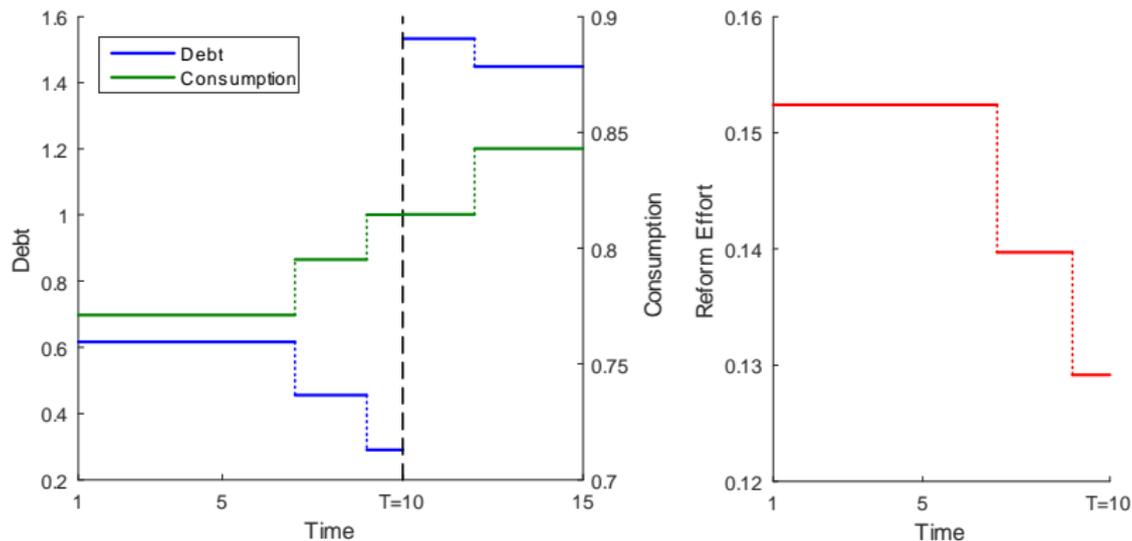
$$u(c_\phi) - X(p_\phi) + \beta \left( (1 - p_\phi) \underline{\omega}_\phi + p_\phi \bar{\omega}_\phi \right) \geq W(0, \underline{w}) - \phi \quad (\text{PC})$$

$$p_\phi = \arg \max_{p \in [\underline{p}, \bar{p}]} -X(p) + \beta \left( (1 - p) \underline{\omega}_\phi + p \bar{\omega}_\phi \right) \quad (\text{IC})$$

- 1  $P, \bar{P}$  can be interpreted as PV of creditors' exp. profits
- 2  $\omega_\phi$  is the promised utility conditional on the state (i.e., the realization of  $\phi$ )

# Assistance Plan

- An agency (e.g., the *IMF*)...
  - ① Buys the outstanding initial debt  $b_0$
  - ② sets a constant transfer (loan) per period
  - ③ requests a repayment ( $b_n$ ) as soon as the recession ends
  - ④ sweetens the deal each time the borrower gets a low  $\phi$
  - ⑤ out-of-equilibrium threat: drop borrower if effort deviation
- Initial promise  $v_0$  depends on the expected profit of the intervention:
  - Here zero profit implies:  $P(v_0) = \Pi(b_0)$ .



**Figure:** Implementation of constrained efficiency by means of an assistance program: simulation of consumption, effort and "implicit debt" over time.

## If the Planner Cannot Verify Effort...

- **Proposition:** if the planner cannot verify effort, then the planning (constrained optimal) allocation is equivalent to the market equilibrium with gdp-linked debt.
- Note: the result requires that the punishment for deviation is to go to the mkt with state-contingent debt.