Default and Interest Rate Shocks: Renegotiation Matters

Victor Almeida
Carlos Esquivel
Timothy J. Kehoe
Juan Pablo Nicolini

Barcelona School of Economics
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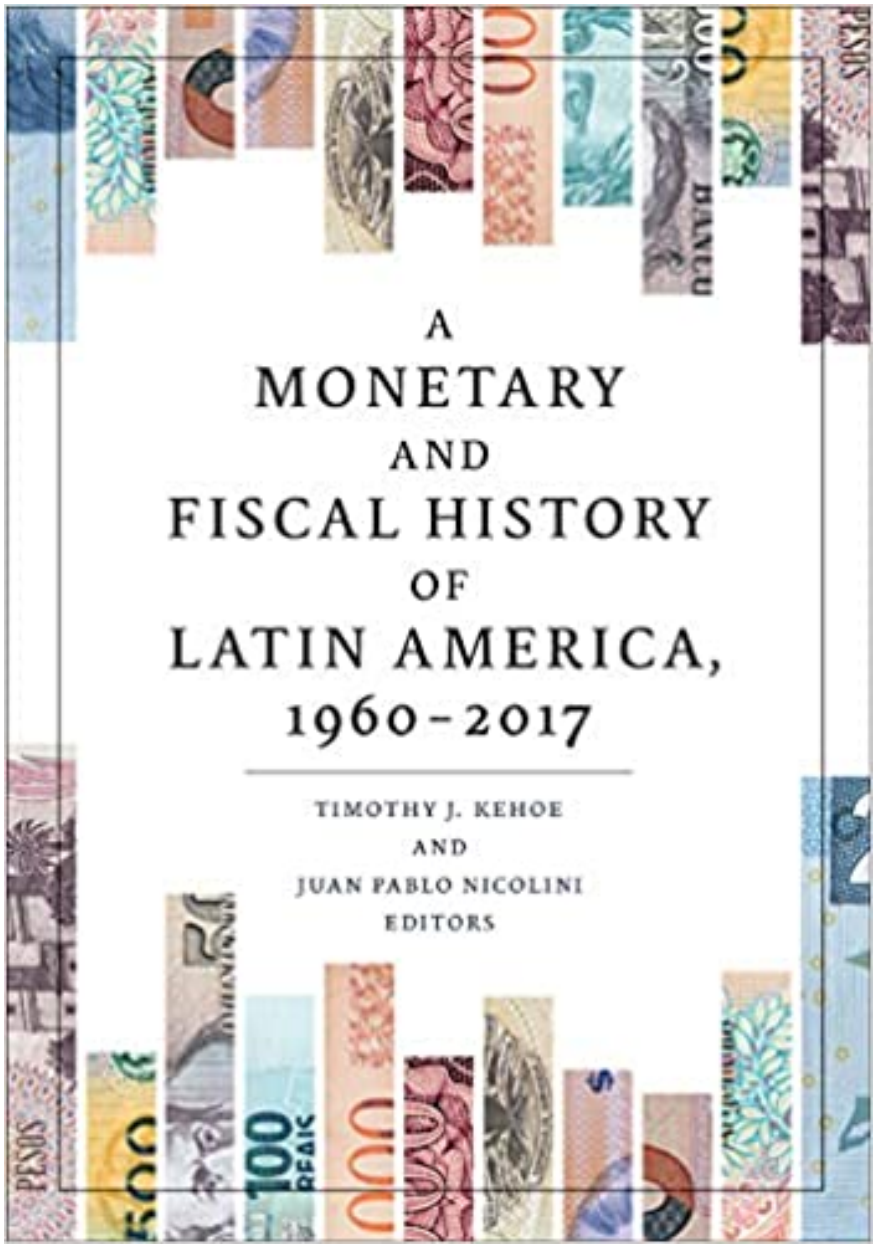
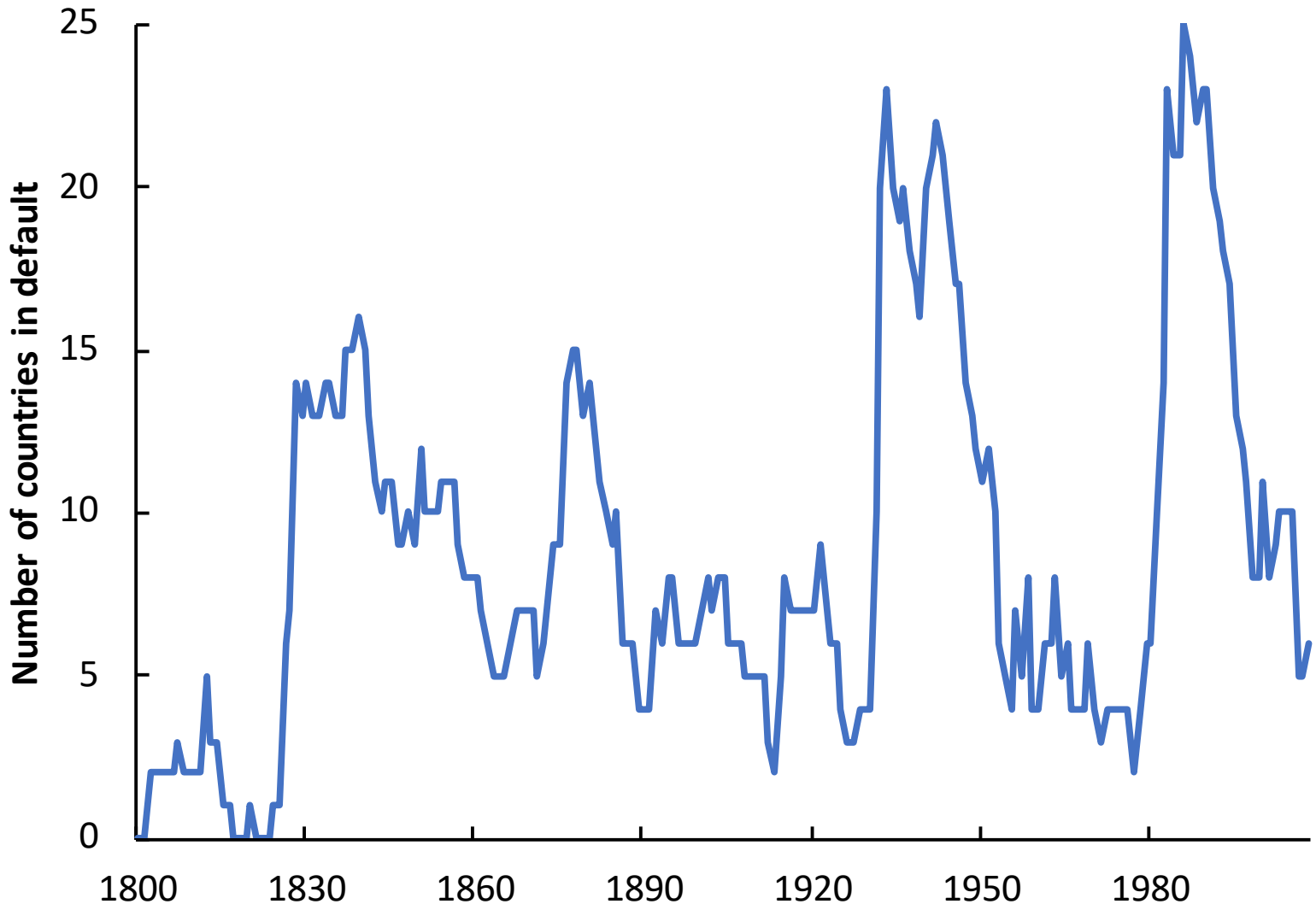
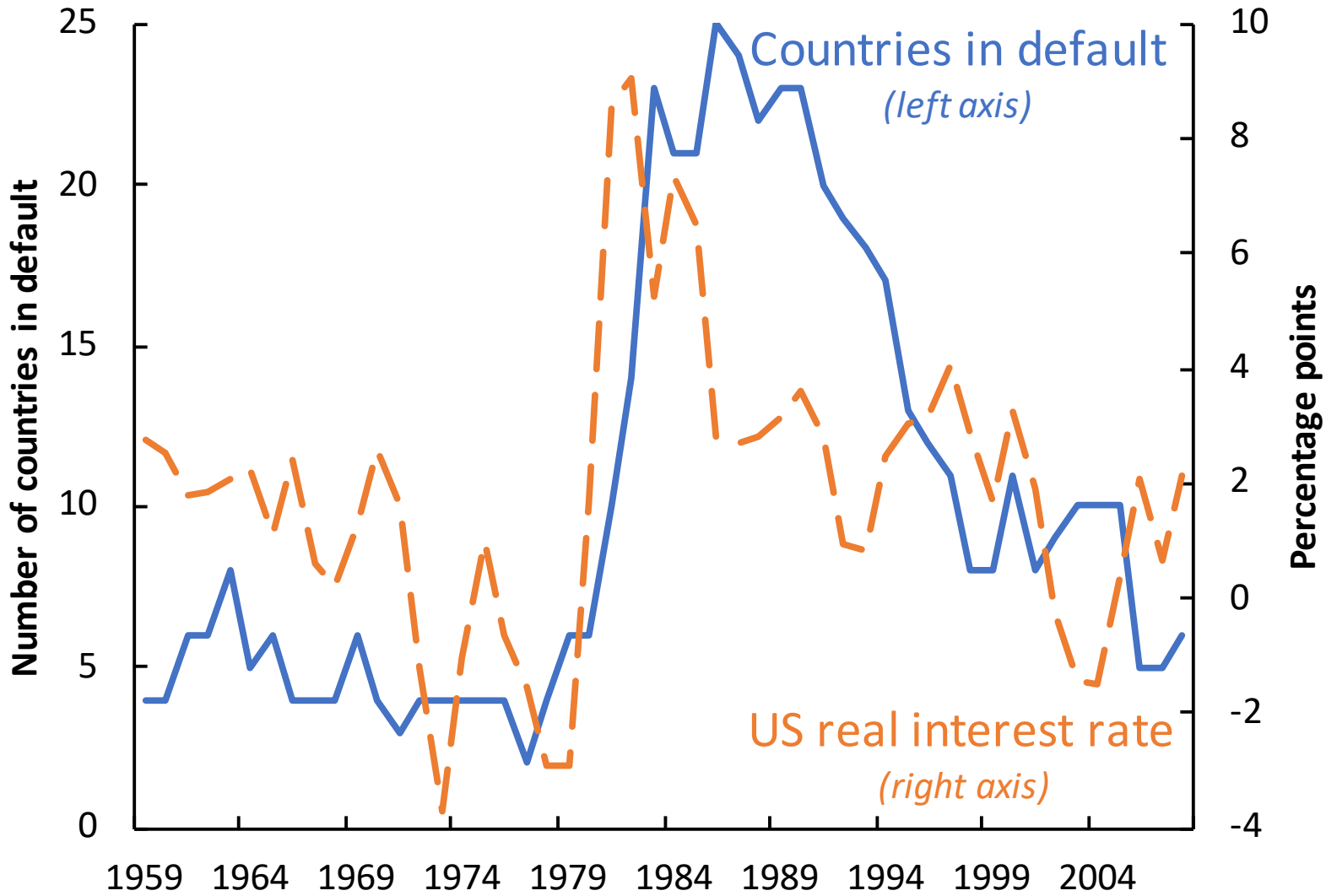
A Monetary and Fiscal History of Latin America, 1960-2017



Default status over time



Default status and US real interest rate



This paper

- Volcker Shock could have caused defaults in 1980s
- Sovereign default model with renegotiation of debt level
- World interest rates and default incentives
  - Standard mechanism: higher $r \implies$ higher borrowing costs
  - Our mechanism: higher $r \implies$ higher expected haircut
- Quantitative results:
  - Standard mechanism is negligible
  - Our mechanism is large
  - Set of states for which an increase in r explains the crisis is 12 times larger

Related literature

- **Sovereign default model**
  - Aguiar and Gopinath (2006), Arellano (2008)
- **Long term debt**
  - Hatchondo and Martinez (2009), Chatterjee and Eyigungor (2012)
- **Debt renegotiation**
  - Yue (2010), Hatchondo, Martinez, and Sosa-Padilla (2014)
- **Varying risk free interest rates**
  - Guimaraes (2011), Johri, Khan, and Sosa-Padilla (2016), Tourre (2017)

Model, environment

- Small open economy with stochastic income y_t

$$\log y_t = \rho \log y_{t-1} + \epsilon_t,\ \epsilon_t \sim N\left(0, \sigma_\epsilon^2\right)$$

- Preferences for consumption each period $u\left(c_t\right) = \frac{c_t^{1-\eta}-1}{1-\eta}$

- Sovereign can issue long term bonds, the stock of bonds is $b_t \in \left[\underline{b}, \bar{b}\right]$, $\underline{b} \leq 0$, $\bar{b} > 0$ finite

- Every period a fraction γ of outstanding bonds matures, the law of motion of the stock of bonds is:

$$b_{t+1} = \left(1-\gamma\right) b_t + i_t$$

- Large number of risk-neutral competitive lenders with deep pockets

Model, environment

- Volcker Shock: $r_t \in \left\{r^H, r^L\right\}$ follows a Markov chain with $Pr\left(r^H | r^j\right) = \lambda\left(r^j\right),\ j \in \{H, L\}$
- At the beginning of each period the sovereign can default:
  - Payment γb_t is not made
  - Income is $h\left(y_t\right) = y_t - \max\left\{0, \phi_0 y_t + \phi_1 y_t^2\right\},\ \phi_0 < 0 < \phi_1$
  - The stock of bonds is frozen: $b_{t+1} = b_t$
  - An opportunity to renegotiate arrives with probability θ

Model, state

- The state of the economy in period t is (b_t, y_t, r_t, z_{t-1})
  - b_t is the debt level
  - y_t is income
  - r_t is the interest rate
  - $z_{t-1} \in \{0, 1\}$ indicates if the sovereign was in default in $t-1$

Model, sovereign

- If the sovereign paid its debt in the previous period:

$$V(b, y, r, 0) = \max_{d \in \{0,1\}} \left\{ (1-d) V^P(b, y, r) + d V^D(b, y, r) \right\}$$

where the value of repaying is:

$$V^P(b, y, r) = \max_{b^P} \left\{ u(c) + \beta \mathbb{E}\left[V\left(b^P, y', r', 0\right) \right] \right\}$$
$$s.t. \quad c + \gamma b = y + q^P\left(b^P, y, r\right)\left[b^P - (1-\gamma) b\right]$$

and the value of defaulting is:

$$V^D(b, y, r) = u(c) + \beta \mathbb{E}\left[\theta V(b, y', r', 1) + (1-\theta) V^D(b, y', r') \right]$$
$$s.t. \quad c = h(y)$$

- If the sovereign defaulted in the previous period and has an opportunity to renegotiate:

$$V(b, y, r, 1) = \max_{a \in \{0,1\}} \left\{ a V^P\left(b^R(b, y, r), y, r\right) + (1-a) V^D(b, y, r) \right\}$$

Model, renegotiation

Renegotiated debt is the solution to a Nash Bargaining problem:

$$b^R(b,y,r) = \arg\max_{\tilde{b}} \left\{ S^{LEN}\left(\tilde{b},b,y,r\right)^{\alpha} S^{SOV}\left(\tilde{b},b,y,r\right)^{1-\alpha} \right\}$$

$$s.t. \quad S^{LEN}\left(\tilde{b},b,y,r\right) \geq 0 \text{ and } S^{SOV}\left(\tilde{b},b,y,r\right) \geq 0$$

where the surplus of the sovereign is

$$S^{SOV}\left(\tilde{b},b,y,r\right) = V^P\left(\tilde{b},y,r\right) - V^D(b,y,r)$$

and the surplus of the lenders is :

$$S^{LEN}\left(\tilde{b},b,y,r\right) = \gamma\tilde{b} + q^P\left(b^P\left(\tilde{b},y,r\right),y,r\right)(1-\gamma)\tilde{b} - q^D(b,y,r)\,b$$

Model, equilibrium

An equilibrium is value and policy functions, bonds price schedules, and a rule for renegotiated debt b^R such that:

1. Given prices and b^R, the value and policy functions solve the sovereign's problem

2. Bonds price schedules are consistent with lenders making zero profits in expectation

3. Given prices and the value and policy functions, b^R solves the bargaining problem

Market value of bonds

Market value of bonds in repayment:

$$q^P\left(b', y, r\right) b' = \frac{1}{1+r}\mathbb{E}\left[\left\{1 - d\left(b', y', r'\right)\right\}\left\{\gamma + (1-\gamma) q^P\left(b^P\left(b', y', r'\right), y', r'\right)\right\} b'\right] + \frac{1}{1+r}\mathbb{E}\left[d\left(b', y', r'\right) q^D\left(b', y', r'\right) b'\right]$$

Market value of bonds

Market value of bonds in repayment:

$$q^P\left(b',y,r\right)b' = \frac{1}{1+r}\mathbb{E}\left[\left\{1-d\left(b',y',r'\right)\right\}\left\{\gamma+(1-\gamma)q^P\left(b^P\left(b',y',r'\right),y',r'\right)\right\}b'\right] + \frac{1}{1+r}\mathbb{E}\left[d\left(b',y',r'\right)q^D\left(b',y',r'\right)b'\right]$$

Market value of defaulted bonds:

$$\begin{aligned} q^D\left(b',y,r\right)b' = \frac{\theta}{1+r}\mathbb{E}\Big[a\left(b',y',r'\right)b^R\left(b',y',r'\right)\{\gamma \\ +(1-\gamma)q^P\left(b^P\left(b^R\left(b',y',r'\right),y',r'\right),y',r'\right)\}\Big] \\ + \frac{\theta}{1+r}\mathbb{E}\left[\left\{1-a\left(b',y',r'\right)\right\}q^D\left(b',y',r'\right)b'\right] \\ + \frac{1-\theta}{1+r}\mathbb{E}\left[q^D\left(b',y',r'\right)b'\right] \end{aligned}$$

Characterization of the renegotiation game

- Proposition: Market value $q^D(b', y, r)b'$ does not depend on b'
- Proposition: Renegotiated debt b^R does not depend on b
- Proposition: As $\alpha \to 0$ both $q^D \to 0$ and $b^R \to 0$
- Conjecture: For any $\alpha \in [0, 1]$
  - $q^P(b', y, r^H) \leq q^P(b', y, r^L)$
  - $q^D(b', y, r^H) \leq q^D(b', y, r^L)$
  - $b^R(y, r^H) \leq b^R(y, r^L)$

High interest rates and default incentives

The sovereign defaults if

$$V^P(b, y, r) < V^D(b, y, r)$$

Standard mechanism:

- $V^P\left(b, y, r^H\right) < V^P\left(b, y, r^L\right)$ (*higher borrowing costs*)

Our mechanism (with persistent r):

- $V^D\left(y, r^H\right) > V^D\left(y, r^L\right)$ (*lower expected renegotiated debt*)

High interest rates and spreads

$$q^P(b', y, r) = \underbrace{\frac{1}{1+r}}_{\text{Standard mechanism}} \mathbb{E}\left[\{1 - d(\cdot)\}\left\{\gamma + (1-\gamma)\, q^P\left(b^P(\cdot), y', r'\right)\right\}\right]$$

$$+ \underbrace{\frac{1}{1+r}}_{\text{Standard mechanism}} \mathbb{E}\left[\underbrace{d(b', y', r')\, q^D(b', y', r')}_{\text{Our mechanism}}\right]$$

Standard mechanism:

- Higher r reduces q^P

Our mechanism (with persistent r):

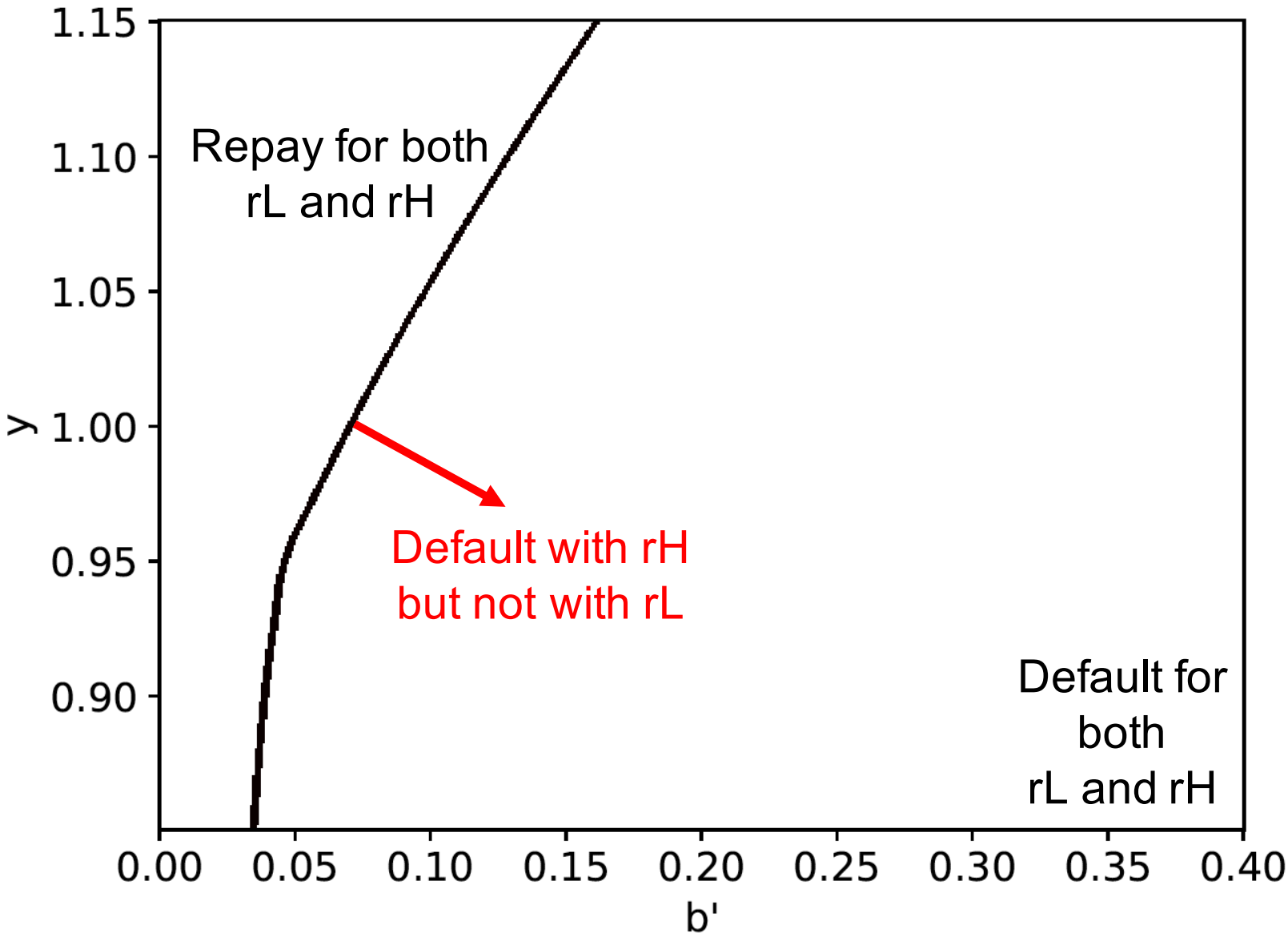
- Higher r' reduces $b^R \longrightarrow$ reduces q^D

Calibration: Mexico 1982

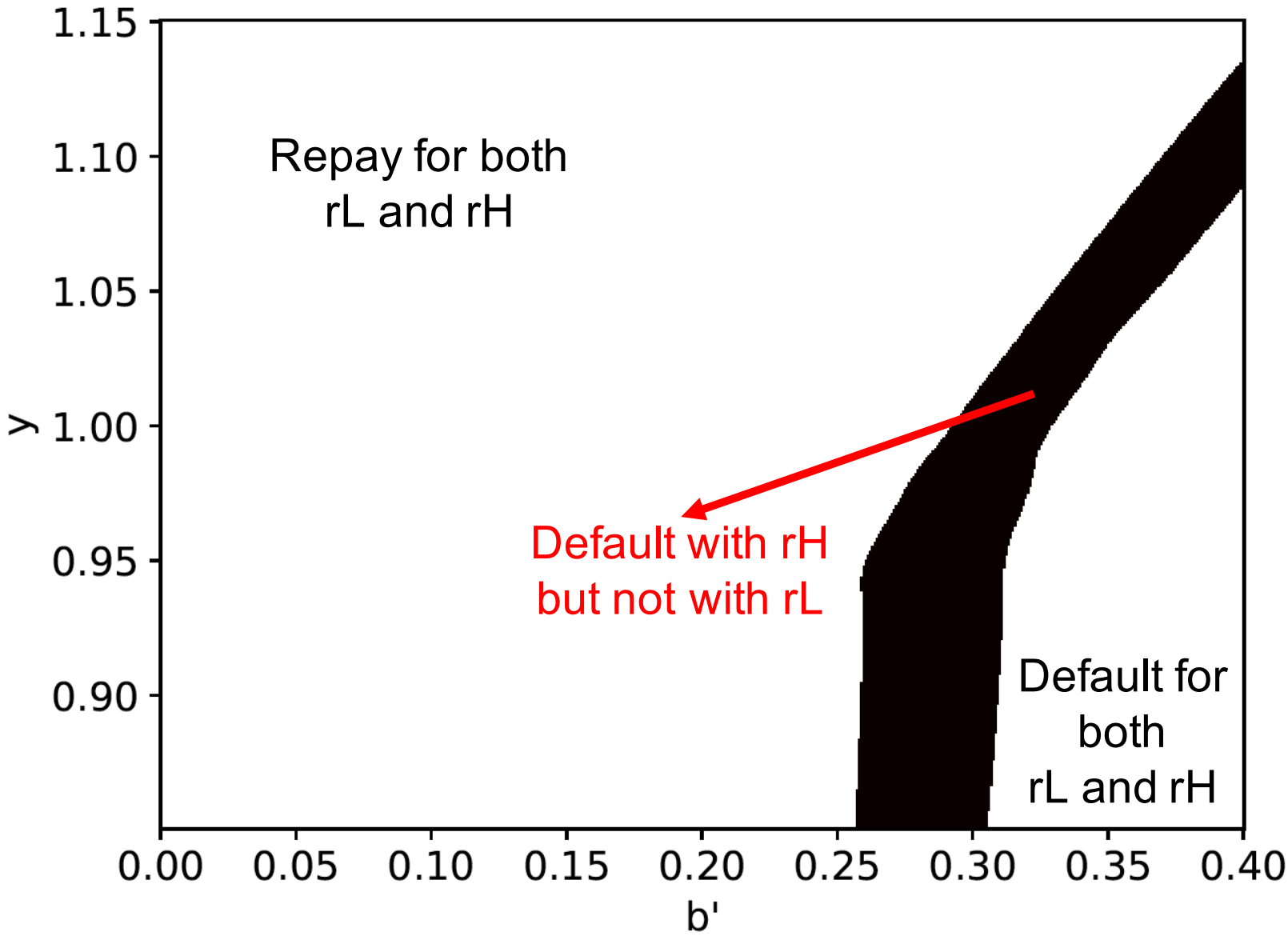
Parameters		Values	Details
Low r	r_L	1.2%	1955 - 1980
High r	r_H	6.2%	1981 - 1985
Pr(low to high r)	$\lambda(r_L)$	1%	Duration of 100 years
Pr(high to low r)	$1-\lambda(r_H)$	20%	Duration of 5 years
Pr(renegotiation)	θ	28%	Arellano (2008)
Maturity rate	γ	0.75	Sixteen month bonds
Discount factor	β	0.94	LR interest rate of 6%
Risk aversion	η	2	Standard
Income process	ρ	0.705	AR(1) estimation
	σ_ϵ	0.040	annual data 1933-1983

Parameter		Value	Moment	Data	Model
Bargaining power	α	0.40	Haircut in 1990	30.5%	23.1%
Quadratic income	ϕ_0	-0.25	Default probability	3.0%	3.54%
cost function	ϕ_1	0.26	Debt-to-GDP ratio	19.3%	18.6%

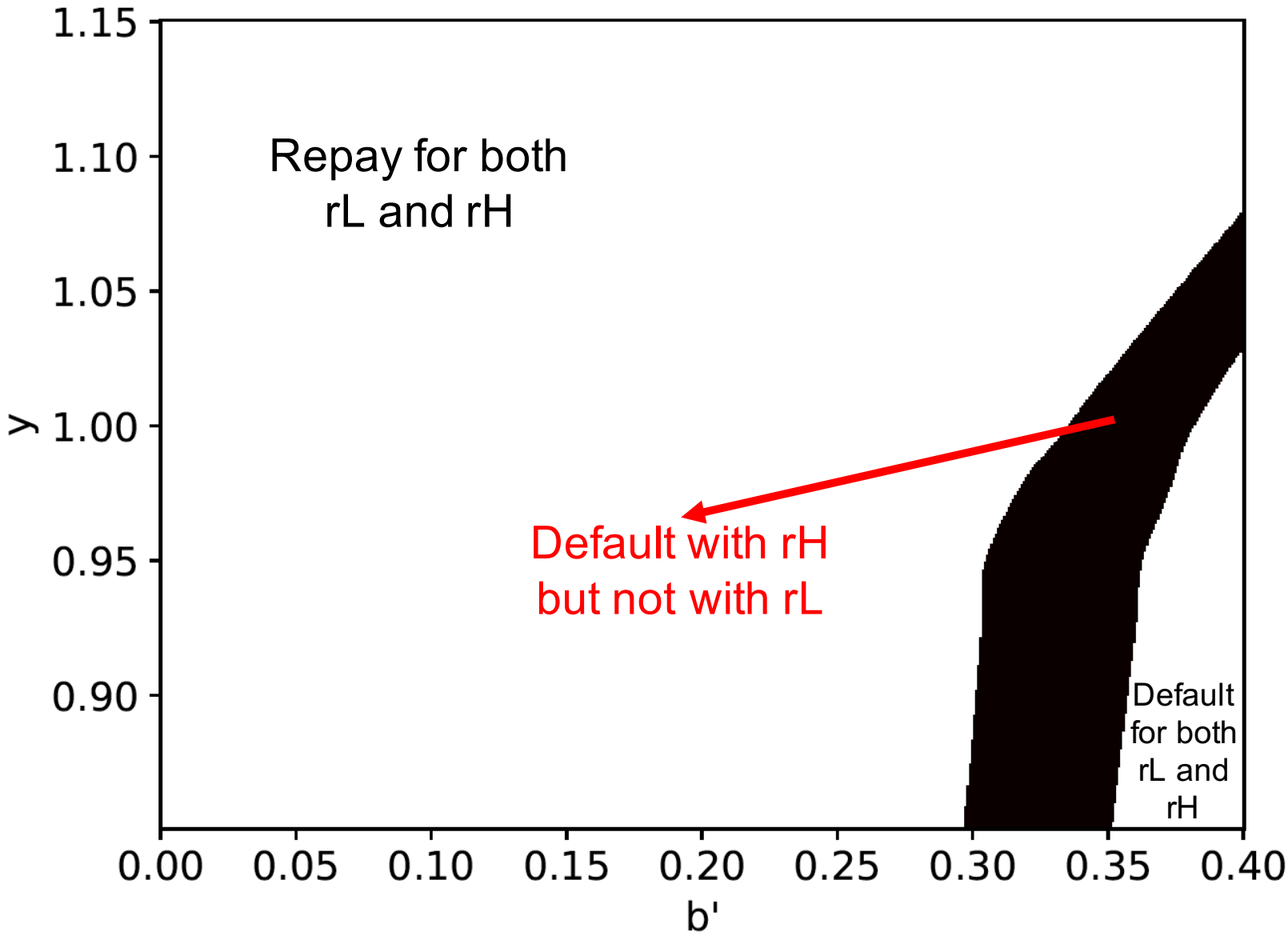
Model, $\alpha = 0.0$



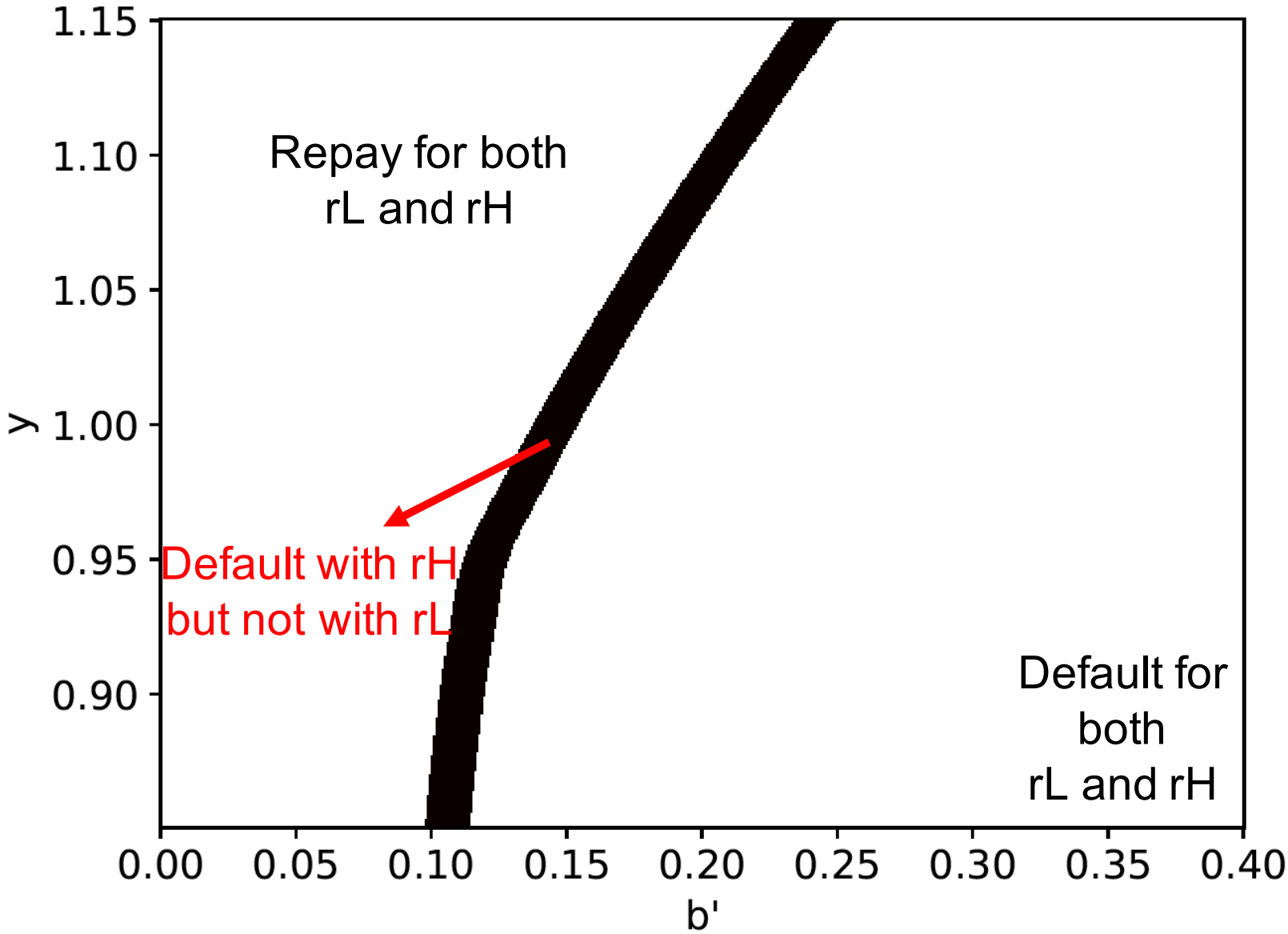
Model, $\alpha = 0.4$



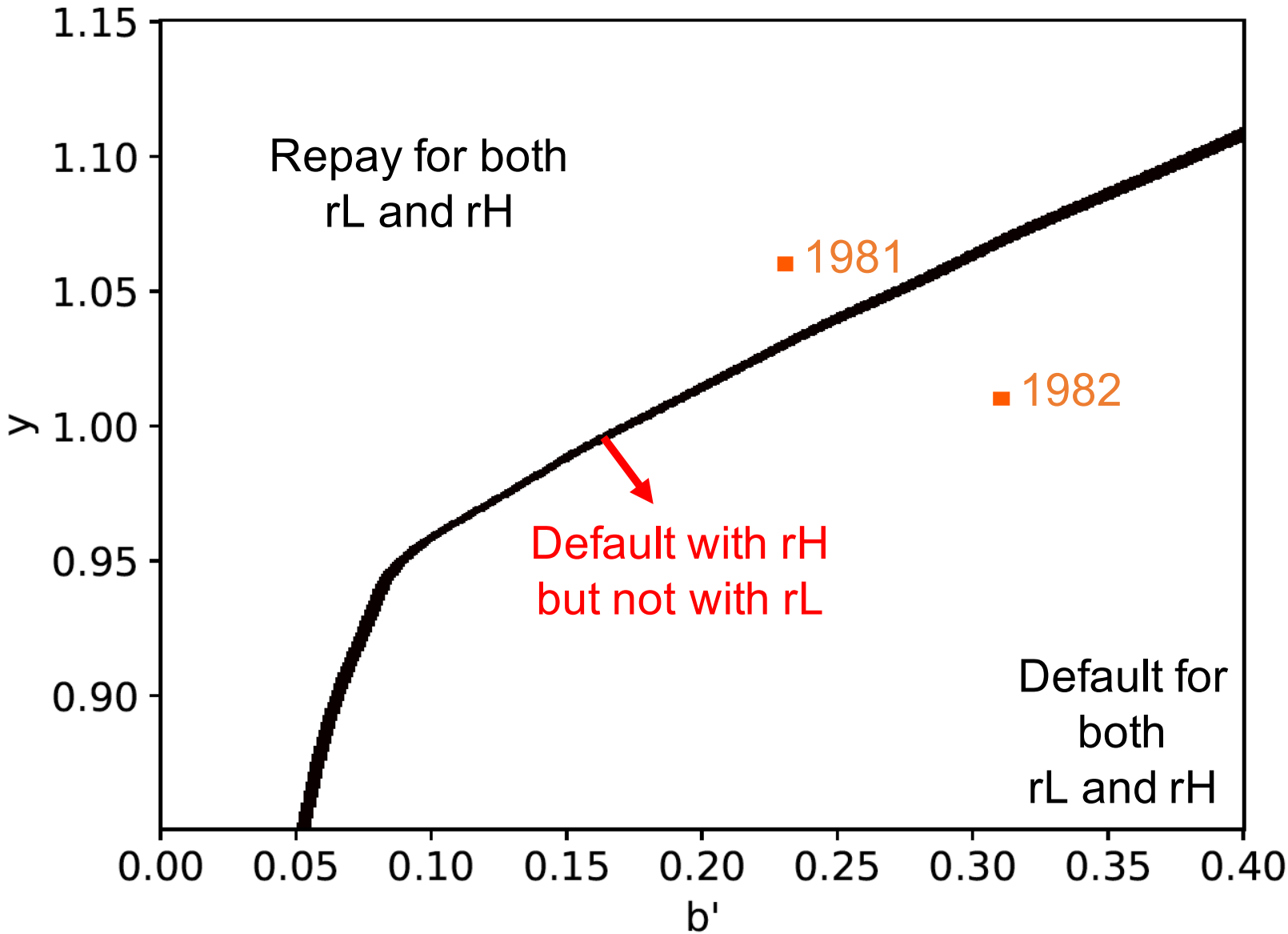
Model, $\alpha = 0.5$



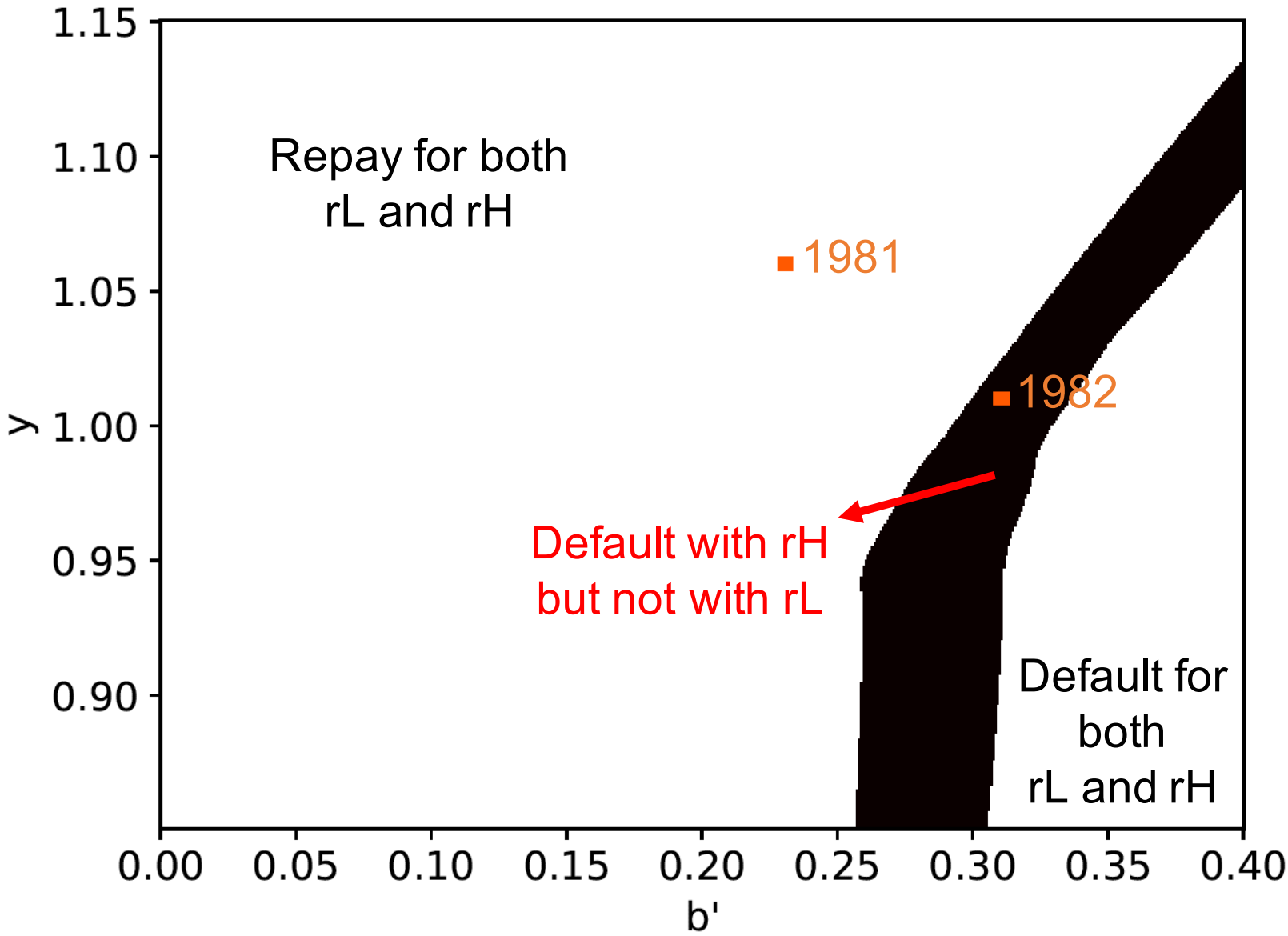
Model, $\alpha = 0.10$



Model, no renegotiation, $\alpha = 0.0$



Model, renegotiation, $\alpha = 0.4$



Renegotiation failure

- Renegotiation attempts every two years
- Renegotiation unsuccessful until Brady Plan in 1989/1990
- Potential explanation: US regulators did not allow banks to write down the debt

"Had these institutions been required to mark their sometimes substantial holdings of underwater debt to market or to increase loan-loss reserves to levels close to the expected losses on this debt (as measured by secondary market prices), then institutions such as Manufacturers Hanover, Bank of America, and perhaps Citicorp would have been insolvent." (Lewis William Seidman, *Full Faith and Credit*)

History of lost decade

"The entire Ford administration, including me, told the large banks that the process of recycling petrodollars to the less developed countries was beneficial, and perhaps a patriotic duty." (Lewis William Seidman, *Full Faith and Credit*)

- 1979 reinterpretation of law
  - Loans to a single borrower could not exceed 10 percent of bank's capital: different government agencies in foreign countries are different borrowers
- Regulation during 1980s
  - No reserves requirements for delinquent LDCs loans
  - First bank to recognize loses was Citibank in 1987
  - Loans to LDCs to keep up with interest payments