

# On the Welfare Costs from External Sovereign Borrowing

Mark Aguiar<sup>1</sup>   Manuel Amador<sup>2</sup>   Stelios Fourakis<sup>3</sup>

<sup>1</sup>Princeton University and NBER

<sup>2</sup>Minneapolis Fed, University of Minnesota and NBER

<sup>3</sup>University of Minnesota

September 13, 2019

The views here do not necessarily represent the views of the Federal Reserve Bank  
of Minneapolis nor the Federal Reserve System.

# Starting point

- ▶ Sovereign debt
- ▶ Governments borrow, and sometimes default
- ▶ Growing quantitative literature
- ▶ Today: small tour of the literature using a particular lens

# Starting point

- ▶ Households and politicians
  - ▶ Disagree on how to discount future
  - ▶ Politicians more impatient than (average) household

# Starting point

- ▶ Households and politicians
  - ▶ Disagree on how to discount future
  - ▶ Politicians more impatient than (average) household
  
- ▶ Borrowing and government debt
  - ▶ Fundamentally an inter-temporal decision
  - ▶ Distorted by political economy

# Starting point

- ▶ Households and politicians
  - ▶ Disagree on how to discount future
  - ▶ Politicians more impatient than (average) household
- ▶ Borrowing and government debt
  - ▶ Fundamentally an inter-temporal decision
  - ▶ Distorted by political economy
- ▶ How to improve things?
  - ▶ Simple/transparent rules may work best

# What we do

- ▶ Consider a very simple rule
  - ▶ Remove ALL gov't access to international debt markets

# What we do

- ▶ Consider a very simple rule
  - ▶ Remove ALL gov't access to international debt markets
- ▶ Evaluate in recent quantitative sovereign debt models:
  - ▶ Compare outcomes with and without this rule

# What we do

- ▶ **Disagreement**

- ▶ Difference in discount factors between households and decision makers.
- ▶ Key political economy parameter



# What we do

## ▶ Disagreement

- ▶ Difference in discount factors between households and decision makers.
- ▶ Key political economy parameter

Two questions when evaluating the rule

1. What is the level of disagreement that keep households indifferent wrt the rule?
2. How large are the (households') welfare gains?

## Results: A decomposition

Costs from gov't market access:

1. Front-loading of expenditures
2. Excess-variability of expenditures
3. Default costs

## Results: A decomposition

Costs from gov't market access:

1. Front-loading of expenditures
  - ▶ Not much here: not much disagreement, small welfare gains
  - ⇒ Debt is not that large
2. Excess-variability of expenditures
3. Default costs

# Results: A decomposition

Costs from gov't market access:

1. Front-loading of expenditures

- ▶ Not much here: not much disagreement, small welfare gains

⇒ Debt is not that large

2. Excess-variability of expenditures

*(You may think this should go the other way!)*

- ▶ Creates disagreement about external market access

- ▶ But welfare magnitudes small

3. Default costs

# Results: A decomposition

Costs from gov't market access:

## 1. Front-loading of expenditures

- ▶ Not much here: not much disagreement, small welfare gains
- ⇒ Debt is not that large

## 2. Excess-variability of expenditures

*(You may think this should go the other way!)*

- ▶ Creates disagreement about external market access
- ▶ But welfare magnitudes small

## 3. Default costs

- ▶ Large disagreement: Rule valuable
- ▶ Larger welfare effects:  $\approx 1\%$  of consumption

## Warming up: A benchmark exercise

## Warming up: A benchmark exercise

- ▶ Deterministic small open economy with endowment  $y$
- ▶ Government:
  - ▶ Manages external debt subject to **ad-hoc debt limit**  $\bar{b}$
  - ▶ Discounts the future at rate  $\rho_G$
- ▶ Households:
  - ▶ Enjoy same utility flows (CRRA,  $\sigma$ ), discount at  $\rho_H \leq \rho_G$
  - ▶ Consume from endowment net of government transfers
  - ▶ No inter-temporal decision, no labor supply decision

## Warming up: A benchmark exercise

- ▶ Compare household utility when the government borrows *starting with zero debt* versus the case where government cannot



## Warming up: A benchmark exercise

- ▶ Compare household utility when the government borrows *starting with zero debt* versus the case where government cannot
- ▶ Only three parameters needed:
  - ▶ Elasticity of inter-temporal substitution,  $1/\sigma$
  - ▶ International discount factor,  $r$
  - ▶ Ad-hoc debt limit,  $\bar{b}/y$

## Warming up: government's problem

- ▶ With access to borrowing.
  - ▶ Government chooses consumption for  $b' < \bar{b}$ :

$$u'(c) = \beta_G(1+r)u'(c')$$

where  $\beta_G = e^{-\rho_G}$ ,  $b_0 = 0$  and budget constraint:

$$c = y - (1+r)b + b'$$

- ▶ At some point,  $b' = \bar{b}$ , and  $c = y - r\bar{b}$

## Warming up: government's problem

- ▶ With access to borrowing.
  - ▶ Government chooses consumption for  $b' < \bar{b}$ :

$$u'(c) = \beta_G(1+r)u'(c')$$

where  $\beta_G = e^{-\rho_G}$ ,  $b_0 = 0$  and budget constraint:

$$c = y - (1+r)b + b'$$

- ▶ At some point,  $b' = \bar{b}$ , and  $c = y - r\bar{b}$
  - ▶ Enough to obtain the consumption process,  $c_t^*$ .
- ▶ Without access to borrowing,  $c_t = y$

## Warming up: HH welfare

- ▶ Households: same instantaneous utility function  
but discount factor:  $\beta_H = e^{-\rho_H}$

- ▶ With access to borrowing:

$$W_0 = \sum_{t=0}^{\infty} \beta_H^t u(c_t^*)$$

- ▶ Without access:

$$W^A = \frac{u(y)}{1 - \beta_H}$$

## Warming up: Welfare calculation

Welfare comparison in consumption units:

$$\hat{\lambda} = \left( \frac{W_0}{W_A} \right)^{\frac{1}{1-\sigma}} - 1$$

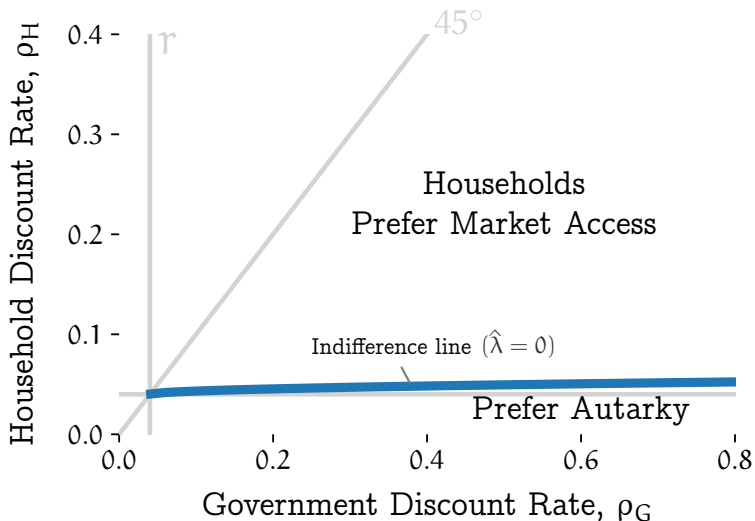
- ▶  $\hat{\lambda} = 0$ : households are indifferent
- ▶  $\hat{\lambda} > 0$ : households prefer access
- ▶  $\hat{\lambda} < 0$ : households prefer no access

## Warming up: A benchmark exercise

$$\sigma = 2, r = 0.04, \bar{b}/y = 0.25 \text{ (annual rates)}$$

## Warming up: A benchmark exercise

Indifference between Access and Autarky



## A benchmark exercise: Welfare magnitudes

$$\sigma = 2, r = 0.04, \bar{b}/y = 0.25, \rho_G = 0.20$$



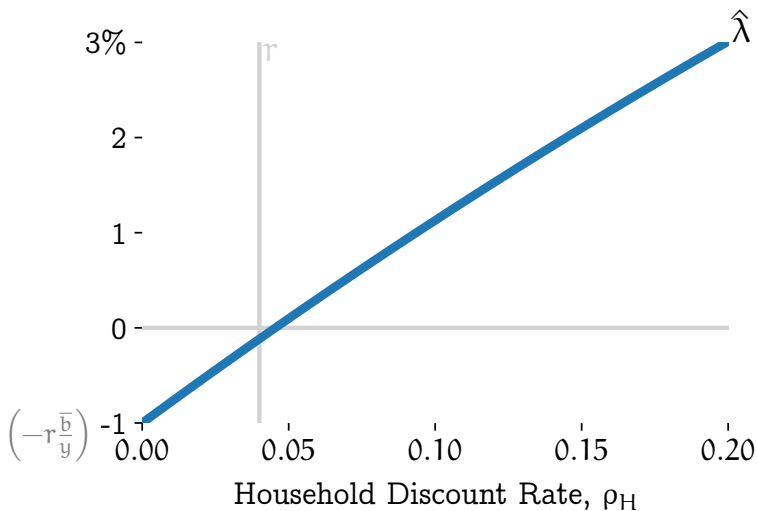
## A benchmark exercise: Welfare magnitudes

Welfare Gains ( $\hat{\lambda}$ ) from Financial Market Access



## A benchmark exercise: Welfare magnitudes

Welfare Gains ( $\hat{\lambda}$ ) from Financial Market Access



## A benchmark exercise: Summary

- ▶ Just a bit of impatience enough for HH to prefer market access
- ▶ Welfare **gains** from access potentially large

Front-loading of expenditures: Not a strong case for banning external sovereign borrowing.

How robust is this?

## A benchmark exercise: Summary

- ▶ Simple benchmark misses many things:
  - ▶ No uncertainty
  - ▶ No default in equilibrium
  - ▶ No default costs
  - ▶ No relevant maturity choice
- ▶ Recent quantitative sovereign debt models have these
  - ▶ Still, some other ones missing ...

# The Eaton-Gersovitz model

# The Eaton-Gersovitz model

- ▶ Small open economy
- ▶ Stochastic endowment process  $y(s)$
- ▶ Government borrows abroad using an uncontingent (but defaultable) bond

It can default, output drops to  $y^D(s)$

- ▶ Foreigners are risk-neutral, discount at  $R$

# The Eaton-Gersovitz model

- ▶ Small open economy
- ▶ Stochastic endowment process  $y(s)$
- ▶ Government borrows abroad using an uncontingent (but defaultable) bond

It can default, output drops to  $y^D(s)$

- ▶ Foreigners are risk-neutral, discount at  $R$
- ▶ Government lacks commitment:
  - ▶ To repay its debts
  - ▶ To future deficits / debt accumulation

## The Eaton-Gersovitz model: Timing

- ▶ Government inherits debt,  $b$ , and state  $s$  is realized
- ▶ Then, it decides to default or not
- ▶ If it does not, then issues new bonds at price  $q$ , consumes, and obtains a value  $V(b, s)$
- ▶ If it defaults, then obtains a value  $\underline{V}(s)$



## The Eaton-Gersovitz model: Timing

- ▶ Government inherits debt,  $b$ , and state  $s$  is realized
- ▶ Then, it decides to default or not
- ▶ If it does not, then issues new bonds at price  $q$ , consumes, and obtains a value  $V(b, s)$
- ▶ If it defaults, then obtains a value  $\underline{V}(s)$

This timing eliminates the possibility of failed auctions.

Simple but very rich model

## The Eaton-Gersovitz model: Budget constraint

How do we deal with maturity?

A bond is a promise to pay a geometrically decaying coupon.

$\delta$  is the rate of decay:

$$c = y(s) - b + q \times \underbrace{(b' - \delta b)}_{\text{issuances}}$$

## The Eaton-Gersovitz model: Markov Equilibria

$$V(\mathbf{b}, s) = \max_{\mathbf{b}'} \left\{ u(\mathbf{c}) + \beta_G \sum_{s'|s} \pi(s'|s) \max\{V(\mathbf{b}', s'), \underline{V}(s')\} \right\}$$

subject to:

$$\mathbf{c} = \mathbf{y}(s) - \mathbf{b} + \mathbf{q}(\mathbf{b}', s)(\mathbf{b}' - \delta \mathbf{b})$$

## The Eaton-Gersovitz model: Markov Equilibria

$$V(\mathbf{b}, s) = \max_{\mathbf{b}'} \left\{ u(\mathbf{c}) + \beta_G \sum_{s'|s} \pi(s'|s) \max\{V(\mathbf{b}', s'), \underline{V}(s')\} \right\}$$

subject to:

$$\mathbf{c} = \mathbf{y}(s) - \mathbf{b} + \mathbf{q}(\mathbf{b}', s)(\mathbf{b}' - \delta \mathbf{b})$$

---

$$\underline{V}(s) = u(\mathbf{y}^D(s)) + \beta_G \sum_{s'|s} \pi(s'|s) (\theta V(0, s') + (1 - \theta) \underline{V}(s'))$$

$\theta$ : re-entry probability

# The Eaton-Gersovitz model: Markov Equilibria

Bond price:

$$q(\mathbf{b}, s) = \frac{1}{R} \underbrace{\sum_{s'|s} \pi(s'|s) \mathbf{1}_{\{V(\mathbf{b}, s') \geq \underline{V}(s')\}}}_{\text{prob of no default}} \left( 1 + \underbrace{\delta q(\mathcal{B}(\mathbf{b}, s'), s')}_{\text{bond price tomorrow}} \right)$$

where  $\mathcal{B}$  is the debt policy function

## The Eaton-Gersovitz model: The Rule

Autarky welfare (starting from zero debt) for the government:

$$V^A(s) = u(y(s)) + \beta_G \sum_{s'|s} \pi(s'|s) V^A(s')$$

## The Eaton-Gersovitz model: The Rule

Autarky welfare (starting from zero debt) for the government:

$$V^A(s) = u(y(s)) + \beta_G \sum_{s'|s} \pi(s'|s) V^A(s')$$

In any Markov equilibrium, and for any maturity  $\delta$ ,

$$V(0, s) \geq V^A(s)$$

for all  $s \in S$ .

A government will not shut itself out.

## The Eaton-Gersovitz model: Household's welfare

Value with Market Access ( $\mathcal{D}$ : equilibrium default policy)

$$W(\mathbf{b}, s) = u\left(y(s) - \mathbf{b} + q(\mathcal{B}(\mathbf{b}, s), s)(\mathcal{B}(\mathbf{b}, s) - \delta \mathbf{b})\right) + \beta_H \sum_{s'|s} \pi(s'|s) [(1 - \mathcal{D}(\mathbf{b}, s'))W(\mathcal{B}(\mathbf{b}, s), s') + \mathcal{D}(\mathbf{b}, s')\underline{W}(s')]$$

$$\underline{W}(s) = u(y^D(s)) + \beta_H \sum_{s'|s} \pi(s'|s) (\theta W(0, s') + (1 - \theta)\underline{W}(s'))$$



## The Eaton-Gersovitz model: Household's welfare

Value with Market Access ( $\mathcal{D}$ : equilibrium default policy)

$$W(\mathbf{b}, s) = u\left(y(s) - \mathbf{b} + q(\mathcal{B}(\mathbf{b}, s), s)(\mathcal{B}(\mathbf{b}, s) - \delta \mathbf{b})\right) + \beta_H \sum_{s'|s} \pi(s'|s) [(1 - \mathcal{D}(\mathbf{b}, s'))W(\mathcal{B}(\mathbf{b}, s), s') + \mathcal{D}(\mathbf{b}, s')\underline{W}(s')]$$

$$\underline{W}(s) = u(y^D(s)) + \beta_H \sum_{s'|s} \pi(s'|s) (\theta W(0, s') + (1 - \theta)\underline{W}(s'))$$

Value without Market Access:

$$W^A(s) = u(y(s)) + \beta_H \sum_{s'|s} \pi(s'|s) W^A(s').$$

# Goal

Welfare gains in terms of consumption

$$(1 + \lambda) = \left[ \frac{\sum \pi^\infty(s_0) W(0, s_0)}{W^A} \right]^{\frac{1}{1-\sigma}}$$

## Decomposing the consumption process

$C(h_t)$ : eqm consumption given shocks and exclusion history  $h_t$ .  
 $h_0$  starting history with no debt.  $d_t$  default indicator.

---

Consumption without default costs:

$$c^{ND}(h_t) \equiv (1 - d_t)C(h_t) + d_t y(s_t)$$

Expected consumption without default costs:

$$\bar{c}^{ND}(t) \equiv \sum_{h_0} \pi^\infty(s_0) \sum_{h_t} \pi(h_t|h_0) c^{ND}(h_t)$$

Expected autarkic consumption:

$$\bar{c}_A(t) \equiv \sum_{s_0} \pi^\infty(s_0) \sum_{h_t} \pi(h_t|h_0) y(s_t) = y^\infty$$

## Welfare measures

Equilibrium household welfare:

$$W(0) \equiv \sum_{s_0} \pi^\infty(s_0) \sum_{t=0}^{\infty} \sum_{h_t} \pi(h_t|h_0) \beta_H^t u(C(h_t))$$

Equilibrium household welfare without default costs:

$$W^{\text{ND}}(0) \equiv \sum_{s_0} \pi^\infty(s_0) \sum_{t=0}^{\infty} \sum_{h_t} \pi(h_t|h_0) \beta_H^t u(c^{\text{ND}}(h_t))$$

Equilibrium household welfare without default cost and uncertainty:

$$\bar{W}^{\text{ND}}(0) \equiv \sum_{t=0}^{\infty} \beta_H^t u(\bar{c}^{\text{ND}}(t))$$

Autarkic household welfare without uncertainty

$$\bar{W}^{\text{A}}(0) \equiv \frac{u(y^\infty)}{1 - \beta_H}$$

## An Exact Decomposition

Welfare gains in terms of consumption

$$\begin{aligned}(1 + \lambda) &= \left[ \frac{W_0}{\bar{W}^A} \right]^{\frac{1}{1-\sigma}} \\ &= \underbrace{\left[ \frac{W_0}{W^{\text{ND}}(0)} \right]^{\frac{1}{1-\sigma}}}_{1+\lambda_D} \times \underbrace{\left[ \frac{W^{\text{ND}}(0)}{\bar{W}^{\text{ND}}(0)} \times \frac{\bar{W}^A}{\bar{W}^A} \right]^{\frac{1}{1-\sigma}}}_{1+\lambda_V} \times \underbrace{\left[ \frac{\bar{W}^{\text{ND}}}{\bar{W}^A} \right]^{\frac{1}{1-\sigma}}}_{1+\lambda_T} \\ &= (1 + \lambda_D) \times (1 + \lambda_V) \times (1 + \lambda_T)\end{aligned}$$

$\lambda_D$ : role of *default costs*.

$\lambda_V$ : role of the *variability* of consumption.

$\lambda_T$ : welfare effects generated by the *tilting* of consumption.

# The Eaton-Gersovitz model: Parameters

- ▶ In all exercises
  - ▶ Period is a quarter, utility parameter:  $\sigma = 2$
  - ▶ Same output process (targeted to Argentina)<sup>1</sup>
- ▶ Other parameters vary across calibrations:
  - ▶ Real interest rate,  $r$
  - ▶ Maturity of the bonds,  $\delta$
  - ▶ Discount rate of the government,  $\rho_G$
  - ▶ Re-entry probability after default,  $\theta$
  - ▶ Output losses after default,  $\{y^D\}$

<sup>1</sup> Includes endowment specification of Chatterjee-Eyigungor (2012) to guarantee existence of pure strategy equilibria.

## Aguiar-Gopinath (2006) “transitory” calibration

One period bonds,  $y^D = 0.98y$ ,

$$\boxed{\rho_G = 0.89 \text{ (annual)}},$$

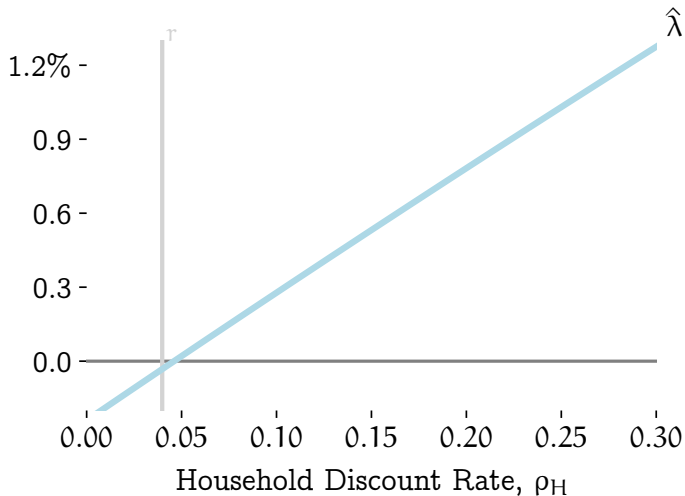
Quarterly:  $\theta = 0.1$ ,  $r = 0.01$

$\hat{\lambda}$ : result using benchmark model without uncertainty/default.

$\lambda, \lambda_{I,D,V}$ : actual results from model.

# Aguiar-Gopinath (2006) “transitory” calibration

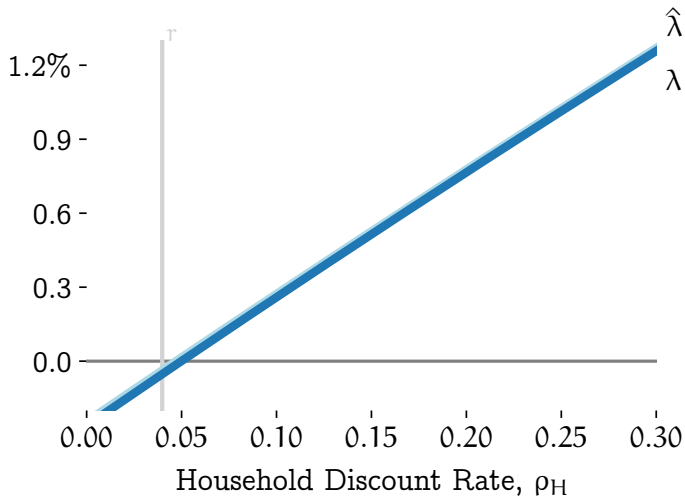
Welfare Gains from Financial Market Access





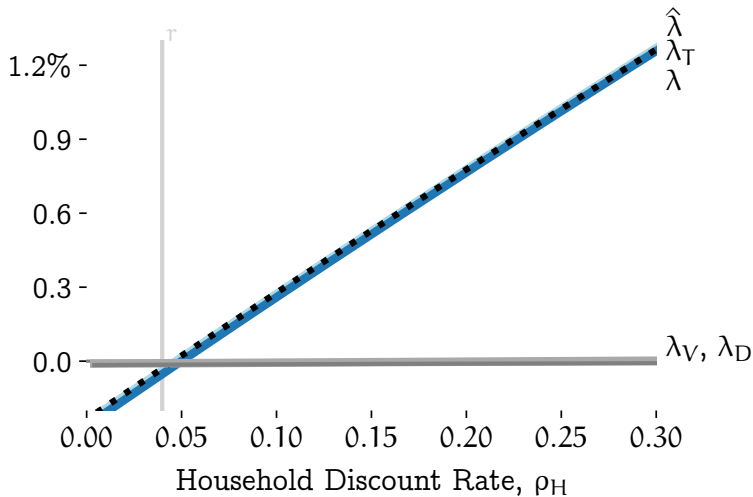
# Aguiar-Gopinath (2006) “transitory” calibration

Welfare Gains from Financial Market Access



# Aguiar-Gopinath (2006) “transitory” calibration

Welfare Gains from Financial Market Access



## Aguiar-Gopinath (2006) calibration: Summary

- ▶ Benchmark exercise right on top of AG calibration
  - ▶ Uncertainty does not add much
- ▶ Default probability is small
- ▶ Debt to output ratio is small

## Arellano (2008) calibration: Non-linear costs

- ▶ Improves model fit by introducing non-linear costs of default

$$y^D(s) = \min\{y(s), \lambda \mathbb{E}y\}$$

- ▶ Default is *less* costly in low endowment states
- ▶ Default probability comparable to the data

## Arellano (2008) calibration: Non-linear costs

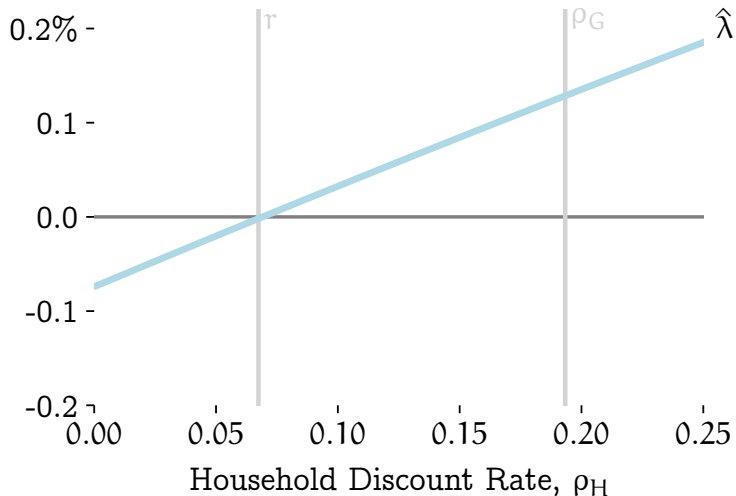
One period bonds,  $\rho_G = 0.19$  (annual),

$$y_t^D = \min\{y_t, 0.97\mathbb{E}y\}$$

Quarterly rates:  $\theta = 0.28$ ,  $r = 0.017$

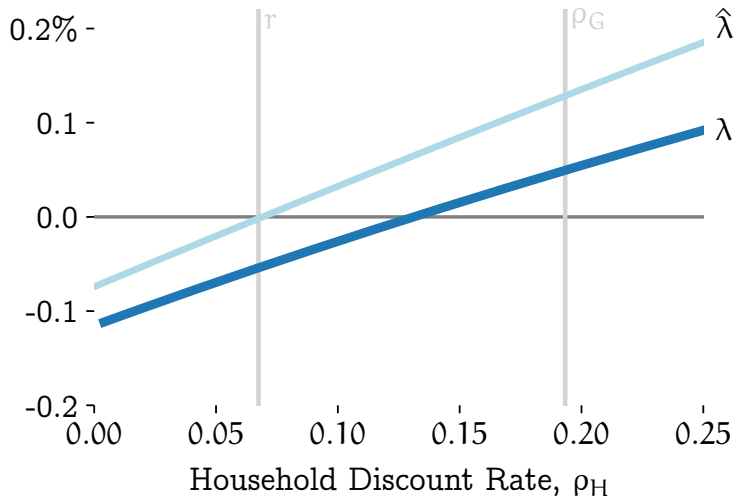
## Arellano (2008) calibration: Non-linear costs

### Welfare Gain Decomposition



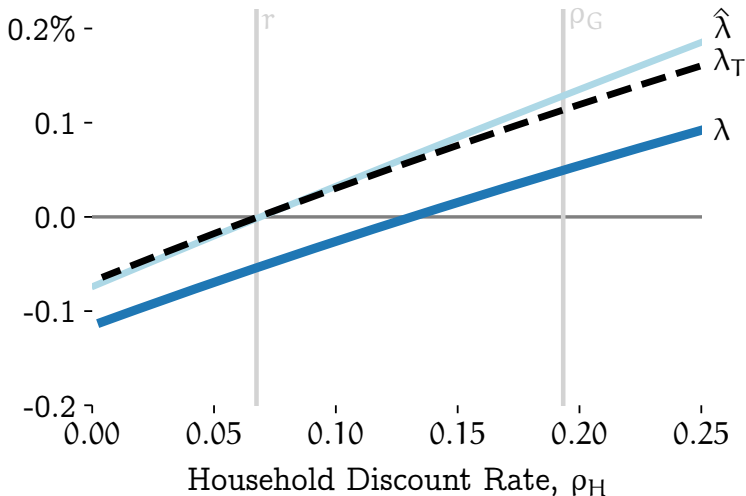
## Arellano (2008) calibration: Non-linear costs

### Welfare Gain Decomposition



# Arellano (2008) calibration: Non-linear costs

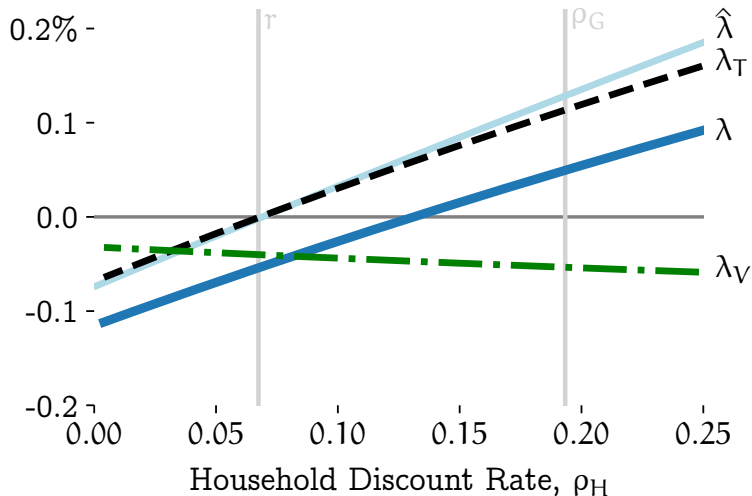
## Welfare Gain Decomposition





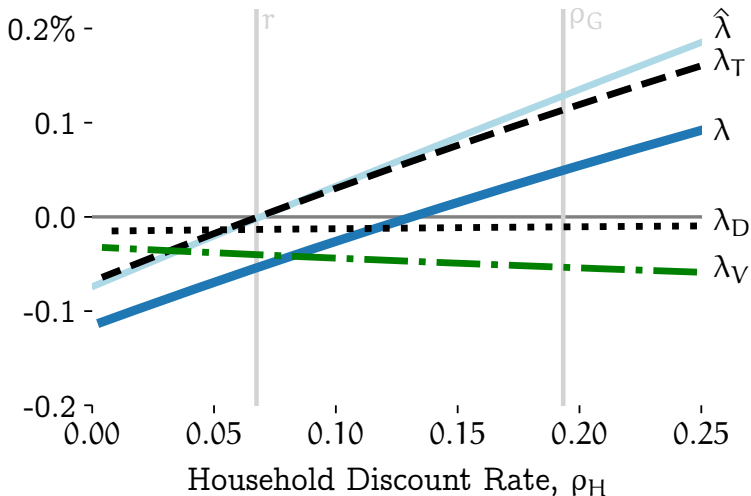
# Arellano (2008) calibration: Non-linear costs

## Welfare Gain Decomposition



# Arellano (2008) calibration: Non-linear costs

## Welfare Gain Decomposition



## Arellano (2008) calibration: Summary

- ▶ Disagreement
  - ▶ HH with less than 10% annual discount **prefer no access**
- ▶ By borrowing more in good times than bad
  - ▶ Government **introduces more variability** to the expenditure allocation
  - ▶ Opposite of consumption smoothing intuition
- ▶ Households dislike this – but magnitudes remain small
- ▶ What about default costs?
  - ▶ Default probability is higher, but equilibrium default costs are small

## Chatterjee and Eyigungor ('12): Long bonds

- ▶ These first models have problems:
  - ▶ Debt/output ratios were too small
  - ▶ Spreads were not volatile enough

## Chatterjee and Eyigungor ('12): Long bonds

- ▶ These first models have problems:
  - ▶ Debt/output ratios were too small
  - ▶ Spreads were not volatile enough
- ▶ Chatterjee and Eyigungor ('12) introduced long term bonds
  - ▶ Government borrows in bonds with maturity longer than one period
  - ▶ Also allowed for a more flexible specification of default costs
  - ▶ Significantly more complex to solve .. but much better fit

## Chatterjee and Eyigungor ('12): Long bonds

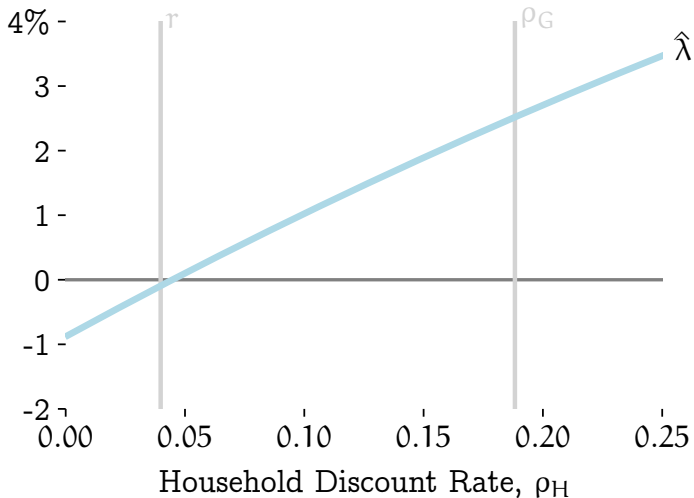
Long duration bonds,  $\rho_G = 0.19$  (annual)

Flexible default costs

Quarterly rates:  $\theta = 0.0385$ ,  $r = 0.01$

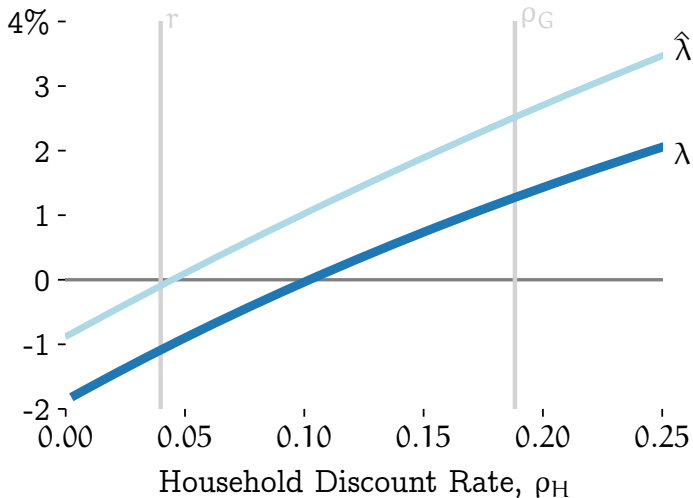
# Chatterjee and Eyigungor ('12): Long bonds

## Welfare Gain Decomposition



# Chatterjee and Eyigungor ('12): Long bonds

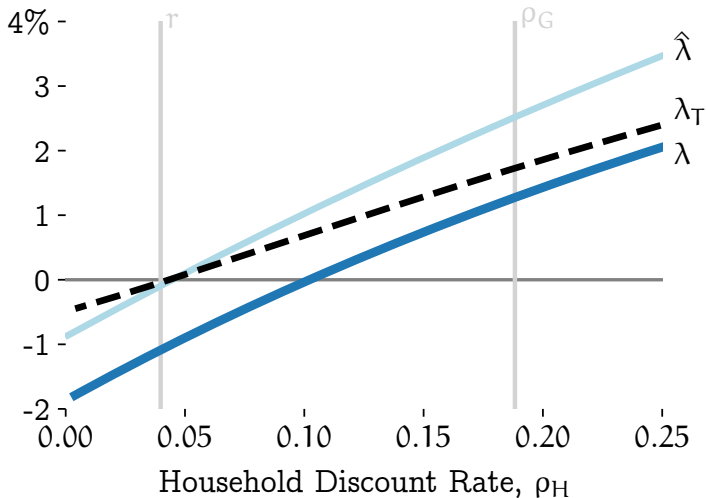
## Welfare Gain Decomposition





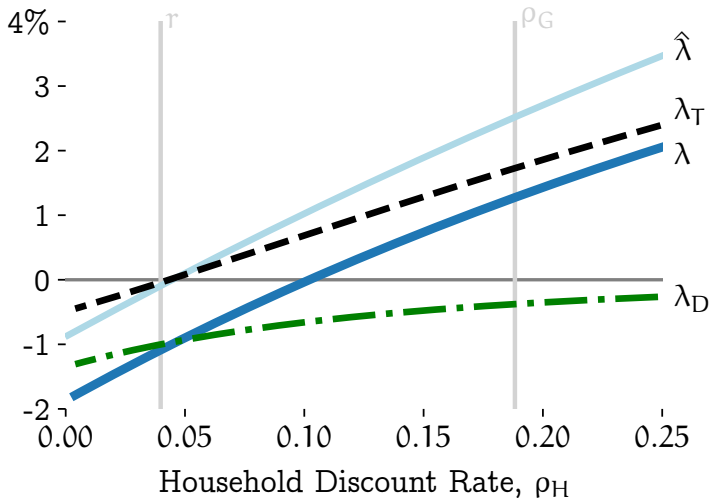
# Chatterjee and Eyigungor ('12): Long bonds

## Welfare Gain Decomposition



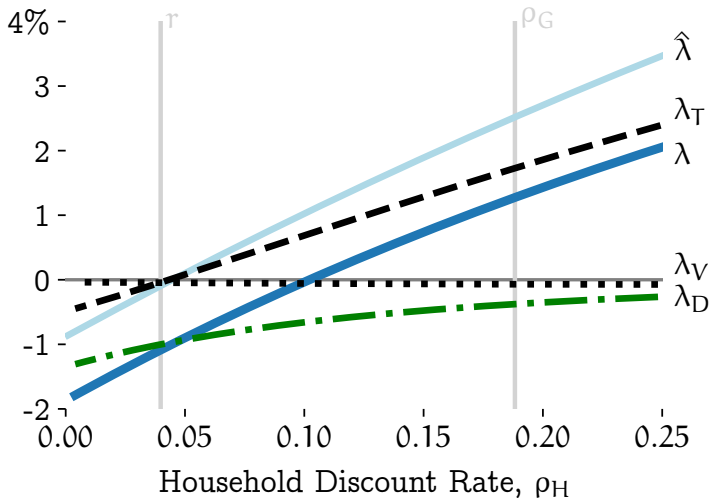
# Chatterjee and Eyigungor ('12): Long bonds

## Welfare Gain Decomposition



# Chatterjee and Eyigungor ('12): Long bonds

## Welfare Gain Decomposition



## Chatterjee and Eyigungor (2012): Summary

- ▶ Disagreement remains
  - ▶ HH with less than 10% annual discount prefer no access
- ▶ Welfare magnitudes much larger ( $\approx 1\%$ )
  - ▶ Much larger debt to output ratio
  - ▶ Default is happening in equilibrium and it is costly

## Conclusions

- ▶ When the government is impatient and can borrow, it generates three type of costs to more patient households:
  - ▶ It distorts allocation towards the present
  - ▶ It introduces extra variability in expenditures
  - ▶ It exposes the country to costly defaults
- ▶ The latter significantly strengthens the case against access to external sovereign debt markets.

# Conclusions

Default costs are key for welfare .. but we don't know enough

We are missing other things ..

- ▶ HH (private) external borrowing and investment
- ▶ Self-fulfilling debt runs / failed auctions / sudden stops
- ▶ Distortions in the composition of government expenditures
- ▶ Non-expected utility

.. leave this for future work.