Mortgage Boom in Peru: Lending and Borrowing Constraints in a DSGE framework

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Motivation

- Housing and mortgage markets played an important role in the financial crisis that affected most developed economies in the recent past.
- Prior to the Great Recession, many of those countries experienced increasing housing prices, massive capital inflows and credit booms.
- Peru has been experiencing those patterns for more than a decade.
- **What causes mortgage credit booms?**

Financial Constraints and Credit Booms

Justiniano et al. (2015)

- Draw a distinction between supply and demand for credit as potential drivers of a credit boom.
- Credit demand shifters: borrowing constraints.
  - Kiyotaki and Moore (1997), Iacoviello (2005).
  - Modelling: collateral constraint tied to real estate stock value.
  - Loosening: households have access to mortgage with higher loan-to-value or multiple mortgages on the same property.
- Loan supply shifters: lending constraints.
  - Justiniano et al. (2013, 2015), Mian and Sufi (2009).
  - Modelling: leverage restrictions on financial intermediaries.
  - Loosening: financial intermediation innovation and inflow of foreign funds. Securitization.

Peruvian Case

Mortgage Credit Supply Expansion

- Banks access to international financial markets.
- Increasing competition in banking industry.
- New mortgage credit markets related companies.

Mortgage Credit Demand Expansion

- New and favorable macro trends and national housing shortage.
- Mortgage credit demand-boosting public funds and programs.
  - *Fondo MiVivienda, TechoPropio, Crédito MiHogar.*
  - Access of low and middle class households to mortgage credits.
  - Higher LTV's, longer periods, conditioned subsidies to reduce payments.

Purpose

Objective

- Determine the relative importance of the relaxation of lending and borrowing constraints as drivers of the mortgage credit boom observed in Peru during the last decade.

Approach

- Develop a large-scale DSGE model for a small open economy with partially dollarized credit markets and borrowing, lending constraints and other shocks.
- Historical shock decomposition (HSD) and counterfactual simulations (CS) exercises.

An Overview I

Agents

- **Patient households**: consume, work and accumulate housing and save.
- **IDC households**: consume, work and accumulate housing and hold debt denominated in domestic currency (Soles).
- **IFC households**: consume, work and accumulate housing and hold debt denominated in foreign currency (Dollars).
- **Entrepreneurs**: produce intermediate goods using capital and labor. Hold debt denominated in Soles.

Markets

- **Labour market**: HH supply differentiated labour through labour unions.
- **Capital and housing producers**: use a technology subjected to investment adjustment costs.
- **Producing sector**: domestic, importing and exporting retailers, and final good producers.
- **Banking system**: use deposits, reinvested profits and foreign debt to grant loans to impatient agents. Subjected to leverage restrictions.

An Overview II

Macro Environment

- **Government**: uses lump sum taxes to finance public expenditure.
- **Central bank**: sets the monetary policy rate according to a Taylor Rule.
- **Foreign sector**: foreign Taylor Rule, and foreign output and inflation autoregressive processes.

Financial Constraints

- **Borrowing constraints**: loan-to-value imposed on credit users.
- **Lending constraints**: leverage restriction on bank (unique lender).

Patient Households

- Patient households' program:

$$\text{Max } E_0 \sum_{t=o}^{\infty} \beta_P^t \left[\frac{\left(c_t^P(\iota) - \zeta c_{t-1}^P(\iota)\right)^{1-\sigma_c}}{1-\sigma_c} + \varepsilon_{h,t} \frac{h_t^P(\iota)^{1-\sigma_h}}{1-\sigma_h} - \frac{n_t^P(\iota)^{1-\sigma_n}}{1-\sigma_n} \right]$$

$$\text{s.t. } P_t c_t^P + P_t^h \left(h_t^P - (1-\delta_h) h_{t-1}^P\right) + d_t^P \leq W_t n_t^P + R_{t-1}^d d_{t-1}^P - T_t + \Pi_t^P$$

IDC Households

- IDC households' program:

$$\text{Max } E_0 \sum_{t=o}^{\infty} \beta_{IDC}^t \left[\frac{\left(c_t^{IDC}(\iota) - \zeta c_{t-1}^{IDC}(\iota)\right)^{1-\sigma_c}}{1-\sigma_c} + \varepsilon_{h,t} \frac{h_t^{IDC}(\iota)^{1-\sigma_h}}{1-\sigma_h} - \frac{n_t^{IDC}(\iota)^{1-\sigma_n}}{1-\sigma_n} \right]$$

$$\text{s.t. } P_t c_t^{IDC} + P_t^h \left(h_t^{IDC} - (1-\delta_h)\, h_{t-1}^{IDC}\right) + R_{t-1}^{bIDC} b_{t-1}^{IDC} \leq W_t n_t^{IDC} + b_t^{IDC} - T_t$$

$$\text{s.t. } R_t^{bIDC} b_t^{IDC} \leq m_t^{IDC} E_t \left[P_{t+1}^h (1-\delta_h) h_t^{IDC}\right]$$

IFC Households

- IFC households' program:

$$\text{Max } E_0 \sum_{t=o}^{\infty} \beta_{IFC}^t \left[\frac{\left(c_t^{IFC}(\iota) - \zeta c_{t-1}^{IFC}(\iota)\right)^{1-\sigma_c}}{1-\sigma_c} + \varepsilon_{h,t} \frac{h_t^{IFC}(\iota)^{1-\sigma_h}}{1-\sigma_h} - \frac{n_t^{IFC}(\iota)^{1-\sigma_n}}{1-\sigma_n} \right]$$

$$\text{s.t. } P_t c_t^{IFC} + P_t^h \left(h_t^{IFC} - (1-\delta_h)\, h_{t-1}^{IFC}\right) + R_{t-1}^{bIFC} S_t b_{t-1}^{IFC} \leq W_t n_t^{IFC} + S_t b_t^{IFC} - T_t$$

$$\text{s.t. } R_t^{bIFC} S_t b_t^{IFC} \leq m_t^{IFC} E_t \left[P_{t+1}^h (1-\delta_h) h_t^{IFC}\right]$$

Banking Sector

- Bank's problem:

$$\text{Max } E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^{P} \Big[R_t^{bIDC} B_t^{IDC} + R_t^{bIFC} S_t B_t^{IFC} + R_t^{bE} B_t^{E} - R_t^{d} D_t - R_t^{b*} S_{t+1} B_t^{*} - K_t^{b} - CK_t^{IDC} - CK_t^{IFC} - CK_t^{E} \Big]$$

$$\text{s.t. } B_t^{IDC} + S_t B_t^{IFC} + B_t^{E} = D_t + S_t B_t^{*} + K_t^{b}$$

$$\text{where } B_t^{IDC} = \gamma^{IDC} b_t^{IDC};\ B_t^{IFC} = \gamma^{IFC} b_t^{IFC};\ B_t^{E} = \gamma^{E} b_t^{E} \text{ and } D_t^{P} = \gamma^{E} d_t^{P}$$

$$s \in \{IDC, E\} CK_t^{s} = \frac{\kappa_{K^{bs}}}{2} \left(\frac{K_t^{b}}{B_t^{s}} - v_{s,t} \right)^2 K_t^{b};\ \ CK_t^{IFC} = \frac{\kappa_{K^{bIFC}}}{2} \left(\frac{K_t^{b}}{S_t B_t^{IFC}} - v_{IFC,t} \right)^2 K_t^{b}$$

Calibration and Estimation

- I partly calibrate and partly estimate the parameters set.

Calibration

- Steady-state ratios: 2003-2015 period average ratios.
- Parameters established in the literature.

Estimation

- Bayesian estimation.
- 14 series: 4 macro, 4 interest rates, 4 financial, 2 foreign series. Source: BCRP's data base.
- Sample period: 2003Q1 - 2015Q4.
- Structural parameters that affect model's dynamics.
- Parameters that govern the shock processes.

Calibration

Parameter	Description	Value
Population Measures		
γ^{IDC}	IDC households' mass measure	0.15
γ^{IFC}	IFC households' mass measure	0.10
γ^{E}	Entrepreneurs' mass measure	0.25
Preferences Parameters		
β_P	Patient households' discount factor	0.998
β_{IDC}	IDC households' discount factor	0.975
β_E	Entrepreneurs' discount factor	0.980
Capital and Housing Producers		
δ_k	Physical capital depreciation rate	0.025
δ_h	Housing depreciation rate	0.0125
Banking sector		
$\bar{m}^{IDC}$	Steady state LTV for IDC households	0.80
$\bar{m}^{IFC}$	Steady state LTV for IFC households	0.70
$\bar{m}^{E}$	Steady state LTV for entrepreneurs	0.60
Aggregate Variables		
$\bar{\pi}$	Steady state gross inflation rate	1.028
$\bar{R}$	Steady state gross interest rate	1.038
Foreign Sector		
$\bar{\pi}^*$	Steady state gross foreign inflation rate	1.020
$\bar{RF}^*$	Steady state gross foreign interest rate	1.021

Estimation

Parameter	Prior distribution			Posterior distribution	
	Shape	Mean	Std. Dev.	Mean	Std. Dev.
Preferences Parameters					
ζ	Beta	0.75	0.10	0.44	0.048
σ_c	Normal	2.00	0.10	1.75	0.050
σ_h	Normal	4.00	0.10	3.98	0.029
σ_n	Normal	4.00	0.10	4.00	0.053
Capital and Housing Producers					
κ_k	Beta	0.20	0.05	0.21	0.015
κ_h	Beta	0.02	0.005	0.02	0.002
Producing Sector					
θ_H	Beta	0.75	0.05	0.63	0.017
θ_F	Beta	0.90	0.05	0.93	0.017
θ_H^*	Beta	0.20	0.10	0.62	0.070
Banking Sector					
$\kappa_{K^{bIDC}}$	Gamma	1.00	0.50	1.15	0.259
$\kappa_{K^{bIFC}}$	Gamma	1.00	0.50	0.003	0.258
$\kappa_{K^{bE}}$	Gamma	1.00	0.50	1.00	0.216
Monetary Policy Rule					
ϕ_R	Beta	0.70	0.10	0.85	0.031
ϕ_π	Normal	1.50	0.10	1.49	0.048
ϕ_R	Normal	0.50	0.10	0.58	0.059

Dynamics Analysis

- Study impulse response functions of a select set of variables.
- IRF's to 1 percent shocks.

Borrowing Constraint Shock

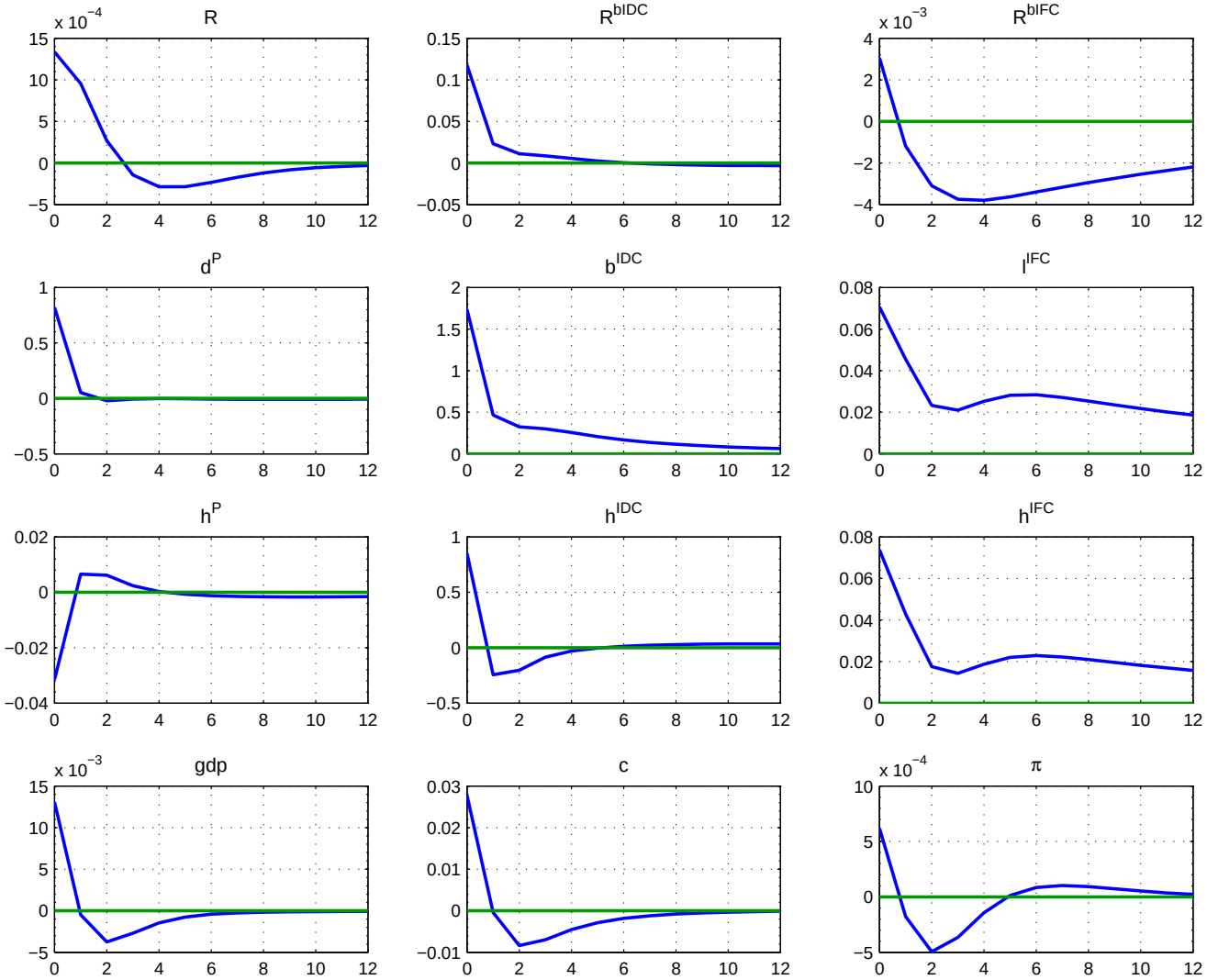
- Positive innovation to IDC loan-to-value process.
- Borrowing constraint slackening.

Lending Constraint Shock

- Negative innovation to IDC bank capital-to-asset ratio process.
- Lending constraint slackening.

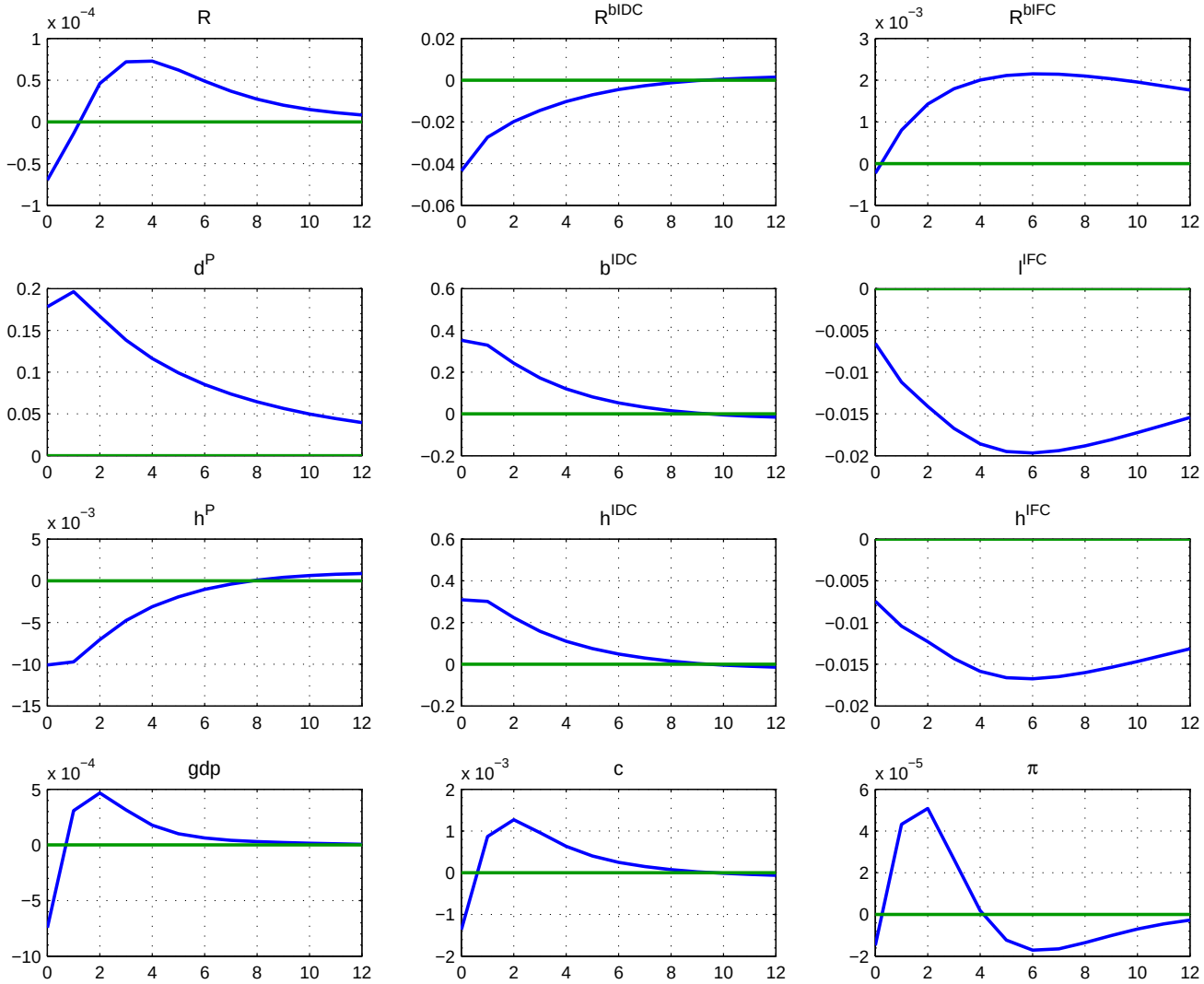
IRF's to a IDC Borrowing Constraint Shock

- 1 percent increase in IDC loan-to-value ratio.



IRF's to a IDC Lending Constraint Shock

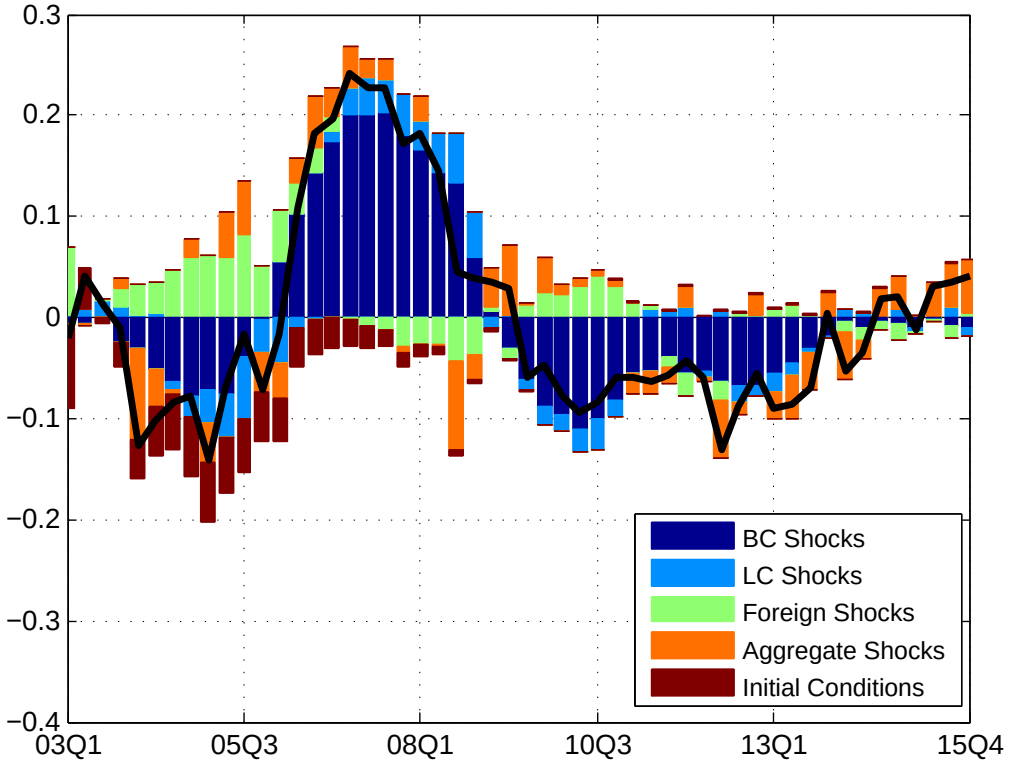
- 1 percent reduction in IDC bank capital-to-assets ratio.



Historical Shock Decomposition - HSD

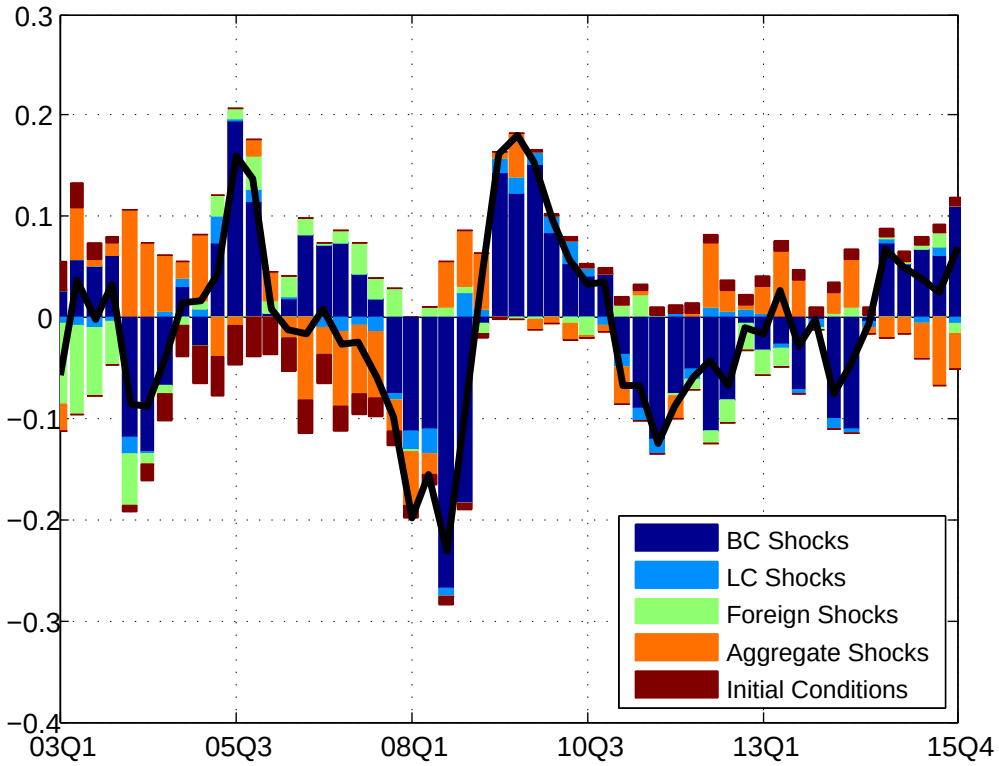
- Shock decomposition: use the Kalman Smoother algorithm to express the endogenous variables as functions of smoothed structural shocks and initial conditions.
- Gerali et al. (2010): smoothed variable is the model's "best guess" given all the data.
- Determine the contribution of the smoothed shocks to the deviations of the endogenous variables from their steady-state.
- Group of shocks: BC Shocks, LC Shocks, Foreign Shocks, Aggregate Shocks.

HSD on IDC Leverage Ratio



- Business cycle fluctuations were driven mainly by borrowing constraints shocks, i.e. mortgage credit demand shifts.
- Lending constraints shocks have a secondary role.

HSD on IFC Leverage Ratio



- Evidence is not as strong as the previous case.
- Borrowing constraints appear to have larger contributions.

Conclusion I

- I draw a distinction between demand and supply for credit as potential drivers of a credit boom and interpret a BC slackening as a credit demand expansion driver and loose LC as loan supply shifter.
- This paper determines the relative importance of the relaxation of LC and BC as drivers of the mortgage credit boom observed in Peru during the last decade.
- I develop a large-scale DSGE model for a SOP with partially dollarized credit markets and conduct HSD and CS exercises.
- I model loose BC as an increase in LTV ratios, while the relaxation of LC is modelled as a decrease in bank capital-to-assets ratios.

Conclusion II

- The results reveal that the two types of impatient HH's leverage ratios' business cycles fluctuations were mainly driven by borrowing constraints shocks or **credit demand shifts**.

Why not LC relaxation?

- In Peru there has not been an important financial intermediation innovation.
- Peruvian banking system is not as integrated to the international financial markets as the American.

Why BC relaxation?

- Consistent with a mortgage credit demand recuperation encouraged by a supportive macroeconomic performance and demand-boosting public programs.

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Entrepreneurs

- Entrepreneurs's problem:

$$\text{Max } E_0 \sum_{t=o}^{\infty} (\beta_E)^t \left(\frac{\left(c_t^E(\iota) - c_{t-1}^E(\iota)\right)^{1-\sigma_c}}{1-\sigma_c} \right)$$

$$\text{s.t. } P_t c_t^E + W_t n_t + P_t^k \left(k_t - (1-\delta_k) k_{t-1}\right) + P_t \psi\left(u_t\right) k_{t-1} + R_{t-1}^{bE} b_{t-1}^E = P_t^W y_{W,t} + b_t^E$$

$$\text{s.t. } R_t^{bE} b_t^E \leq m_t^E E_t \left[P_{t+1}^k (1-\delta_k) k_t^E\right]$$

$$\text{where } y_{W,t}\left(\iota\right) = A_t \left[u_t\left(\iota\right) k_{t-1}\left(\iota\right)\right]^{\alpha} n_t\left(\iota\right)^{1-\alpha}$$

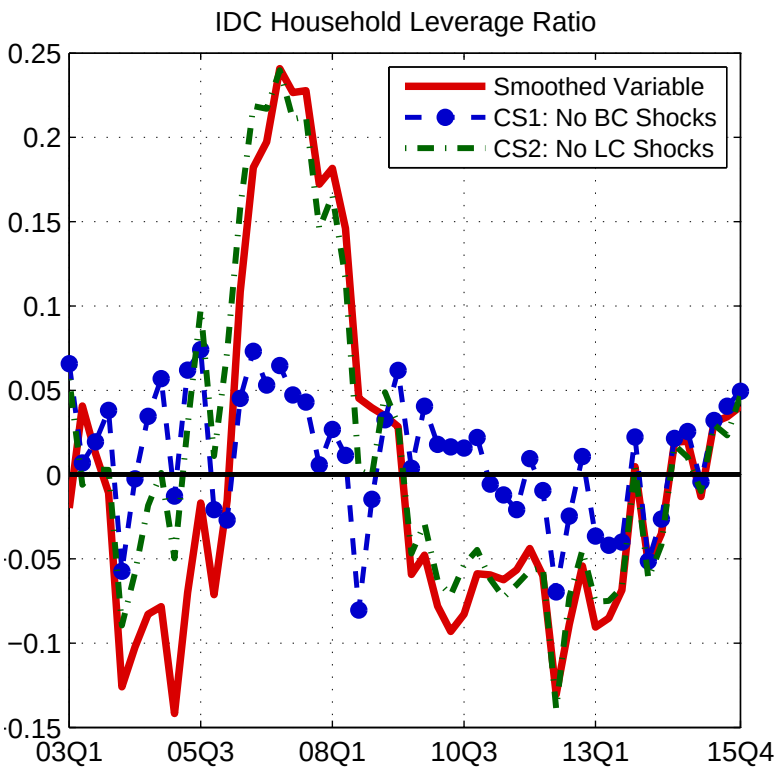
Calibration II

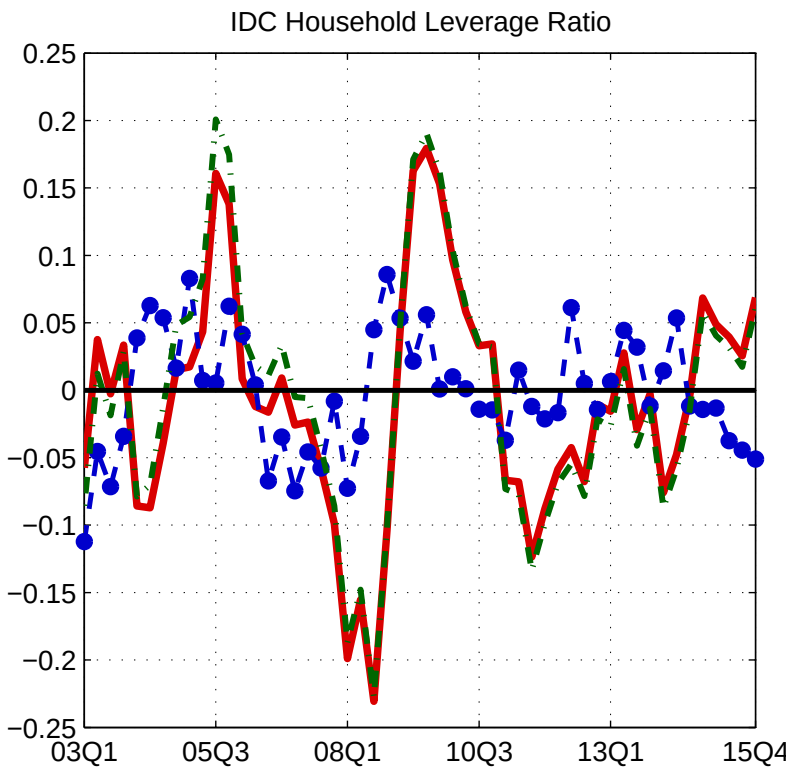
Ratio	Value
National Accounting Ratios	
Absorption to GDP ratio	0.97
Consumption share in GDP	0.63
Investment share in GDP	0.22
Government expenditure share in GDP	0.11
Exports share in GDP	0.26
Imports share in GDP	0.23
External debt to GDP ratio	0.35
Banking Ratios	
IDC Households loans to GDP ratio	0.02
IFC Households loans to GDP ratio	0.02
Entrepreneurs loans to GDP ratio	0.19
Steady state bank capital-to-IDC assets ratio $\bar{v}_{IDC}$	1.69
Steady state bank capital-to-IFC assets ratio $\bar{v}_{IFC}$	1.38
Steady state bank capital-to-EE assets ratio $\bar{v}_{E}$	0.16

Counterfactual Simulations

- Counterfactual simulations as in Brzoza-Brzezina and Makarski (2011): to analyze the relative strength of financial shocks groups affecting the leverage ratios.
- The scenarios CS involve substituting zero values for financial shocks during the entire sample period:
  - CS1: the three borrowing constraint shocks are turned off.
  - CS2: the three lending constraint shocks are shut off.

CS on HH Leverage Ratios





- The results confirm the relevance of the BC shocks set in both cases.