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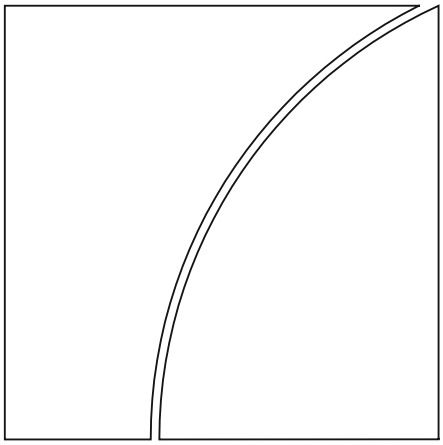

BIS Working Papers

No 505

Phases of Global Liquidity, Fundamentals News, and the Design of Macroprudential Policy

by Javier Bianchi and Enrique G. Mendoza

Monetary and Economic Department

July 2015

Paper produced as part of the
BIS Consultative Council for the Americas
Research Network project "Incorporating financial stability considerations into central bank policy models"

JEL classification: D62, E32, E44, F32, F41

Keywords: Financial crises, macroprudential policy, systemic risk, global liquidity, news shocks

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ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Phases of Global Liquidity, Fundamentals News, and the Design of Macroprudential Policy *

Javier Bianchi
Minneapolis Fed, University of Wisconsin & NBER

Enrique G. Mendoza
University of Pennsylvania, NBER & PIER

Abstract

The unconventional shocks and non-linear dynamics behind the high volatility of financial markets present a challenge for the implementation of macroprudential policy. This paper introduces two of these unconventional shocks, news shocks about future fundamentals and regime changes in global liquidity, into a quantitative non-linear model of financial crises. The model is then used to examine how these shocks affect the design and effectiveness of optimal macroprudential policy. The results show that both shocks contribute to strengthen the amplification mechanism driving financial crisis dynamics. Macroprudential policy is effective for reducing the likelihood and magnitude of financial crises, but the optimal policy requires significant variation across regimes of global liquidity and realizations of news shocks. Moreover, the effectiveness of the policy improves as the precision of news rises from low levels, but at high levels of precision it becomes less effective (financial crises are less likely, but the optimal policy does not weaken them significantly).

Keywords: Financial crises, macroprudential policy, systemic risk, global liquidity, news shocks
JEL Classification Codes: D62, E32, E44, F32, F41

*We thank Chenxin Liu for excellent research assistance. Mendoza acknowledges also the hospitality and support of the Bank for International Settlements, particularly the BIS Representative Office for the Americas, where he was a visitor while working on part of this paper. We also thank the participants at the January 2015 closing Conference of the BIS CCA Research Network on Incorporating Financial Stability Considerations into Central Bank Policy Models for helpful comments and suggestions.

1 Introduction

There is wide consensus on the view that the goal of macroprudential policy is to hamper credit growth in periods of expansion in order to lower the frequency and magnitude of financial crises. There is much less agreement, however, on how to actually design and implement this policy. This is due in part to the lack of a well-established quantitative framework in which non-linear endogenous financial amplification mechanisms can produce infrequent financial crises with realistic features and nested within regular business cycles. Such a framework is a pre-requisite to build a platform that can be useful for evaluating the effectiveness of macroprudential policy tools.

One class of models that has made progress in this direction makes use of the Fisherian debt-deflation mechanism to amplify the effects of exogenous shocks in periods of financial distress, and thus generate nonlinear crisis dynamics. In models of this class, the market failure that justifies the use of macroprudential policy is a pecuniary externality that is ubiquitous in credit markets, because goods or assets used as collateral are valued at market prices: Private agents in a decentralized equilibrium do not internalize the large negative effects of individual borrowing decisions made in "good times" on collateral prices in "bad times," when the debt-deflation mechanism induces large declines in relative prices. As a result, private agents borrow too much, relative to what is socially optimal, and leave the economy vulnerable to financial crises. Pecuniary externalities are typically harmless, but in these models they are not because collateral prices determine borrowing capacity and thus distort real allocations when credit constraints bind.

The literature on Fisherian models has shown that collateral constraints can produce substantial amplification and asymmetry in response to standard-size shocks hitting the typical driving forces of business cycles, such as TFP and terms-of-trade shocks (e.g. Mendoza (2010)), and it has also demonstrated how these models can be used to study the characteristics and effectiveness of various financial policies, including macroprudential policy.[1] Despite this progress, however, most of the models developed to date study macroprudential policy assuming relatively simple structures of exogenous shocks and production technologies. Shocks usually affect TFP or interest rates following conventional, symmetric probabilistic processes known to agents.[2] As a result, two key sources of financial volatility that deviate from this treatment, noisy news about future economic fundamentals and regime shifts in global liquidity, are still absent from the analysis of macroprudential policy. In contrast, empirical studies of credit cycles and financial crises suggest that factors like these are important determinants of credit dynamics and their interaction with the real economy (e.g., Calvo et al. (1996), Shin (2013), Bruno and Shin (2014), Mendoza and

[1] Some of these studies include Bianchi (2011), Benigno et al. (2013), Bianchi and Mendoza (2010 2013), Jeanne and Korinek (2010), Bengui and Bianchi (2014), (see the literature reviews by Galati and Moessner (2013), Galati and Moessner (2014) and Korinek and Mendoza (2014)). See also Schmitt-Grohé and Uribe (2013) and Farhi and Werning (2012) for a literature on prudential policy due to aggregate demand externalities.

[2] A few exceptions include the studies by Boz and Mendoza (2014), Bianchi et al. (2012) and Martin and Ventura (2014), which introduce informational frictions that lead to rational or irrational bubbles in asset valuation in models of credit cycles and macroprudential policy.

Terrones (2012), Borio (2013), Reinhart and Rogoff (2014), Schularick and Taylor (2009)).

This paper aims to fill these gaps by introducing both news shocks and regime switches in global liquidity into a Fisherian model of macroprudential policy. Noisy, but informative, news about future income shocks are introduced as a driving force of credit cycles following the recent macro literature on news and business cycles.[3,4] Shifts in global liquidity are introduced as a regime-switching process in the evolution of world interest rates or leverage limits supported by world capital markets.[5]

The paper presents both theoretical and quantitative findings that highlight the effects of news shocks and global liquidity shifts on the design of optimal macroprudential policy. In addition, we provide a Matlab toolkit that uses global, non-linear solution methods to solve Fisherian models in which a collateral constraint is linked to factor and goods prices, and to evaluate macroprudential policy. These algorithms can be used to solve for the optimal policy and assessing its effects, and also for evaluating the effects of alternative simple policy rules and comparing their performance with the optimal policy.

The results show that both news shocks and regime-switches in global liquidty contribute to strengthen the amplification mechanism driving financial crisis dynamics. Macroprudential policy is implemented as a state-contingent tax on debt that yields the same allocations and prices supported by a constrained-efficient social planner who internalizes the pecuniary externality. This optimal debt tax is an effective tool for reducing the likelihood and magnitude of financial crises, but it requires significant variation across regimes of global liquidity and realizations of news shocks. Moreover, the effectiveness of the policy improves as the precision of news rises from low levels, but at high levels of precision it becomes less effective. High predictive power of current news about future income reduces the probability of financial crises with or without policy intervention, but when crises do occur, the macroprudential debt taxes raised in earlier good times are much less effective at weakening their magnitude.

The rest of the paper is organized as follows. Section 2 describes the decentralized equilibrium of the model without policy intervention. Section 3 examines the problem solved by the financial regulator, the role of macroprudential policy in addressing market failure in the decentralized equilibrium, and the decentralization of optimal macroprudential policy as taxes on debt. Section 4 examines the quantitative predictions of the model. Section 5 provides conclusions and two appendices provide mathematical details and describe the solution toolkit.

[3]For example, in the years leading to the recent European crisis, the prolonged boom of Sourthern Europe could be viewed as related to anticipated benefits from joining the EU.

[4]Notable papers on news and business cycles are Beaudry and Portier (2006), Schmitt-Grohé and Uribe (2012) Jaimovich and Rebelo (2009).

[5]The studies by Calvo et al. (1996) and Shin (2013) document the importance of fluctuations in global capital market conditions and world interest rates in driving domestic credit markets.

2 Model

The model is in the vein of the two-sector models of Sudden Stops proposed by Mendoza (2002) and Durdu et al. (2009), and developed further for the study of optimal macroprudential policy by Bianchi (2011). We introduce news shocks affecting future income and regime-switches in global liquidity into a framework similar to theirs.

2.1 Household's problem

Consider a small open economy inhabited by a representative household who consumes tradable and nontradable goods, denoted c^T and c^N respectively, and who has a fixed endowment of hours $\bar{h}$ that can be rented out as labor for production in each sector. Preferences are given by a standard intertemporal utility function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c). \tag{1}$$

In this expression, $\mathbb{E}(\cdot)$ is the expectation operator, and β is the discount factor. The period utility function $u(\cdot)$ is a standard concave, twice-continuously differentiable function that satisfies the Inada condition. The consumption basket c is a CES aggregator with elasticity of substitution $1/(\eta+1)$ between c^T and c^N, given by:

$$c = \left[\omega \left(c^T\right)^{-\eta} + (1-\omega)\left(c^N\right)^{-\eta}\right]^{-\frac{1}{\eta}}, \eta > 1, \omega \in (0,1).$$

Since labor supply is in fixed supply, we ignore the disutility of labor without loss of generality.

Normalizing the price of tradable goods to 1 and denoting the relative price of nontradables by p^N, the agent's budget constraint is:

$$q_t b_{t+1} + c_t^T + p_t^N c_t^N = b_t + y_t^T + p_t^N y_t^N \tag{2}$$

The representative agent has access to a global market of one-period, non-state-contingent bonds denominated in units of tradable goods sold at a price $q_t = 1/R_t$, where R_t is the exogenous gross world real interest rate. The stochastic process of the interest rate exhibits regime switches that characterize periods of high and low global liquidity, as explained below. The agent begins the period with bond holdings b_t and chooses b_{t+1}, and collects stochastic endowment income in the form of tradable and nontradable goods, y_t^T and y_t^N. The stochastic process of y_t^N follows a standard Markov process to be specified later. In contrast, the stochastic process of y_t^T is influenced by "news shocks," along the lines of the literature on news and business cycles (see Beaudry and Portier (2013) for a recent survey). In particular, every period the representative agent receives noisy information (i.e. news) that relates to the future evolution of y_t^T.

The representative agent faces a credit constraint that limits its debt not to exceed a fraction

κ of its total income in units of tradables:

$$q_t b_{t+1} \geq -\kappa(y_t^T + p_t^N y_t^N) \tag{3}$$

This collateral constraint can be viewed as resulting from enforcement or institutional frictions by which lenders are only able to harness a fraction κ of a borrower's income in case of non-repayment, or it can also be thought of as capturing observed practices in credit markets, such as the scoring alogorithms used in household credit.

The separation between tradables and nontradables in the credit constraint is intended to capture the "liability dollarization" phenomenon typical of emerging economies: Foreign liabilities are generally contracted in hard currencies, which represent tradable goods, but are backed up by the income generated in both tradables and nontradables sector of the economy. The contracting of the liabilities often occurs via bank intermediation, with domestic banking systems borrowing abroad in hard currencies and lending at home in the domestic currency, but more recently direct borrowing in corporate bonds has also surged (see Shin, 2013, Bruno and Shin (2014)).

The representative agent chooses optimally the stochastic processes $\{c_t^T, c_t^N, b_{t+1}\}_{t\geq 0}$ to maximize expected lifetime utility (1) subject to sequences of budget constraints (2) and credit constraints (3), taking b_0 and $\left\{p_t^N\right\}_{t\geq 0}$ as given. This maximization problem yields the following first-order conditions:

$$\lambda_t = u_T(t) \tag{4}$$

$$p_t^N = \left(\frac{1-\omega}{\omega}\right)\left(\frac{c_t^T}{c_t^N}\right)^{\eta+1} \tag{5}$$

$$\lambda_t = \frac{\beta}{q_t}\mathbb{E}_t\left[\lambda_{t+1} + \mu_t\right] \tag{6}$$

$$q_t b_{t+1} + \kappa\left(y_t^T + p_t^N y_t^N\right) \geq 0, \qquad \text{with equality if } \mu_t > 0, \tag{7}$$

where u_T denotes the partial derivative of the utility function with respect to c_t^T, λ_t is the Lagrange multiplier on the budget constraint, and μ_t is the Lagrange multiplier on the credit constraint. Notice that regime switches in global liquidity affect borrowing incentives via their effect on the marginal benefit of borrowing in the right-hand-side of the Euler equation (6), and that news about future values of y_t^T alter both incentives to borrow at t and expectations of future borrowing capacity. Hence, changes in global liquidity and news shocks affect the volatility of capital flows and the economy's vulnerability to financial crisis.

2.2 Competitive Equilibrium

The competitive equilibrium is given by sequences of allocations $\{c_t^T, c_t^N, b_{t+1}\}_{t\geq 0}$ and prices $\left\{p_t^N\right\}_{t\geq 0}$ such that: (a) the representative agent maximizes utility subject to the budget and

collateral constraints taking prices as given, and (b) the market-clearing conditions of the market of nontradable goods holds:

$$c_t^N = y_t^N$$

This condition, together with the agents' budget constraint, implies that the resource constraint of the small open economy's tradables sector also holds: $c_t^T = y_t^T - q_t b_{t+1} + b_t$.

2.3 News Shocks and Global Liquidity Regimes

The formulation of news shocks affecting the stochastic process of y_t^T follows the specification proposed by Durdu et al. (2013). News shocks take the form of noisy signals about future fundamentals, in our case future tradables income.The signal precision has the following form:

$$p(s_t = i | y_{t+1}^T = l) = \begin{cases} \theta & \text{if } i = l \\ \frac{1-\theta}{N-1} & \text{if } i \neq l \end{cases}$$

where s_t is the signal that the economy receives at date t, N is the number of possible realizations of y_t^T at any date t, and θ is the signal precision parameter. When $\theta = \frac{1}{N}$, the signals are completely uninformative, because $p(s_t = i | y_{t+1}^T = l)$ simply assigns a uniform probability of $1/N$ to all values the signal can take, regardless of the value of y_{t+1}^T. Hence, the signal does not add any information useful to alter the expectations about y_{t+1}^T that are formed using the probabilitic process of y^T alone. When $\theta = 1$, the signals have perfect precision, because they allow the agent to perfectly anticipate the value of y_{t+1}^T (i.e. a given value of $y_{t+1}^T = l$ will be expected to occur with perfect certainty when the signal $s_t = l$ is observed).

The Markov chain for the joint evolution of y^T and s is:

$$\begin{aligned} \Pi(y_{t+1}^T, s_{t+1}, y_t^T, s_t) &\equiv p(s_{t+1} = k, y_{t+1}^T = l | s_t = i, y_t^T = j) \\ &= p(y_{t+1}^T = l | s_t = i, y_t^T = j) \sum_m \left[p(y_{t+2}^T = m | y_{t+1}^T = l) p(s_{t+1} = k | y_{t+2}^T = m) \right], \end{aligned}$$

where the conditional forecast probability is derived following Bayes' theorem:

$$p(y_{t+1}^T = l | s_t = i, y_t^T = j) = \frac{p(s_t = i | y_{t+1}^T = l) p(y_{t+1}^T = l | y_t^T = j)}{\sum_n p(s_t = i | y_{t+1}^T = n) p(y_{t+1}^T = n | y_t^T = j)}$$

Expectations in the optimization problem solved by the representative agent are taken using $\Pi(\cdot)$ instead of using just the Markov transition probability matrix of y_t^T to y_{t+1}^T.

Fluctuations in global liquidity across high- and low-liquidity regimes are modeled as regime switches in the world real interest rate, using a standard two-point, regime-switching process with regimes R^h (low global liquidity) and R^l (high global liquidity) with $R^h > R^l$. The continuation

transition probabilities are denoted $F_{hh} \equiv p(R_{t+1} = R^h \mid R_t = R^h)$ and $F_{ll} \equiv p(R_{t+1} = R^l \mid R_t = R^l)$, and the switching probabilities are simply $F_{hl} = 1 - F_{hh}$ and $F_{lh} = 1 - F_{ll}$. The long-run probabilities of the each regime are $\Pi^h = F_{lh}/(F_{lh} + F_{hl})$ and $\Pi^l = F_{hl}/(F_{lh} + F_{hl})$ respectively, and the corresponding mean durations are $1/F_{hl}$ and $1/F_{lh}$. The long-run unconditional mean, variance, and first-order autocorrelation of R are given by the standard formulae:

$$E[R] = (F_{lh}R^h + F_{hl}R^l)/(F_{lh} + F_{hl}) \tag{8}$$

$$\sigma^2(R) = \Pi^h(R^h)^2 + \Pi^l(R^l)^2 - (E[R])^2 \tag{9}$$

$$\rho(R) = F_{ll} - F_{hl} = F_{hh} - F_{lh} \tag{10}$$

We also studied an alternative approach to modeling global liquidity regimes by representing them as changes in κ, instead of changes in R. The quantitative implications of following this approach are discussed later in the paper.

3 Planner's Problem & Macroprudential Policy

We follow Bianchi (2011)'s approach to characterize optimal macroprudential policy. In particular, we construct a constrained planner's problem in which a planner (or financial regulator) chooses directly the economy's holdings of non-state contingent bonds subject to the credit constraint, and lets all other markets clear competitively. The crucial difference is that, in contrast with private agents, the planner internalizes how borrowing decisions affect consumption and labor allocations, which in turn affect the equilibrium price of non-tradables and the tightness of the credit constraint (i.e. the "borrowing capacity").

The planner's dynamic programming problem in recursive form, following the standard convention of denoting with a prime variables dated $t+1$, is defined as follows:

$$V(b,z) = \max_{p^N, c^T, c^N, b'} \left[u\left(\left[\omega \left(c^T\right)^{-\eta} + (1-\omega)\left(c^N\right)^{-\eta} \right]^{-\frac{1}{\eta}} \right) + \beta \mathbb{E} V(b', z') \right]$$

subject to

$$c^T + qb' = b + y^T \tag{11}$$

$$c^N = y^N \tag{12}$$

$$qb' \geq -\kappa(y^T + p^N y^N) \tag{13}$$

$$p^N = \left(\frac{1-\omega}{\omega}\right)\left(\frac{c^T}{c^N}\right)^{\eta+1} \tag{14}$$

The state variables are the current bond holdings, b, and the realizations of the exogenous shocks denoted as $z = (y^T, s, q)$. The constraints faced by the planner are: equation (11) the resource

constraint for tradable goods, equation (12) the market-clearing condition in the nontradable goods market, equation (13) the credit constraint, and the condition that characterizes optimal sectoral consumption allocations (equation (14)).

As shown in Appendix 1, the first-order conditions of the above problem (in sequential form) can be reduced to the following two expressions:

$$\begin{aligned} \lambda_t &= u_T(t) + \mu_t \psi_t \\ \lambda_t &= \frac{\beta}{q_t} \mathbb{E}_t \left[\lambda_{t+1} + \mu_t \right] \end{aligned}$$

where λ_t and μ_t denote respectively the Lagrange multiplier on the resource constraint (equation (11)) and credit constraint (equation (13)), and the term $\psi_t \equiv \kappa \left[\frac{1-\omega}{\omega} (1+\eta) \frac{c_T^T}{y^N} \right]$ captures the effect of an additional unit of tradables consumption on the borrowing capacity via general equilibrium effects on the price of nontradables, which affects the value of collateral.[6] In turn, the term $\mu_t \psi_t$ reflects the fact that, when the credit constraint binds, the social marginal benefit from consumption of tradable goods includes the gains resulting from how changes in consumption help relax the credit constraint, in addition to the marginal utility of tradables consumption.

From a macroprudential perspective, the focus is on how to affect credit allocations in "good times" because of what those allocations can cause in "bad times." Accordingly, the scenario of interest is one in which the credit constraint is not binding at date t (i.e. $\mu_t = 0$) but may be binding at $t+1$ ($E_t[\mu_{t+1}] > 0$). In this scenario, the planner's Euler equation takes this form:

$$u_T(t) = \frac{\beta}{q_t} \mathbb{E}_t \left[u_T(t+1) + \mu_{t+1} \psi_{t+1} \right]$$

Comparing this condition with the household's Euler equation for bonds shows that, as in Bianchi (2011), there is a wedge between the private and social marginal cost of borrowing, given by the term $\mu_{t+1}\psi_{t+1}$. In particular, when the credit constraint is expected to bind, the planner faces a strictly higher marginal cost of borrowing than the representative agent. This is a pecuniary externality, because it results from the fact that the planner makes borrowing choices at t taking into account that the credit constraint could bind at $t+1$, and if it does the Fisherian debt-deflation mechanism will cause a collapse of the relative price of nontradables that will shrink borrowing capacity. The representative agent takes prices as given at all times, and thus does not internalize these effects.

News about domestic fundamentals and regime-switching of global liquidity have important effects on the pecuniary externality. "Good news" at t about future income lead to higher consumption, and since that increase in income has not been realized yet, this leads to an increase in borrowing which makes the economy more vulnerable to hitting the credit constraint. On the

[6] The term in square brackets measures how total income in units of tradables (i.e. the value of collateral) changes with the choice of b_{t+1}, because this choice alters consumption of tradables and the relative price of nontradables.

other hand, by increasing expected future income, the good news also increase on expectation the future borrowing capacity and at the same time reduce future borrowing needs. As a result, we will show below that good news generate a larger fat tail in the distribution of capital flows, by generating an increase in capital inflows and exposing the economy to events where good news turn out not be realized ex post. The regime shifts in global liquidity affect the pecuniary externality because lower interest rates make borrowing cheaper, and lead the economy to take on more debt. A sudden increase in the interest rate, or an adverse income shock, can lead to a decline in consumption, which in turn makes the credit constraint tighter and leads to a sharp reduction in capital flows.

The constrained-efficient allocations and prices that solve the planner's problem can be decentralized as a competitive equilibrium using various policy instruments, including taxes on debt, loan-to-value ratios, capital requirements or reserve requirements (see Bianchi (2011), Stein (2012)). Since the market failure is a pecuniary externality, the natural instrument to consider is a standard tax on the cost of the good associated with the externality, in this case the cost of borrowing. Taxing the cost of borrowing at a rate τ_t, the cost of purchasing bonds in the budget constraint becomes $[q_t/(1+\tau_t)]b_{t+1}$. The optimal macroprudential tax can then be derived as the value of τ_t, which varies across time and states of nature, that equates the Euler equations of bonds of the social planner and the decentralized equilibrium with the tax. Hence, the tax induces private agents to face the social marginal cost of borrowing in the states in which this cost differs from the private cost in the absence of macroprudential policy (assuming in addition that the revenue of the tax is rebated to the household as a lump-sum transfer).[7] The optimal macro-prudential tax can be expressed as follows when the credit constraint does not bind:

$$\tau_t = \frac{\mathbb{E}_t\left[\mu_{t+1}\psi_{t+1}\right]}{\mathbb{E}_t\left[u_T(t+1)\right]} \tag{15}$$

Notice that this tax captures the pecuniary externality, which reflects the possibility of a financial crisis the following period, as analyzed above.[8]

[7] Bengui and Bianchi (2014) study the case where taxes on debt are not perfectly enforceable and show that while this creates a trade-off between the prudential benefits and allocative inefficiencies, taxes remain highly desirable.

[8] When the constraint binds, there is a range of taxes that implements the constrained efficient allocations. In particular, τ such that $u'(c_t) > \beta R(1+\tau)Eu'(c_{t+1})$ with all variables evaluated at the allocations of the social planner would implement the same allocations. Notice that a zero tax implements these allocations if and only if $u'(c_t) > \beta REu'(c_{t+1})$.

4 Quantitative Analysis

4.1 Calibration

The parameter values used to calibrate the model are shown in Table 1. We use a constant-relative-risk-aversion utility function of the form: $u(c) = \frac{c^{(1-\gamma)}}{1-\gamma}$. Note also that, to keep the set of exogenous shocks small, we assume that the nontradables endowment is constant. The parameterization follows closely the one proposed by Bianchi (2011), which was based on data for Argentina, but removing the shocks to the nontradables endowment. The mean endowment of tradables and the deterministic nontradables endowment are both normalized to 1 for simplicity. The coefficient of relative risk aversion is set to a standard value in the DSGE literature, $\gamma = 2$.

The value of η is crucial because it determines the elasticity of substitution in consumption of tradables and nontradables $(1/(1+\eta)$, which in turn affects the response of the price of nontradables to changes in sectoral consumption allocations and hence the size of the pecuniary externality. As Bianchi (2011) reports, empirical estimates of the elasticity of substitution range between 0.40 and 0.83, and we use the same conservative benchmark such that the elasticity of substitution is at the upper bound of this range. Hence $\eta = 0.205$.

Bianchi also set the values of $\beta = 0.91, \omega = 0.31$ and $\kappa = 0.32$ so that three long-run moments of the decentralized equilibrium of the economy he studied match three target moments of the data for Argentina: the share of tradables consumption in the CES aggregator, the average net foreign asset position-GDP ratio (which is -0.29 in the data of Lane and Milesi-Ferretti (2001)), and the observed frequency of financial crises. We use the same parameter values as in Bianchi (2011) since these long-run moments do not change significantly.

The Markov processes of the tradables endowment and news shocks are set as follows. First, we set the Markov process of y^T to include three realizations ($N = 3$), and determine the values of these realizations and their transition probability matrix using the Tauchen-Hussey quadrature algorithm. The algorithm uses the calibrated parameters $\rho_{y^T} = 0.54$ and $\sigma_{y^T} = 0.059$, which are set to macth the first-order autocorrelation and standard deviation of tradables GDP in Argentina in the 1965-2007 period, defining the tradables sector as the sum of manufacturing and primary products. Second, to set the precisions of the date-t signals about y^T_{t+1}, consider that the signals also have three realizations. Hence, following the news framework described earlier, setting $\theta = \frac{1}{3}$ would imply that signals are completely uninformative, while setting $\theta = 1$ would make the signals a perfect predictor of y^T_{t+1} as of date t. In the calibration baseline we set θ to the mid point between these two extremes, so $\theta = \frac{2}{3}$. For simplicity, we also assume that the signal realizations and the vector of realizations of $y^T$are identical.

The regime-switching process of the world interest rate is calibrated to capture the global liquidity phases identified in the studies by Calvo et al. (1996) and Shin (2013), using data on the ex-post net real interest rate on 90-day U.S. treasury bills from the first quarter of 1955 to

the third quarter of 2014 (see Figure 1). Calvo et al. (1996) identified in data for the 1988-1994 period a surge in capital inflows to emerging markets that coincided with a through of -1 percent in the net U.S. real interest rate in the second half of 1993. Shin (2013) found two global liquidity phases, one in the first half of the 2000s with a real interest rate through of around -5.5 percent in early 2004, and another one in the aftermath of the 2008 global financial crisis, with the net real interest rate also hovering around -3 percent since 2009. Taking the average over the troughs in the Calvo et al. sample and in the first of Shin's global liquidity phases, we set a -3.28 percent real interest rate for the high liquidity regime, which in gross terms implies $R^l = 0.9672$. Given this, and the transition probabilities across regimes calibrated below, we set $R^h = 1.0145$ so that the mean interest rate of the regime-switching process matches the full-sample average in our data, which was 0.76 percent.

Constructing estimates of the duration of the global liquidity phases is more difficult, because the era of financial globalization, and hence global liquidity shifts, started in the 1980s, and of the three global liquidity phases observed since then, the third is heavily influenced by the unconventional policies used to contain the crisis. Using data from the first two phases, it follows that the duration of R^l was 10 quarters, which thus leaves a duration for R^h of 60 quarters starting the sample in 1980. Taking these as rough estimates of the mean durations of each regime yields $F_{hh} = 0.9833$ and $F_{ll} = 0.9$.

The model is solved using the time iteration method as in Bianchi (2011), but with the difference that we introduce the news shocks to tradables income as in Durdu et al. (2013), and the interest-rate shock has the regime-switching specification described earlier. Appendix B describes the solution method in detail and provides references to a Matlab code used to solved the model.

4.2 Long-run and Financial Crises Moments

Table 2 shows a subset of the moments that characterize the decentralized equilibrium without policy (DE) and the social planner's equilibrium (SP) that reflects the optimal macroprudential policy. The top panel shows three key long-run moments, the mean net foreign asset position-GDP ratio, the standard deviation of the current account-output ratio, and the probability of a financial crisis, and also the welfare gain of adopting the optimal policy.[9] The mean debt ratios just under 30 percent are about the same in the two scenarios (recall the DE baseline calibration set $\beta = 0.91$ to mach the average NFA-GDP ratio in the data for Argentina, which is 29 percent), but the variability of the current account in DE is roughly twice as large as in SP. Thus, the two economies support the same long-run debt position, but the optimal macroprudential policy reduces the volatility of capital flows by a half. The policy also reduces the probability of crisis

[9] A financial crisis is defined as a state in which the collateral constraint binds and the current account rises by more than two standard deviations (i.e. more than 6.4 and 3.4 percentage points of GDP in the DE and SP respectively).

from 3.7 percent in DE to 2.3 percent in SP.

The mid panel of Table 2 shows five moments that summarize the main features of financial crises: the drops in aggregate consumption (ΔC) and the real exchange rate (ΔRER), the reversal in the current account-output ratio ($\Delta CA/Y$), and the exogenous decline in the tradables endowment (Δy^T). These statistics are averages of the impact effects that occur when a financial crisis hits, and they are computed using the model's long run distribution of the state variables (b, z) conditional on the economy being in a financial crisis state. The Table also shows the average macroprudential tax before a crisis occurs ($E[\tau]\ pre-crisis$), and a set of financial amplification coefficients (Ω^i for $i = C, RER, CA/y$). These coefficients measure the excess response of each variable in states with b such that a financial crisis occurs relative to states with b such that the credit constraint does not bind, both with identical values of z.

The results in the DE column show that financial amplification in this model is powerful, resulting in significant declines in consumption and the real exchange rate, and large current-account reversals. Moreover, financial amplification coefficients are large, showing that the same shocks generate significantly larger responses in financial crises states than in non-crises states.[10]

Comparing across DE and SP columns shows that an average pre-crisis tax of 5.4 percent reduces significantly the effects of the financial amplification on consumption, relative prices and capital inflows. In short, the optimal policy is quite effective at reducing both the probability and the magnitude of financial crises.

The bottom panel of Table 2 isolates the effects of switches in the global liquidity regime, from high global liquidity (R^l) to low global liquidity (R^h). The probability of these particular kind of crisis is low, because by construction of the regime-switching Markov chain these switches are infrequent. When they occur, however, financial crises are more severe, resulting in impact effects on consumption, the real exchange rate and the current account larger than on the average financial crisis. As a result, the average optimal tax pre-crisis is also higher than in the average crisis (6.1 v. 5.4 percent).

Figure 2 plots event-analysis windows that highlight the dynamics around financial crisis events. These windows span seven years and are centered on the year of the financial crisis. The movements that occur when financial crises hit emerge clearly as non-linear fluctuations relative to the pre- and post-crises patterns. The plots also compare the dynamics of the DE with those of the SP. The effectiveness of the optimal macroprudential policy at reducing the severity of financial crises is again visible in these event windows.

The effects of the pecuniary externality on borrowing choices, particularly the incentive to overborrow in the DE and the effectiveness of the macroprudential policy at containing it are both illustrated in the long-run distribution of bond holdings shown in Figure 3. The planner's

[10]This finding extends to variants of this model that introduce the Fisherian mechanism into otherwise conventional RBC models of the small open economy. In particular, Mendoza (2010) found that real shocks of standard size generate effects several orders of magnitude larger when the credit constraints bind than when they do not.

distribution is clearly shifted to the right of the distribution in the DE.

Figure 4 shows the relevance of the three exogenous shocks at work in the model in the seven periods covered in the event windows. As one would expect, financial crises are periods that largely coincide with high real interest rates and low income realizations. But what is more interesting, and captures the effects of the news shocks discussed in the previous section, is that financial crises only occur about half the time when bad news are received (i.e. at t=0 in the top panel of Figure 4, good or average news occur with about 0.5 frequency). Moreover, in the pre-crisis phase the interest rate is more likely to be high and the income realization more likely to be average, but good news are likely to be received with about 40 percent frequency in the period before a financial crisis hits. Hence, financial crises in which news are good a year before and then turn bad (because the income realizations turn out to be low) are quite common.

Figure 5 shows the evolution of the optimal macroprudential tax in the seven-year crisis windows, and also compares the tax dynamics for the baseline value of θ with two alternatives, one where news are less informative (low θ) and one in which news are very informative (high θ). We discuss the effects of news precision later in this Section. In the baseline case, the plot shows the pro-cyclical nature of the optimal tax. The tax rises from about 4 to nearly 6 percent in the years before the crisis, and then drops at the time of the crisis. The tax rises rapidly again in the years after the crisis, which indicates that the policy is quite active most periods and entails significant variability across states of nature.

4.3 Effects of News and the Global Liquidity Regime

We study next the roles that news shocks and global liquidity regime switches play in the baseline results. To start the analysis, Table 3 reports how the moments reported for the baseline scenario in Table 2 change as the precision of the date-t news about y^T_{t+1}varies. The baseline precision was set to $\theta = 0.66$, and Table 3 compares this scenario with four alternatives, two with lower precision ($\theta = 0.35, 0.55$) and two with higher precision ($\theta = 0.75, 0.95$). Recall that the signals are completely uniformative for $\theta = 0.33$, and that for $\theta = 1$ the signal predicts perfectly the value of y^T_{t+1} as of date t. Hence, the values considered in Table 3 range from nearly completely uninformative signals to nearly perfectly informative.

Table 3 shows that the mean of b/y rises slightly and monotonically in both the DE and the SP as the signal precision improves. This is because as signals become more informative they reduce the uncertainty about tomorrow's income, and thus the incentive for self insurance weakens. The effect is small because this reduction in uncertainty affects mainly the income realization at $t+1$ expected as of date t, and hence has a much smaller effect on the overall income uncertainty. The variability of the current account also rises monotonically with the precision of the news in both economies. The probability of financial crises in the DE declines monotonically from about 8 percent with $\theta = 0.35$ to just below 1 percent with $\theta = 0.95$, but for the SP the changes are not

monotonic. The probability first rises with θ and then falls when θ rises from 0.75 tp 0.95. These differences across DE and SP, and the non-monotonicity in the SP case reflect the net result of the offsetting effects of news on borrowing decisions discussed earlier: Good news at date t about y^T_{t+1} induce additional borrowing at t, increasing financial vulnerabiliy, while at the same time the expected future borrowing capacity rises, and reduces future borrowing. In the DE the second effect always dominates, but in the SP the first effect dominates at first as θ rises, but at high θ the second effect dominates. The difference across the DE and SP results is because of the interaction of the effects of news with the removal of the overborrowing effect of the pecuniary externality in the SP allocations.

The mid panel of Table 3 shows an important result: Higher news precision produces significantly larger financial crises in both the DE and SP. In the DE, the average consumption drop and current account reversal in a financial crisis are significantly larger with $\theta = 0.95$ than with $\theta = 0.35$ (-19.7 v. -10.4 percent for consumption, and 22.7 v. 8.3 percentage points for the current account-output ratio), and the drop in the real exchange rate is larger by a factor of 2.3 (79.2 percent with $\theta = 0.95$ v. 34 percent with $\theta = 0.35$).

It is worth noting that the effectiveness of the macroprudential policy displays a non-monotonic pattern as the precision of news improves. The differences in the drops in C and RER, and in the reversal in CA/Y across the DE and the SP all rise as θ rises from 0.35 to 0.75, but from 0.75 to 0.95 all three differences narrow significantly. The mean debt tax pre crisis, first rises from 5.39 to 5.47 percent as θ changes from 0.35 to 0.55, but for higher values of θ it falls slightly, ending at 4.75 percent for $\theta = 0.95$. These results reflect the fact that both private agents and the planner observe and respond to the news shocks, and thus some of the financial instability that results from the effects of news on borrowing choices, and from the possibility that ex-post the news turn out to be wrong, is not something that the macroprudential policy can tackle. It can only tackle the amplification of these effects that occurs via the pecuniary externality.

Figure 5 shows that, in the seven-year event windows, the debt taxes are generally lower at higher θ before and after a financial crisis, which is in line with the above finding that mean debt taxes pre-crises are lower at higher θ for $\theta > 0.55$.

To illustrate the complexity of the optimal debt tax schedule, and how it varies with the three values that the signals can take in the baseline case (with $\theta = 0.66$), Figure 6 shows the schedule of debt taxes for bad, average and good news as a function of the value of b organized in four plots: (a) for low y^T and R_h, (b) for high y^T and R_h, (c) for low y^T and R_l, and (d) for high y^T and R_l. When the date-t income shock is high, debt taxes tend to be the highest when bad news about income at $t+1$ arrive, and they fall as the news turn average or good (for both R_h and R_l). But the ranking changes when the income shock is low, and in this case the ordering also varies depending on whether b is relatively low or high. In particular, for sufficiently low b the ordering of debt taxes as news vary is exactly the opposite of what we obtained when y^T is high: Debt taxes are the highest when news is good, and fall as news turns average to bad. This pattern once

again reflects the opposing forces affecting borrowing decisions with the news shocks, and their interaction with the actual income realization. What does remain the case in all scenarios is that, for sufficiently high b the tax is zero (this is the region where the credit constraint does not bind at t and is not expected to bind at $t+1$), and that as b falls below a threshold value the debt tax always rises as b falls (i.e. the debt tax is increasing in debt).

Figure 7 shows a similar analysis of the debt tax as Figure 6 but now highlighting how debt taxes differ across global liquidity regimes. In this case, we find that debt taxes, when present, are always markedly higher in states with high global liquidity (R_l) than with low global liquidity (R_h), and can be as high as 15 percent for low y^T, good news and high global liquidity. Moreover, there is always a range of debt positions for which the tax is zero and invariant if global liquidity is low, but positive and increasing as debt rises if global liquidity is high. Thus, these results show that optimal macroprudential policy also needs to incorporate significant variation in the policy instrument in response to changes in global liquidity.

Table 4 shows calibration parameters for four experiments in which we changed the nature of the news being received, by changing the variable about which the signals provide information and the specification of global liquidity shocks. Table 5 shows the main moments that each experiment produces. In all four cases the Markov process of y^T is kept as in the baseline. Panel (2), the scenario labeled y^T *news*, R, shows the baseline results in which we have signals about y^T and regime-switching shocks to R. Panel (3), labeled y^T *news*, κ, changes the regime-switching process of global liquidity to shocks to κ, across the κ_L and κ_H values shown in the Table. Panel (1), labeled κ *news* uses also regime-switching shocks in κ but in addition it changes the signals from signals about future y^T to signals about future κ, with a precision of 0.75 (since there are two κ realizations, the midpoint between completely uninformative and perfectly informative signals is now 0.75). Finally, Panel (4), labeled R *news*, moves back to the regime-switching shocks in R, and models the signals as being about future R, again with $\theta = 0.75$ because R has two realizations.

Table 5 shows that the effectiveness of the macroprudential policy varies markedly across the four experiments. The probability of financial crises in both the DE and SP is very different, as well as the moments that characterize financial crises and the pre-crisis mean optimal macroprudential debt tax. In terms of the reduction in the average consumption drop when a financial crisis hits, the policy is most effective in the experiments in Panels (2) and (3) with news about y^T, for which the policy has about the same effectiveness under R shocks or κ shocks, followed by the experiment of Panel (1) with news about future κ , and finally Panel (4), where the policy is least effective. Hence, these results suggest that the optimal macrorpudential policy is also likely to require variation of the policy instrument that captures the nature of the global liquidity movements (i.e. whether they are more reflected in interest rates or in tightness of credit availability) and the variables about which news provide information with different precision.

5 Conclusions

This paper introduced news shocks about future income and regime switches in global liquidity to a Fisherian model of financial crises and macroprudential policy. We characterized analytically an optimal tax on debt that removes the pecuniary externality causing credit market failure in the decentralized equilibrium without policy intervention. This pecuniary externality exists because debt is constrained not to exceed a fraction of the agents' income valued in units of tradable goods, and as a result private agents do not internalize the effects of their borrowing decisions on the equilibrium relative price of nontradables that determines their access to credit. The relative price of nontradables affects borrowing capacity both directly, since it determines the value of nontradables income in units of tradables, and indirectly, because it drives sectoral factor allocations and thus sectoral income.

Quantitative results from an experiment calibrated using data for Argentina show that both news shocks and global liquidity regimes have important effects on the Fisherian financial amplification mechanism. Macroprudential debt taxes are effective tools for reducing both the frequency and magnitude of financial crises, but the effectiveness of the policy varies in a non-monotonic fashion with the precision of the news about future income. At low levels of precision the effectiveness of the policy improves as precision rises, but when precision is high, the effectiveness of the policy falls sharply as precision improves further. At high precision levels, financial crises can be quite severe, but they occur with much lower probability. Moreover, the results also show significant variation of optimal debt taxes when news are good v. bad, when the precision of news varies, and when the regime of global liquidity shifts.

The findings of this paper illustrate the importance of considering unconventional sources of financial instability, such as news about future economic fundamentals and regime-switches in global liquidity, in the design and evaluation of macroprudential policies. The analysis also highlights the usefulness of non-linear global solution methods to quantify accurately the pecuniary externality that justifies policy intervention in models with credit constraints linked to market prices, and to evaluate the effects of macroprudential policy instruments.

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Appendix A: Solution Method

The Matlab code named "endowment.m" provides the algorithm for solving the model. The code is divided in six sections.

Section 1. Parameter Values sets the parameters values shown in table 1. We use 100 points in the grid for bonds and three states for y^T shocks, three states for news shocks and two states for interest rates shocks. The convergence tolerance level for the solution of decision rules, as defined in Section 3 below, is set to $\epsilon = 1e^{-5}$.

Section 2. Construction of Markov Chain discretizes y^T shocks using Tauchen and Hussey's method. The time-series properties of the y^T process that the method targets are estimates obtained by Bianchi (2011)using data for Argentina, and the corresponding moments are reported in table 1. We incorporate news shocks according to the formulae in the Section 2.3 of the paper. Then we add global liquidity shocks to construct the entire transition matrix, assuming y^T shocks and global liquidity shocks are independent.

Section 3. Decentralized Equilibrium solves the decentralized equilibrium using the time-iteration method. Intuitively, this algorithm solves the model by backward recursive-substitution of the model's optimality conditions written in recursive form. In particular, the algorithm solves for the recursive functions $c^T(b,z)$,$P^N(b,z)$ and $B(b,z)$ that satisfy these four conditions:

$$P^N(b,z) = \frac{1-\omega}{\omega}\left(\frac{c^T(b,z)}{y^N}\right)^{1+\eta} \tag{16}$$

$$u_T(c^T(b,z),y^N) \geq \beta R(z) E_z[u_T(c^T(B(b,z),z'),y^N)] \tag{17}$$

$$B(b,z) \geq -\kappa R(z)(P^N(b,z)y^N + y^T(z)) \tag{18}$$

$$c^T(b,z) + q(z)B(b,z) = b + y^T(z) \tag{19}$$

where z is a triple (y^T, q, s) that includes the realizations of the exogenous shocks to y^T, the news signal s, and q (recall that $q = \frac{1}{R}$).

Start the algorithm at an initial point defined by setting $K = 1$ and define conjectures for the equilibrium functions at this point, denoted $c^T_K(b,z)$, $p^N_K(b,z)$ and $B_K(b,z)$. Then proceed with the following steps:

1. Set $B_{K+1}(b,z) = -\kappa R(z)(P^N_K(b,z)y^N + y^T(z))$, and calculate $c^T_{K+1}(b,z)$ using equation 19, which yields $c^T_{K+1}(b,z) = b + y^T(z) - (1/R(z))B_{K+1}(b,z)$

2. Compute
$$U \equiv u_T(c^T_{K+1}(b,z),y^N) - \beta R(z) E_z\left[u_T(c^T_K(B_K(b,z),z'),y^N)\right]$$

3. If $U > 0$, the collateral constraint binds and then equation 16 implies that the equilibrium price must be given by $p^N_{K+1}(b,z) = \frac{1-\omega}{\omega}\left(\frac{c^T_{K+1}(b,z)}{y^N}\right)^{1+\eta}$

4. If $U \leq 0$, the collateral constraint does not bind. Discard the values of $B_{K+1}(b,z)$ and $C^T_{K+1}(b,z)$ set in Step 1, and solve for $c^T_{K+1}(b,z)$ as the recursive function that satisfies the Euler equation 17 with equality using the fsolve root-finding routine. We then compute $P^N_{K+1}(b,z)$ using again equation 16 and $B_{K+1}(b,z)$ using equation 19

5. The above steps will in general produce a new set of functions $c^T_{K+1}(b,z)$, $p^N_{K+1}(b,z)$ and $B_{K+1}(b,z)$ that will differ from the conjectures $c^T_K(b,z)$, $p^N_K(b,z)$ and $B_K(b,z)$. We thus check the convergence criterion $\sup|x_{K+1} - x_K| \leq \epsilon$ for $x = B, c^T, p^N$. If the criterion fails, the conjectures are replaced with the solutions $c^T_{K+1}(b,z)$, $p^N_{K+1}(b,z)$ and $B_{K+1}(b,z)$ and the procedure returns to step 1 using these new conjectures. If the convergence criterion $\sup|x_{K+1} - x_K| \leq \epsilon$ holds, the recursive functions are a solution to the decentralized competitive equilibrium in recursive form.

Section 4. Social Planner solves the social planer's problem. The algorithm is also a time-iteration code similar to that of decentralized equilibrium. The difference is that u_T in equation 17 becomes

$$u^{SP}_T = u_T + \mu^{SP}\psi$$

where $\mu^{SP} \geq 0$, with strict inequality if the collateral constraint 18 binds, and ψ is the externality term given by $\kappa(\eta+1)\left(\frac{1-\omega}{\omega}\right)\left(\frac{c^T}{y^N}\right)^{\eta}$.

Section 5. Welfare Calculation takes the optimal policy functions we derived from section 3 and 4 of the Matlab code, and iterates until convergence to get value functions of the private agent and social planer. We then calculate the welfare gain as in Bianchi (2011).

Section 6. Optimal Tax calculates optimal macro-prudential tax according to equation 15.

Section 7. Plot generates Figure 6 and Figure 7.

The Matlab code named "simulation.m" simulate our model. The code is divided in three sections.

Section 1. Simulation simulates our model for 101,000 periods. The first 1,000 periods are discarded to eliminate initial condition dependence.

Section 2. Event Analysis identifies sudden stop events, and find the surrounding three periods before and after the event.

Section 3. Plot generates Figure 4, 3 and 2.

Appendix B: Tables

Table 1: Baseline Model Parameters

Parameter	Values
y^N	1
N_{y^T}	3
$E[y^T]$	1
ρ_{y^T}	0.54
σ_{y^T}	0.059
β	0.91
γ	2
η	0.205
κ_L	0.32
ω	0.31
θ	$\frac{2}{3}$
R^h	1.0145
R^l	0.9672
F_{hh}	0.9833
F_{ll}	0.9

Table 2: Baseline Model Moments

Long-run Moments	(1) DE	(2) SP
$E[B/Y]$	-29.37%	-29.16%
$\sigma(CA/Y)$	0.03221	0.01775
Welfare Gain [1]	n/a	0.126%
Prob of Crisis	3.67%	2.26%
Financial Crisis Moments [2]		
ΔC	-14.32%	-9.20%
ΔRER	-47.87%	-28.38%
$\Delta CA/Y$	13.66%	7.01%
Δy^T	-9.88%	-9.88%
Ω^C [3]	15.47	4.30
Ω^{RER}	23.24	4.99
$\Omega^{CA/Y}$	15.62%	7.93%
$E[\tau]$ pre-crisis [4]	n/a	5.41%
Switch from R_l to R_h		
Prob of Crisis	0.043%	0.032%
ΔC	-17.15%	-11.14%
ΔRER	-60.38%	-35.52%
$\Delta CA/Y$	17.23%	9.07%
Δy^T	-9.88%	-9.88%
$E[\tau]$ pre-crisis	n/a	6.06 %

[1] The welfare gain ω at state (b,y^T) is given by $(1+\omega(b,y^T))^{1-\sigma}V^{DE}(b,y^T) = V^{SP}(b,y^T)$. The long-run average is taken over the entire ergodic distribution.

[2] Financial Crisis is defined as a period in which the constraint binds and the current account (CA/Y) exceeds two standard deviation of current account in the ergodic distribution of the decentralized economy.

[3] Ω are financial amplification coefficients, which are ratios of these average impact effects over the average impact effects that shocks of the same magnitude produce when the credit constraint does not bind.

[4] The average τ in the period before crisis

Table 3: News Signal Comparison

θ	(1) **0.35**		(2) **0.55**		(3) **0.66**		(4) **0.75**		(5) **0.95**	
Long-run Moments	DE	SP	DE	SP	DE	SP	DE	SP	DE	SP
$E[B/Y](\%)$	-28.98	-28.87	-29.13	-28.96	-29.37	-29.15	-29.65	-29.40	-30.81	-30.80
$\sigma(CA/Y)$	0.0279	0.0114	0.0297	0.0142	0.0320	0.0176	0.0344	0.0208	0.0320	0.0277
Prob of Crisis (%)	7.96	0.16	4.7	0.72	3.68	2.22	2.77	2.24	0.96	0.72
Welfare Gain (%)	n/a	0.138	n/a	0.132	n/a	0.126	n/a	0.119	n/a	0.06
Financial Crisis Moments										
ΔC (%)	-10.38	-5.92	-12.34	-7.44	-14.28	-9.12	-16.77	-11.42	-19.68	-16.94
ΔRER (%)	-31.99	-17.06	-39.61	-22.14	-47.70	-28.12	-58.76	-36.70	-79.21	-66.73
$\Delta CA/Y$ (%)	8.34	2.99	10.99	4.87	13.58	6.91	16.98	9.73	22.74	19.03
$E[\tau]$ pre-crisis (%)	n/a	5.39	n/a	5.47	n/a	5.43	n/a	4.82	n/a	4.75
Switch from R_l to R_h										
Prob of Crisis (%)	0.126	0.007	0.084	0.033	0.043	0.040	0.035	0.029	0.014	0.009
ΔC (%)	-12.30	-6.76	-13.13	-7.65	-17.68	-11.45	-18.41	-12.65	-19.97	-17.26
ΔRER (%)	-39.33	-19.81	-42.98	-23.00	-62.49	-36.52	-66.72	-41.60	-83.25	-66.05
$\Delta CA/Y$ (%)	10.56	3.72	11.70	4.79	17.90	9.40	19.12	11.09	22.97	18.82
$E[\tau]$ pre-crisis (%)	n/a	7.48	n/a	7.46	n/a	7.41	n/a	6.87	n/a	6.58

$\theta = 1$ means perfect signal, and $\theta = \frac{1}{3}$ means useless signal

Table 4: Parameter Values Used for News on Different Shocks

Parameter	(1) κ news	(2) y^T news,R	(3) y^T news,κ	(4) R news
y^N	1	1	1	1
N_{y^T}	4	3	3	5
$E[y^T]$	1	1	1	1
ρ_{y^T}	0.54	0.54	0.54	0.54
σ_{y^T}	0.059	0.059	0.059	0.059
β	0.91	0.91	0.91	0.91
γ	2	2	2	2
η	0.205	0.205	0.205	0.205
κ_L	0.3	0.32	0.3	0.32
κ_H	0.5	n/a	0.5	n/a
ω	0.31	0.31	0.31	0.31
News Quality	0.75	$\frac{2}{3}$	$\frac{2}{3}$	0.75
R_H	1.00775	1.0145	1.00775	1.0145
R_L	n/a	0.9672	n/a	0.9672
F_{hh}	0.9833	0.9833	0.9833	0.9833
F_{ll}	0.9	0.9	0.9	0.9

Table 5: Model Moments for News on Different Shocks

Model Moment	(1) κ news		(2) y^T news,R (Baseline)		(3) y^T news,κ		(4) R news	
Long-run Moments	DE	SP	DE	SP	DE	SP	DE	SP
$\sigma(CA/Y)$	0.0374	0.0254	0.0322	0.0177	0.0344	0.0209	0.0341	0.0282
Welfare Gain (%)	n/a	0.098	n/a	0.126	n/a	0.114	n/a	0.060
$E[B/Y]$ (%)	-28.24	-27.71	-29.37	-29.16	-28.31	-27.93	-29.12	-28.91
Prob of Crisis (%)	4.29	0.01	3.67	2.26	3.41	2.06	2.12	0.57
Financial Crisis Moments								
ΔC (%)	-16.73	-12.51	-14.32	-9.20	-14.92	-10.01	-19.07	-15.70
ΔRER(%)	-58.64	-41.02	-47.87	-28.38	-51.37	-31.94	-72.43	-57.27
$\Delta CA/Y$ (%)	15.94	10.21	13.66	7.01	14.92	8.42	19.08	14.47
Δy^T (%)	-12.17	-13.14	-9.88	-9.88	-8.74	-9.90	-13.96	-15.81
$E[\tau]$ pre-crisis (%)	n/a	6.36	n/a	5.41	n/a	4.44	n/a	6.15
Switch from High Liquidity to Low Liquidity								
Prob of Crisis %	0.576	0.096	0.039	0.032	0.72	0.31	0.032	0.007
ΔC (%)	-16.58	-11.47	-17.15	-11.14	-15.77	-10.67	-16.10	-11.07
ΔRER (%)	-63.77	-40.98	-60.38	-35.52	-59.39	-37.45	-58.65	-37.91
$\Delta CA/Y$ (%)	18.74	11.81	17.24	9.07	18.32	11.40	15.68	9.09
Δy^T (%)	-6.10	-13.14	-9.88	-9.88	-4.22	-9.40	-10.93	-15.81
$E[\tau]$ pre-crisis (%)	n/a	6.58	n/a	6.06	n/a	4.39	n/a	4.37

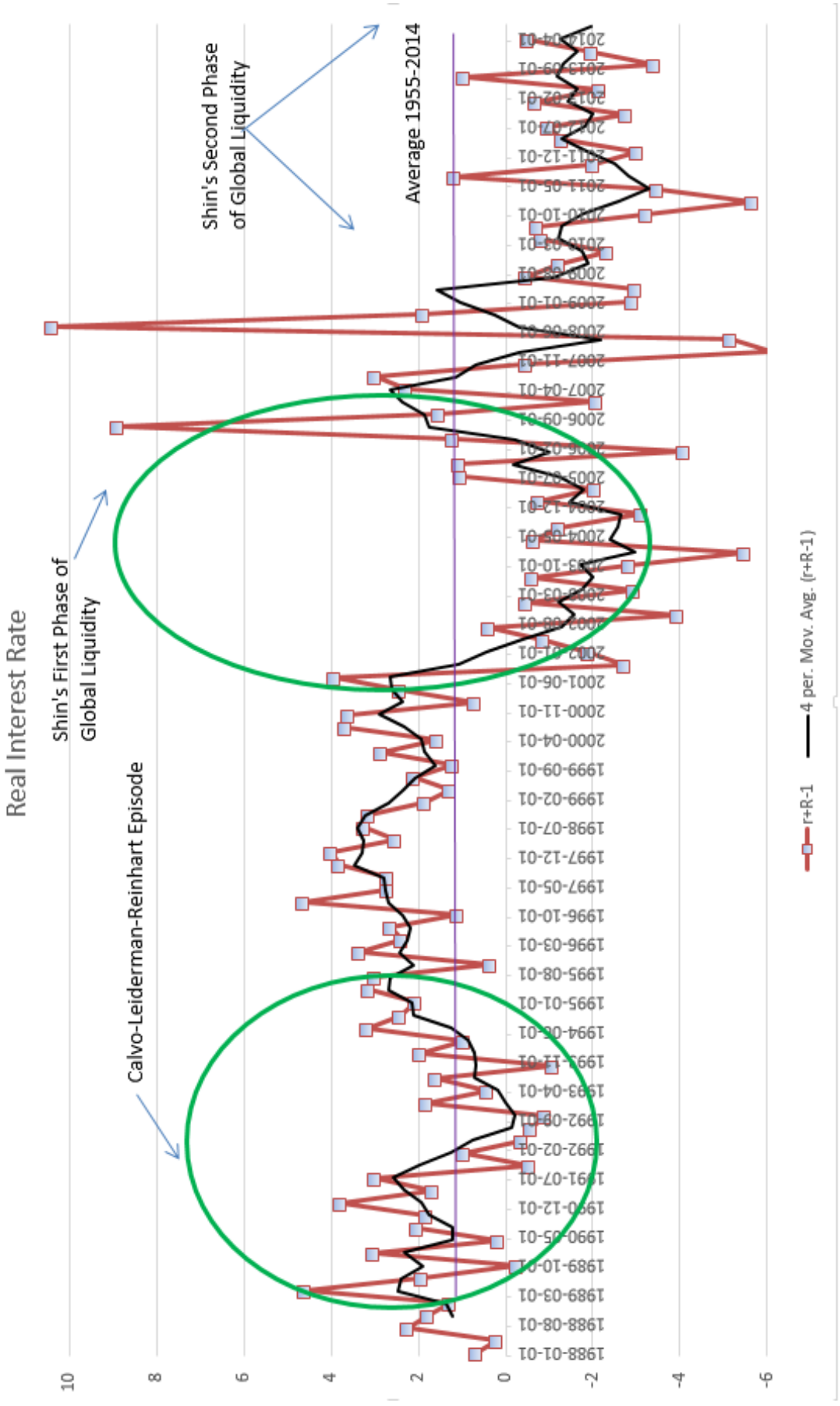

Figure 1: Global Liquidity Regimes

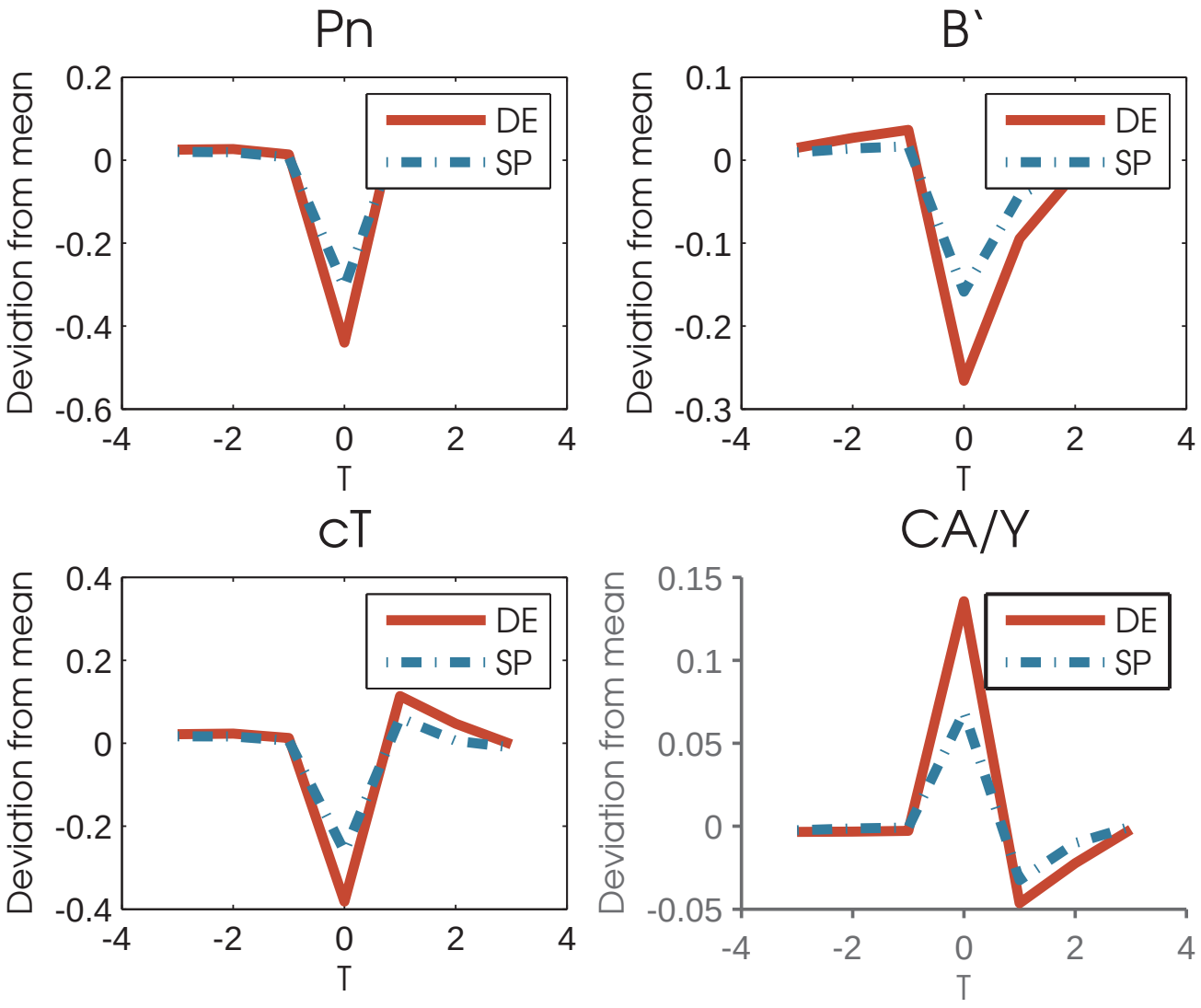

Figure 2: Baseline DE vs SP around Crisis

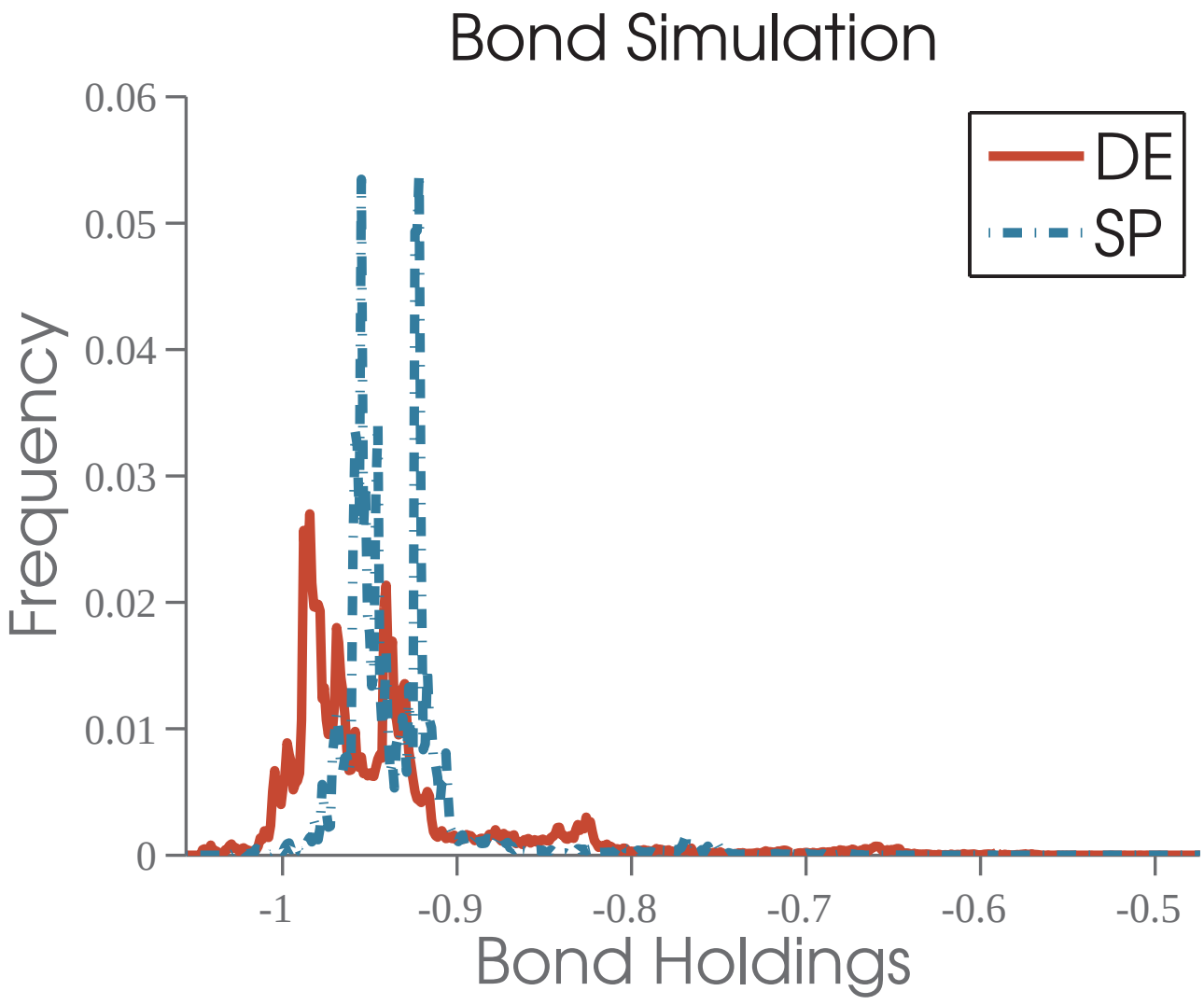

Figure 3: Baseline Ergodic Distribution of Bond Holdings

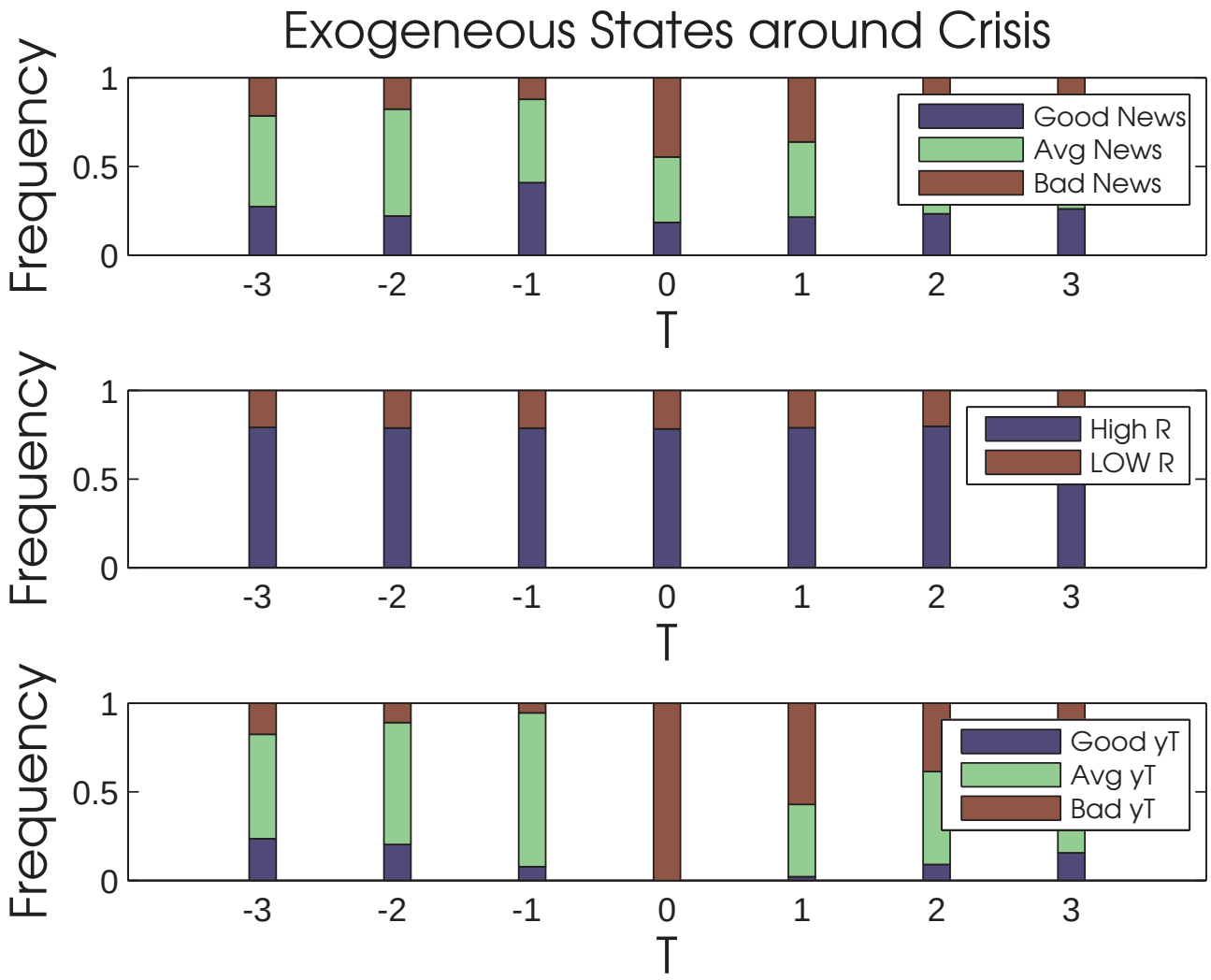

Figure 4: Baseline Exogenous States around Crisis

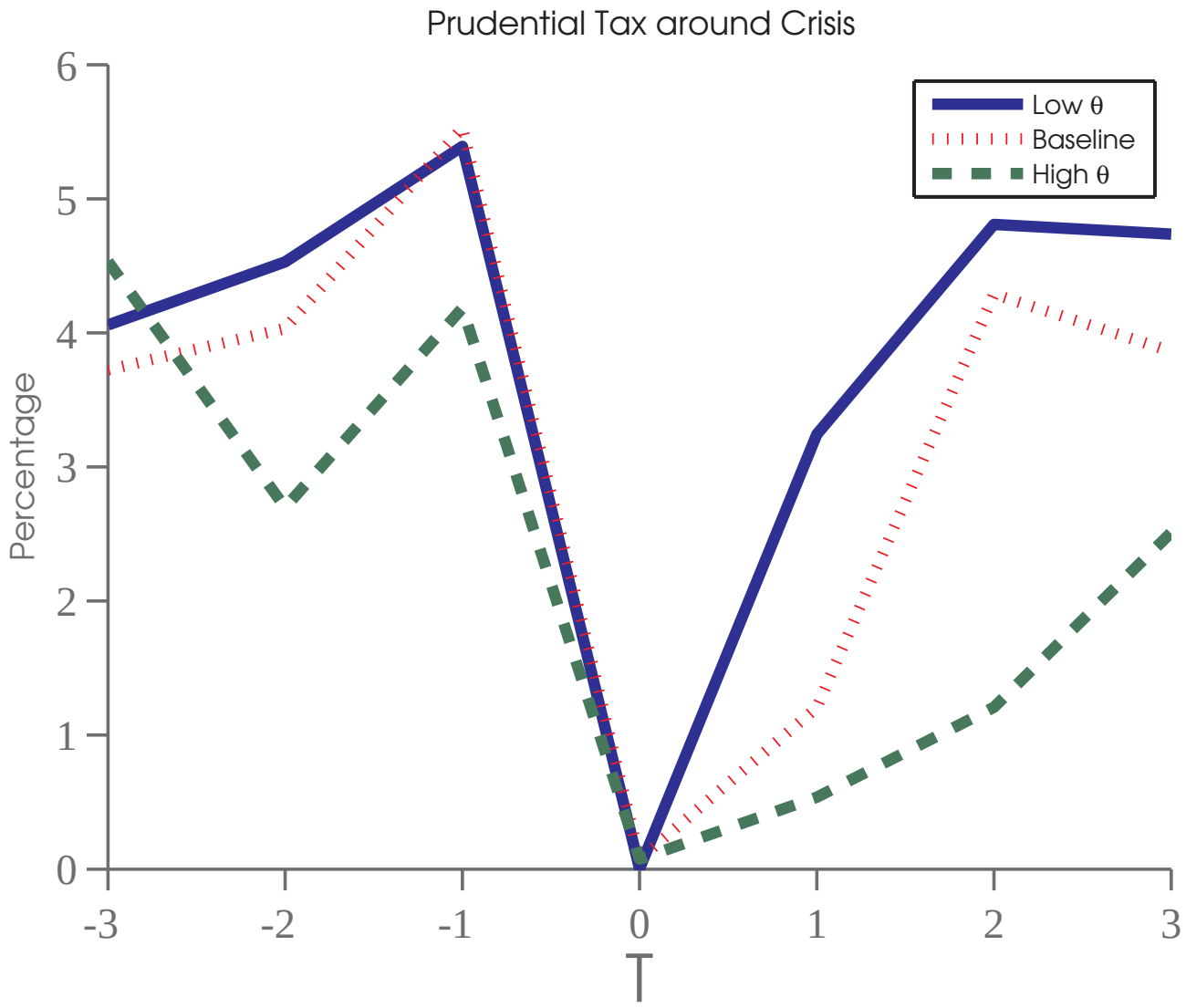

Figure 5: Optimal Debt Tax around Crises: Baseline, High and Low News Precision

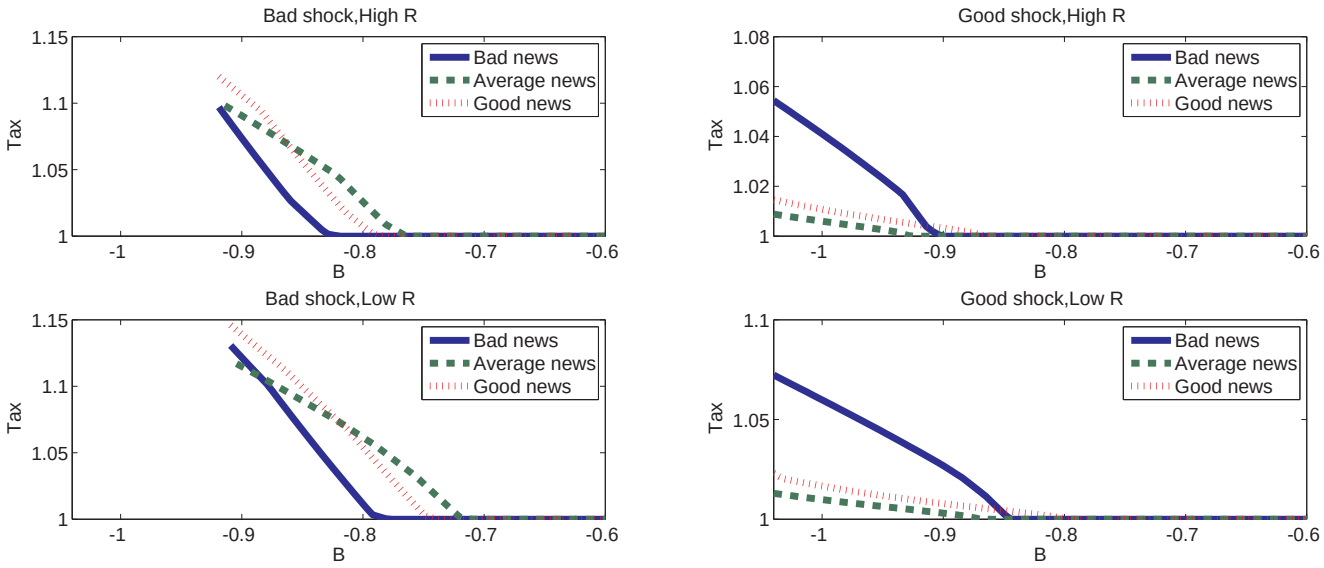

Figure 6: Baseline Debt Tax: Effect of News

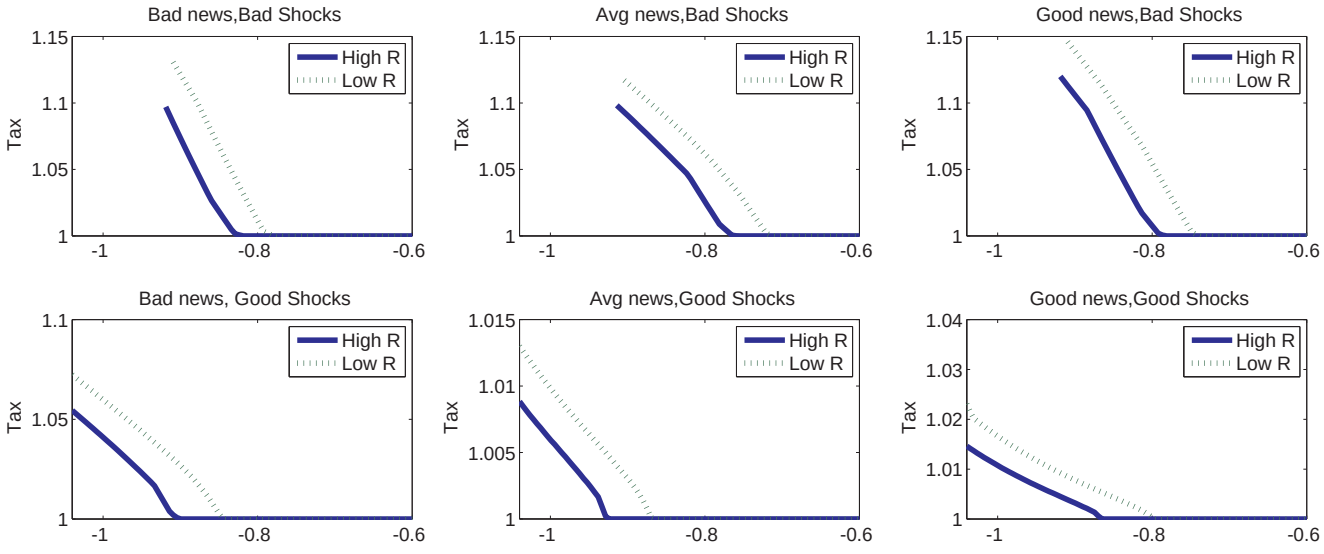

Figure 7: Baseline Debt Tax: Effect of Interest Rate