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Abstract

Speculative booms are vulnerable to shifts in risk perceptions, which can generate demand recessions. In a model where investors' heterogeneous asset valuations spur speculation, we study whether monetary policy should lean against booms, lowering asset prices to reduce this vulnerability. Optimal policy leans and thereby mitigates recessions, even when leaning is unexpected and surprises investors. This policy backloads hikes and steepens the yield curve during booms, with asset prices declining gradually, not sharply. In contrast, front-loaded leaning can erode investors' wealth, depress demand for risky assets and deepen downturns ("sow the wind"). Our results apply in low-interest-rate environments.

Keywords: business cycles, speculation, monetary policy, leaning against the wind.

JEL classification: E32, E43, E44, E52, G12, D84.

Resumen

Los *booms* especulativos son vulnerables a los cambios en la percepción del riesgo, que pueden desencadenar recesiones de la demanda. En un modelo en el que la heterogeneidad en las valoraciones de los activos por parte de los inversores impulsa la especulación, analizamos si la política monetaria debería actuar de manera preventiva frente a los *booms (leaning against the wind),* reduciendo los precios de los activos para disminuir esta vulnerabilidad. La política óptima adopta este enfoque preventivo y, de este modo, mitiga las recesiones, incluso cuando dicha actuación es inesperada y sorprende a los inversores. Esta estrategia retrasa las subidas de los tipos de interés y aumenta la pendiente de la curva de rendimientos durante los períodos de expansión, por lo que permite que los precios de los activos disminuyan de forma gradual en lugar de sufrir caídas bruscas. Por el contrario, una actuación preventiva demasiado adelantada *(front-loaded leaning)* puede erosionar la riqueza de los inversores, reducir la demanda de activos de riesgo y agravar las recesiones posteriores («sembrar vientos para recoger tempestades»). Nuestros resultados son aplicables a entornos caracterizados por tipos de interés bajos.

Palabras clave: ciclos económicos, especulación, política monetaria, actuación preventiva frente a los *booms*.

Códigos JEL: E32, E43, E44, E52, G12, D84.

Speculative booms are vulnerable to shifts in sentiment or risk perceptions. If investor optimism reverses, falling asset valuations can generate a demand recession (Caballero and Simsek 2020b). When a boom is underway, should the central bank adjust monetary policy to mitigate this risk and, if so, how?

Two empirical patterns suggest a case for leaning against speculative booms by raising interest rates: elevated market sentiment predicts a subsequent decline in economic activity, and accommodative monetary policy tends to bolster asset values, risking amplification of the boom.[1] Moreover, while aggregate demand externalities motivate macroprudential regulation (Farhi and Werning 2016; Korinek and Simsek 2016), institutional frictions can limit regulation's cyclical responsiveness. As a result, the policy rate itself is a candidate macroprudential tool (Caballero and Simsek 2020a). However, tightening monetary policy unexpectedly can trigger the very balance-sheet damage it seeks to prevent. In a business cycle model with leveraged investors, we show that this tension is resolved by leaning gradually, through a phased-in tightening that avoids a sharp initial drop in asset prices while preserving leaning's macroprudential benefits.

In the model, investors with heterogeneous valuations trade risky assets, with leveraged optimists (high-valuation investors) borrowing from pessimists. A risk premium shock can turn a speculative boom into a recession, with the zero lower bound (ZLB) binding for the policy interest rate. Two forces shape optimal monetary policy. First, the announcement effect: if leaning is adopted unexpectedly and lowers asset prices on impact, optimists suffer balance-sheet losses, eroding their wealth share and deepening the subsequent recession. Second, leaning's macroprudential benefit: conditional on the optimists' wealth share before the bust, lower asset prices during the boom soften the decline in optimists' wealth share at the bust, mitigating the recession.

A main result is that optimal monetary policy leans and raises welfare while ameliorating the announcement effect. Optimal policy phases in tightening to minimize the initial asset price drop. This design raises expectations of future policy rates and lets asset prices decline gradually if the boom persists. It thereby preserves optimists'

[1] López-Salido et al. (2017) show that elevated credit-market sentiment predicts a decline in economic activity two years later. The values of long-term financial assets respond to monetary-policy announcements, with risk premia as one potential channel (Gertler and Karadi 2015; Kekre and Lenel 2022). Bianchi et al. (2022) find that accommodative monetary-policy regimes coincide with persistently high asset valuations.

balance sheets at announcement while attenuating the asset price decline at the onset of a recession. Optimal policy also takes into account that leaning reduces output below potential during booms and slows optimists' wealth accumulation.

The economy begins in a boom with high asset prices. Asset valuations can fall without a change in current productivity, consistent with evidence of fluctuations in risk premia (Cochrane 2011). Low asset values reduce aggregate demand through a consumption–wealth effect. With the ZLB binding in recessions, the central bank cannot fully restore demand, making optimists' wealth share the key state variable linking monetary policy to real activity.

During the boom, unexpected, front-loaded reductions in asset prices can hit optimists' balance sheets and deepen the subsequent recession—showing that poorly designed leaning may "sow the wind" and reap more severe downturns. Optimal monetary policy allows *leaning without sowing* through a "bear steepening" of the yield curve: Upon announcement, expected future policy rates rise, while the policy rate temporarily falls. With endogenous bust risk, optimal leaning reduces the likelihood of recession and hence may be implemented by raising the policy rate even in the short run without inducing an unexpected fall in asset prices. Overall, the announcement effect need not dissuade central banks from leaning; instead, it can inform the design of leaning policy.

To assess these mechanisms quantitatively, we calibrate the model using U.S. business-cycle data on asset returns and the sensitivity of intermediary capital to asset prices. Simple (non-optimal) leaning policies that depress asset prices throughout the boom generate welfare losses through the announcement effect. In contrast, optimal policy leans and mitigates the announcement effect by temporarily postponing leaning's macroprudential benefits, with only small welfare costs from this postponement. Optimal policy thereby improves welfare relative to conventional policy that never leans.[2] Our results apply in low-interest-rate environments, in which proximity to the ZLB limits how much the policy rate can be cut to counter a fall in asset prices following a speculative phase.[3]

[2]In the model, a conventional output-stabilization rule sets the interest rate in a boom equal to the neutral rate consistent with full resource utilization.

[3]Option-implied measures suggest that, during the past two decades, there has often been a substantial probability of a ZLB episode over a three-year horizon, including at times when the prevailing policy rate was meaningfully above zero. See Supplemental Appendix A.

Beyond these results, we present three extensions.

Endogenous bust probability. Our first extension allows leaning to affect the likelihood of a recession. Leaning's recession-dampening benefit operates as before. Under some conditions—when optimists' leverage constraint binds or investors agree about how policy affects bust risk—a given leaning rule attenuates the decline in optimists' wealth share by the same magnitude as in the benchmark model. However, lower bust risk (under pessimists' beliefs) slows optimists' wealth accumulation during the boom, with adverse effects that persist into any recession.[4] We then study optimal policy under the assumption that a leaning policy that lowers optimists' wealth share upon announcement raises the bust arrival rate, but a leaning policy that avoids the announcement effect and subsequently leans lowers the bust arrival rate. Thus, by construction, front-loaded leaning raises bust risk, whereas phased-in leaning reduces it. Under this assumption, despite the new cost of leaning (slower growth of optimists' wealth share during booms), optimal policy still leans, gradually reducing asset prices as in the benchmark model. In our quantitative exercise, the endogenous reduction in bust risk increases the welfare gain relative to the exogenous-risk benchmark. Nonetheless, optimal policy reduces the asset price by a smaller magnitude, because a longer expected boom duration amplifies the welfare cost of depressing boom-time output below potential.

Good booms, bad booms. Many speculative booms end in a sharp downturn ("bad booms"), but others ("good booms") do not (Gorton and Ordoñez 2019). We extend the model so that a speculative boom can turn non-speculative; that is, speculation can dissipate before a bust arrives. The central bank cannot observe the boom type ex ante and must apply a single policy rule. The presence of good booms dilutes leaning's benefits: the cost of below-potential output is paid during both boom types, but recession-dampening benefits accrue only when bad booms go bust.

We assume that investors disagree about bust risk but agree about the rate at which speculation dissipates. Our results are contingent upon this strong assumption, which preserves the model's tractability. With this assumption, leaning attenuates the fall in optimists' wealth share by the same magnitude as in the benchmark. We also study a specific, non-optimal leaning policy that mimics the recession-dampening benefit of

[4] Pessimists' beliefs govern this channel because their leverage limit never binds (see Sections 1 and 5.1).

tighter regulation. With unexpected leaning and uncertainty about boom type, small, phased-in doses of this leaning policy imply first-order welfare gains from mitigating recessions, while imposing only second-order costs from holding output below potential during both good and bad booms. This is a local result, characterizing welfare effects of a small deviation from conventional (Wicksellian) policy. As before, the phase-in design attenuates announcement-effect losses.

Optimal systematic leaning and the anticipation effect. To study systematic leaning, we analyze two-cycle environments. Optimal systematic policy leans, phasing in tightening as booms begin. In contrast, non-optimal leaning policies that depress asset prices throughout booms generate an anticipation effect: In recessions, investors reduce demand for risky assets because they anticipate that leaning will cap asset prices in subsequent booms. This channel can depress recessionary asset prices and utilization by lowering expected recovery-state valuations. Optimal systematic policy ameliorates the anticipation effect, through a design that mirrors optimal unexpected leaning. Both the announcement effect (balance-sheet channel) and the anticipation effect (price-cap channel) are mitigated by softening initial pressure on asset prices, upon announcement or as booms begin.

Related literature. Our paper relates to a New Keynesian business-cycle literature studying demand shocks that affect asset prices, such as risk premium shocks (Caballero and Simsek 2020b) and noise shocks (Lorenzoni 2009).[5] This literature also analyzes monetary policy (Gilchrist and Leahy 2002). In Dupor (2005), policy should respond to irrational-expectations shocks to dampen inefficient investment. In Christiano et al. (2010), booms from optimistic productivity news can be curbed by rules with a role for credit growth. With credit frictions, Cúrdia and Woodford (2010) show that simple rules that respond to credit spreads can closely match Ramsey policy. We contribute by characterizing optimal leaning in a risk-centric model: Poorly designed leaning can exacerbate recessions, while an optimal phased-in approach preserves leaning's benefits while limiting its costs.

[5] Confidence shocks drive business cycles in Angeletos et al. (2018), Angeletos and Lian (2021), and Ilut and Saijo (2021); their mechanisms do not necessarily rely on price rigidities. In Mertens (2011), information dispersion amplifies volatility, but leaning can stabilize stock prices and raise welfare. Beaudry and Portier (2007) study news about future fundamentals in a neoclassical setting.

Our paper features investors' beliefs as a driver of speculation and boom-bust cycles (Minsky 1977; Bordalo et al. 2018). In our framework, beliefs affect valuations and risk premia, and we abstract from runs on intermediaries and market freezes. With departures from rational expectations, Fontanier (2025) shows how macroprudential regulatory and monetary policies can achieve constrained efficiency. A complementary but distinct approach emphasizes lenders' limited information about borrowers (Dang et al. 2017). In Boissay et al. (2016), moral hazard and asymmetric information in the interbank market may lead to sudden market freezes and severe recessions. Boissay et al. (2025) develop a New Keynesian model with endogenous financial crises, showing that monetary policy affects crisis probabilities in the short run (an aggregate-demand channel) and the medium run (through capital accumulation) and that persistently loose policy followed by sharp tightening can precipitate crises.

In practice, central banks can be inattentive to the buildup of speculative pressures when setting short-term rates, delaying leaning until a large number of indicators are "flashing red" (Kashyap and Stein 2023). Such a delayed reaction pattern has produced episodes of unexpected monetary tightening with adverse consequences. The Federal Reserve's 1928 tightening, aimed at curbing the stock market boom, was followed by a recession and the market crash in 1929 (Friedman and Schwartz 1963). More recently, with less catastrophic results, the 2012–13 tightening discussion led to the "taper tantrum." We offer a mechanism, rooted in investor sentiment, through which leaning can exacerbate downturns—a concern emphasized in Svensson (2017)—while showing that optimal design can attenuate those costs.[6] A central channel is high-valuation investors' wealth, as in Kekre and Lenel's (2022) analysis of monetary policy transmission.

Related evidence: monetary policy, booms, and subsequent instability. Jiménez et al. (2025) find that rate hikes materially raise crisis risk when they follow prolonged cuts. Grimm et al. (2023) show that persistently accommodative policy predicts medium-term instability. Rapid credit and asset price growth (Greenwood et al. 2022) and unexpected rate hikes during credit and asset price booms (Schularick et al. 2021) are associated with

[6] Bernanke and Gertler (2001) note that central banks' attempts to affect asset prices have had "dangerously unpredictable" effects on market psychology. A distinct unintended consequence is that leaning might enlarge asset price bubbles (Galí 2014). Allen et al. (2022), in a model with speculation and risk-shifting, find that leaning is more effective when it disproportionately discourages riskier investments.

higher crisis risk. While our framework is not a crisis model, these findings motivate our focus on policy during speculative booms: in the model, prolonged accommodation can foster elevated valuations and macroeconomic vulnerability, and well-designed leaning can mitigate that buildup. The model also highlights why unexpected tightening in booms may be costly, through its effects on asset values and leveraged investors' balance sheets.

The rest of the paper is structured as follows. Section 1 presents the model. Section 2 presents the calibration. Section 3 analyzes the announcement of leaning during a boom. Section 4 studies optimal policy with the announcement effect. Section 5 offers extensions and sensitivity analyses. A final section concludes.

1. Model

This section presents a risk-centric framework based on Caballero and Simsek (2020b). We closely follow the version of Caballero and Simsek (2020a), which studies systematic ("preannounced") leaning in a single boom-bust cycle. We modify their model by assuming that the economy begins in a speculative boom under Wicksellian policy (the central bank sets the real interest rate at the neutral rate that achieves full utilization during the boom). With the boom underway, the central bank may have the opportunity to unexpectedly adopt leaning, generating the announcement effect. Later, we characterize optimal policy and its implementation. We also extend the model to include an endogenous bust probability, a mixture of "good" and "bad" booms, and systematic leaning in multi-cycle models (introducing the anticipation effect). As additional contributions, we quantify the model using asset-return data across business cycles and provide a new closed-form solution for the recessionary asset price.

Potential output, asset-valuation shocks, and the adoption of leaning monetary policy. Time is continuous, $t \in [0, \infty)$. There is a single consumption good and a single factor of production, capital. The set of aggregate states is denoted by S. At time t in state $s \in S$, the capital stock is $k_{t,s}$, and capital utilization is $\eta_{t,s}$. Output of the consumption good is denoted by $y_{t,s}$, with $y_{t,s} = \eta_{t,s} k_{t,s}$. The capital stock grows at the rate:

$$\frac{\dot{k}_{t,s}}{k_{t,s}} = g_s - \delta(\eta_{t,s}), \tag{1}$$

where g_s is the growth rate of capital before depreciation in state s and the depreciation rate is $\delta(\eta_{t,s})$. The growth rate g_s is an exogenous parameter. The depreciation function $\delta(\eta_{t,s})$ is weakly increasing and weakly convex.[7] Higher utilization increases current output but also depreciation.

The four states, $s \in \{0,1,2,3\} \equiv S$, differ with respect to the growth rate of capital and the monetary policy in place. The growth rate of capital (before depreciation) is high in states 0 and 1, low in state 2, and high again in state 3. The parameters satisfy $g_2 < \min\{g_0, g_1, g_3\}$. Therefore, states 0 and 1 are labeled the boom, state 2 is the recession, and state 3 is referred to as the recovery. Changes in the exogenous growth rate of capital are labeled asset valuation or risk premium shocks because such shifts lead to changes in asset prices without affecting short-run productivity.[8]

The policy rule in $s = 0$ is a conventional output-stabilization rule in which the central bank sets the interest rate equal to the neutral rate consistent with full resource utilization during this boom state.[9] The defining feature of state 1 (that distinguishes it from state 0) is that, when the transition to state 1 occurs, the central bank can change its policy rule. In $s = 1$, the central bank can adopt leaning or retain the inherited rule.

The economy transitions across states according to a Poisson process. From state 0, the economy can enter state 1 (a change in the policy rule while the economy is booming) or directly enter state 2 (a recession). From state 1, the economy can transition into recession. The recession is followed by a recovery (state 3) in which the central bank implements conventional policy. $s = 3$ is an absorbing state, with no further state transitions.

Transition rates and belief disagreements. There are two types of investors: optimists o and pessimists p. According to the beliefs of investor $i \in \{o,p\}$, the transition from state s to s' occurs at a Poisson arrival rate $\lambda^i_{s\to s'}$. During boom states, pessimists perceive a higher bust arrival rate, relative to optimists: $\lambda^p_{s\to 2} > \lambda^o_{s\to 2} > 0$, for $s \in \{0,1\}$. During the recession ($s = 2$), optimists perceive a higher recovery arrival rate: $\lambda^o_{2\to 3} > \lambda^p_{2\to 3} > 0$. Thus, optimists value risky assets more than pessimists regardless of the economy's state

[7] There is a threshold $\underline{\eta}$ such that the depreciation function is strictly convex for $\eta_{t,s} > \underline{\eta}$.

[8] For an interpretation of these shocks as arising from fluctuations in risk (the actual or perceived volatility of aggregate productivity shocks) or risk aversion, see Caballero and Simsek (2020b).

[9] Full resource utilization is defined later in this section and characterized in Eq. (11). The neutral rate in $s = 0$ is provided in Eq. (20).

(during the boom and recession).[10] Because we are interested in studying the boom-time adoption of leaning, the transition to state 1 must be at least partly unexpected. For simplicity, we assume that state 1's arrival is *fully unexpected*: $\lambda^i_{0\to 1} = 0$ for $i \in \{o, p\}$.

We denote the planner's beliefs by $\lambda^{pl}_{s\to s'}$. We assume that the planner ascribes a positive transition rate from boom to bust $\lambda^{pl}_{1\to 2} > 0$ and from bust to recovery $\lambda^{pl}_{2\to 3} > 0$.[11]

State 1 represents the decision point where the central bank can adopt leaning policy; with state 1's arrival, there is no change in economic fundamentals. The boom states differ only with regard to the policy rule, with $g_0 = g_1$ and $\lambda^i_{0\to 2} = \lambda^i_{1\to 2}$ for $i \in \{o, p, pl\}$. After state 1 arrives, the expected time until recession (under beliefs i) is $1/\lambda^i_{1\to 2}$, exactly equal to the expected time until recession in state 0. If the central bank retains the traditional output-stabilization rule in state 1, then state 1's arrival involves no change in utilization, the risk-free rate, investors' consumption, or beliefs about recession arrival (the risk-free rate and consumption are described later).[12] In Section 5.1, we allow the transition arrival rates to be influenced by monetary policy.

Financial assets, leverage, and portfolio choice. There are two financial assets. The risky asset is a claim on all output, with total value $Q_{t,s}k_{t,s}$, where $Q_{t,s}$ is the price of a unit of capital in terms of the final good. The instantaneous return on capital (absent state transition) is

$$r_{t,s} = \underbrace{\frac{y_{t,s}}{Q_{t,s}k_{t,s}}}_{\text{Dividend yield}} + \underbrace{g_s - \delta(\eta_{t,s}) + \frac{\dot{Q}_{t,s}}{Q_{t,s}}}_{\text{Capital gains}}. \tag{2}$$

The risk-free asset has zero net supply and an instantaneous return $r^f_{t,s}$. Investor i has financial wealth $a^i_{t,s}$ and chooses consumption $c^i_{t,s}$ and the share of wealth allocated to the risky asset $\omega^i_{t,s}$ (which also captures investors' leverage). There is a leverage limit in

[10] Our results arise from persistent heterogeneity in investors' valuations for risky assets. This heterogeneity emerges from belief disagreements in which optimists and pessimists do not change roles, but could also arise from heterogeneous risk aversion (Kekre and Lenel 2022). As Caballero and Simsek (2020b) note, the persistence of belief disagreements allows an interpretation of optimists as intermediaries or relatively risk-tolerant investors.

[11] Our theoretical results, including the welfare analysis, do not require additional assumptions about objective transition rates or the planner's beliefs. The theoretical results do not depend on whether optimists or pessimists are closer to the truth. The timing of the transition from state 0 to state 1 is exogenous, stochastic, and not controlled by the planner. The planner's beliefs $\lambda^{pl}_{0\to 1}$ and $\lambda^{pl}_{0\to 2}$ do not affect our results, because policy in $s = 0$ is assumed to be the traditional output-stabilization rule.

[12] That investors perceive a strictly positive arrival rate for a transition from $s = 0$ to $s = 2$ is necessary for our analysis. Without this assumption, investors in state 0 would believe the economy has reached an absorbing state, and there would be no leverage or speculation. Our intention is to study unexpected leaning amid a speculative boom, with leverage reflecting belief differences about recession arrival.

boom states, $\omega^i_{t,s} \leq \bar{\omega}$ for $s \in \{0,1\}$.[13] There is no leverage limit in other states, which highlights that dynamics are not driven, as in much of the literature, by a leverage limit in the bad state. Because $\bar{\omega} = 1$ imposes the absence of leverage-fueled speculation, we assume $\bar{\omega} > 1$.

Investors maximize the discounted utility of consumption and have log preferences with discount rate ρ. The problem of an investor of type i at time t in state s is:

$$V^i_{t,s}(a^i_{t,s}) = \max_{\{c^i_{\tau,\tilde{s}},\omega^i_{\tau,\tilde{s}}\}_{\tau \geq t,\tilde{s}}} \mathbb{E}^i_{t,s}\left[\int_t^\infty e^{-\rho(\tau-t)} \log c^i_{\tau,\tilde{s}} d\tau\right] \tag{3}$$

subject to the law of motion (for all t and s) for the investor's wealth absent state transition,

$$da^i_{t,s} = (a^i_{t,s}(r^f_{t,s} + \omega^i_{t,s}(r_{t,s} - r^f_{t,s})) - c^i_{t,s})dt, \tag{4}$$

the evolution of the investor's wealth upon transition from state s to s',

$$a^i_{t,s'} = a^i_{t,s}\left(1 + \omega^i_{t,s}\frac{Q_{t,s'} - Q_{t,s}}{Q_{t,s}}\right), \tag{5}$$

and the leverage constraint $\omega^i_{t,s} \leq \bar{\omega}$ for $s \in \{0,1\}$. The expectations operator $\mathbb{E}^i_{t,s}[\cdot]$ corresponds to investor i's beliefs regarding arrival rates for state transitions.

Financial assets: Market clearing. A type-i investor holds risky assets worth $\omega^i_{t,s}a^i_{t,s}$ and safe assets worth $(1-\omega^i_{t,s})a^i_{t,s}$. Market clearing for the risky and safe assets requires

$$\sum_{i\in\{o,p\}} \omega^i_{t,s}a^i_{t,s} = Q_{t,s}k_{t,s} \quad \text{and} \quad \sum_{i\in\{o,p\}} (1-\omega^i_{t,s})a^i_{t,s} = 0. \tag{6}$$

That is, financial markets clear when investors' total wealth equals the value of the market portfolio, $\sum_{i\in\{o,p\}} a^i_{t,s} = Q_{t,s}k_{t,s}$.

Nominal rigidities and equilibrium in the goods market. The model's supply side has nominal rigidities in the New Keynesian tradition. There is a continuum of competitive firms that own the capital stock and produce the final good, which is the numeraire. Absent nominal rigidities, firms set the utilization rate to balance the marginal cost of higher depreciation against the marginal benefit of higher output. That is, firms solve

$$\max_{\eta_{t,s}} \eta_{t,s}k_{t,s} - \delta(\eta_{t,s})Q_{t,s}k_{t,s}. \tag{7}$$

Therefore, without price rigidities, firms set $\delta'(\eta_{t,s})Q_{t,s} = 1$.

With nominal rigidities, as in New Keynesian models, firms meet any level of demand

[13] The leverage limit can be interpreted as a regulatory cap or as a market-imposed constraint arising from contracting frictions.

at the current price so long as the price of the consumption good exceeds the marginal cost. The consumption good is the numeraire. Thus, firms produce

$$y_{t,s} = \eta_{t,s} k_{t,s} = c^o_{t,s} + c^p_{t,s}, \tag{8}$$

so long as $\delta'(\eta_{t,s})Q_{t,s} \leq 1$. For simplicity, prices are assumed to be completely fixed.[14] Hence, by setting the nominal interest rate, the central bank also sets the real interest rate.

Definition 1 Private-sector equilibrium. *Conditional on a process for the interest rate* $\{r^f_{t,s}\}_{t\in[0,\infty),s\in S}$*, private-sector equilibrium is a collection* $\{\eta_{t,s}, k_{t,s}, Q_{t,s}, r_{t,s}, a^o_{t,s}, a^p_{t,s}, c^o_{t,s}, c^p_{t,s}, \omega^o_{t,s}, \omega^p_{t,s}\}_{t\in[0,\infty)}$ *such that capital evolves according to Eq.* (1)*, the risky asset's instantaneous return satisfies Eq.* (2)*, investors maximize expected utility (Eqs.* (3)–(5)*), asset markets clear (Eq.* (6)*), and the consumption-good market clears (Eq.* (8)*) with the marginal cost of production weakly below the price of the consumption good. The economy's initial condition is the initial wealth of optimists and pessimists,* $(a^o_{0,0}, a^p_{0,0})$.

Output-asset price relation. Output is connected to the asset price according to

$$\eta_{t,s} k_{t,s} = y_{t,s} = c^o_{t,s} + c^p_{t,s} = \rho(a^o_{t,s} + a^p_{t,s}) = \rho Q_{t,s} k_{t,s}, \tag{9}$$

where the first equality follows from the production function, the second equality from goods-market clearing, the third from investors' optimal consumption-saving decision under log preferences, and the fourth from financial-market clearing. With log utility, demand-determined output is a constant fraction of aggregate wealth. From Eqs. (2) and (9), the asset return absent transition is

$$r_{t,s} = \rho + g_s - \delta(\eta_{t,s}) + \frac{\dot{Q}_{t,s}}{Q_{t,s}}. \tag{10}$$

That is, the dividend yield is the discount rate ρ. The output-asset price relation holds both with and without nominal rigidities. This relation, together with the first-order condition of firms' problem without nominal rigidities (Eq. (7)), also permits a characterization of utilization and the asset price absent nominal rigidities, which are time-invariant and denoted by η^* and Q^*, respectively:

$$\delta'(\eta^*)\eta^* = \rho \quad \text{and} \quad Q^* = \frac{\eta^*}{\rho}. \tag{11}$$

[14] For analysis of speculative frenzies with partly rigid prices, see Barlevy (2022).

Thus, utilization satisfies $\frac{\eta_{t,s}}{\eta^*} = \frac{Q_{t,s}}{Q^*}$. When $Q_{t,s} < Q^*$, there is an aggregate-demand shortfall, and utilization is below the level that would be obtained absent nominal rigidities.

Equilibrium in asset markets. Define the wealth share of type-i investors as

$$\alpha^i_{t,s} = \frac{a^i_{t,s}}{Q_{t,s}k_{t,s}} \quad \text{for } i \in \{o,p\}. \tag{12}$$

Optimists' wealth share, $\alpha^o_{t,s} = 1 - \alpha^p_{t,s}$, is the key state variable. The budget constraint implies that the type-i wealth share after the transition from state s to s' satisfies

$$\frac{\alpha^i_{t,s'}}{\alpha^i_{t,s}} = 1 + \left(\omega^i_{t,s} - 1\right)\left(1 - \frac{Q_{t,s}}{Q_{t,s'}}\right). \tag{13}$$

A transition that lowers the asset price also reduces an investor's wealth share if the investor has (gross) leverage greater than 1. Investors choose their leverage such that the risk-adjusted return on the risky asset weakly exceeds the risk-free rate,

$$r_{t,s} + \lambda^i_{s\to s'}\frac{\alpha^i_{t,s}}{\alpha^i_{t,s'}}\frac{Q_{t,s'} - Q_{t,s}}{Q_{t,s'}} \geq r^f_{t,s}, \tag{14}$$

which holds with equality if the leverage limit is not binding.[15] Absent transition, the evolution of wealth shares satisfies:[16]

$$\frac{\dot{\alpha}^i_{t,s}}{\alpha^i_{t,s}} = \lambda^p_{s\to s'}\frac{\alpha^p_{t,s}}{\alpha^p_{t,s'}}\left(1 - \frac{\alpha^i_{t,s'}}{\alpha^i_{t,s}}\right). \tag{15}$$

Through their leverage choice, type-i investors determine their wealth share upon transition ($\alpha^i_{t,s'}$) and how fast their wealth share grows absent transition ($\dot{\alpha}^i_{t,s}$). The leverage decision allocates wealth across these two potential outcomes, with a higher wealth share upon transition requiring slower growth absent transition.

In equilibrium, optimists have positive net leverage ($\omega^o_{t,s} > 1$), while pessimists have negative net leverage ($\omega^p_{t,s} < 1$). When the optimists are unconstrained, Eqs. (14)–(15) simplify considerably:

$$\frac{\alpha^i_{t,s'}}{\alpha^i_{t,s}} = \frac{\lambda^i_{s\to s'}}{\bar{\lambda}_{s\to s'}(\alpha^o_{t,s})} \quad \text{and} \quad \frac{\dot{\alpha}^i_{t,s}}{\alpha^i_{t,s}} = \underbrace{\bar{\lambda}_{s\to s'}(\alpha^o_{t,s})}_{\text{Wealth-weighted belief}} - \lambda^i_{s\to s'}, \tag{16}$$

where $\bar{\lambda}_{s\to s'}(\alpha^o_{t,s}) \equiv \lambda^o_{s\to s'}\alpha^o_{t,s} + \lambda^p_{s\to s'}(1-\alpha^o_{t,s})$. We also obtain the risk-balance condition:

$$r_{t,s} + \bar{\lambda}_{s\to s'}(\alpha^o_{t,s})\left(1 - \frac{Q_{t,s}}{Q_{t,s'}}\right) = r^f_{t,s}. \tag{17}$$

[15] Eqs. (14)–(15) apply for $(s,s') \in \{(0,2),(1,2),(2,3)\}$, consistent with the state transition possibilities and beliefs specified earlier in this section.

[16] Pessimists' beliefs, superscript p, appear in Eq. (15) because pessimists' leverage constraint never binds. Hence, applied to pessimists (with $i = p$), Eq. (14) holds with equality and can be used to price assets.

If the leverage limit is slack, all investors perceive the same expected *risk-adjusted* return on the risky asset because their differing portfolios—optimists are leveraged—imply different risk adjustments. Consequently, per Eq. (17), the bust asset price is determined as if there were a representative investor with the wealth-weighted average belief.

Monetary policy and asset price in the recession and recovery. Private-sector equilibrium (Definition 1) was defined conditional on a process for the risk-free rate, $\{r^f_{t,s}\}_{t\in[0,\infty),s\in S}$. Next, we explain our assumptions about the monetary policy rule and characterize the equilibrium under those assumptions. Because we solve for the equilibrium by backward recursion, we start with the recovery state.

We begin by defining the neutral rates in the recession and recovery. Let τ_3 denote the time of transition to recovery ($s=3$). The neutral rate during recovery, $\{r^*_{t,3}\}_{t\in[\tau_3,\infty)}$, is defined as a process such that if the central bank sets $r^f_{t,3}=r^*_{t,3}$ whenever the economy is in $s=3$, then utilization and the asset price equal their levels absent nominal rigidities ($\eta_{t,3}=\eta^*$ and $Q_{t,3}=Q^*$ for $t\geq\tau_3$). The neutral rate during the recession, $\{r^*_{t,2}\}$, is defined analogously, taking as given neutral policy in the subsequent recovery: if $r^f_{t,2}=r^*_{t,2}$ in state $s=2$ and $r^f_{t,3}=r^*_{t,3}$ in state $s=3$, then utilization and the asset price in each of those states equal their levels absent nominal rigidities (in particular, $\eta_{t,2}=\eta^*$ and $Q_{t,2}=Q^*$ in the recession). We assume that the central bank sets the risk-free rate equal to the positive neutral rate during the recovery, $r^f_{t,3}=r^*_{t,3}=\rho+g_3-\delta(\eta^*)>0$, and thereby achieves full utilization in the recovery. The neutral rate is positive during the recovery and negative during the recession, reflecting assumptions about asset-valuation parameters.[17]

To analyze the recession ($s=2$), we begin with Q^i_2, the asset price when i-type investors hold all the wealth. Using the risk-balance condition in Eq. (17), this asset price solves: $\lambda^i_{2\to3}(1-\frac{Q^i_2}{Q^*})=-(\rho+g_2-\delta(\frac{Q^i_2}{Q^*}\eta^*))$. Pessimists perceive a recovery arrival rate lower than optimists do ($\lambda^p_{2\to3}<\lambda^o_{2\to3}$). Hence, the all-pessimist price is lower than the all-optimist price, which in turn is below the price consistent with full utilization: $Q^p_2<Q^o_2<Q^*$. The recessionary asset price is further characterized in the next lemma.

Lemma 1 (Asset price in the recession) *In the recession $s=2$, the asset price is below its efficient level ($Q_{t,2}<Q^*$), is a function of optimists' wealth share ($Q_{t,2}=Q_2(\alpha^o_{t,2})$), and*

[17] See Supplemental Appendix A.

is increasing in optimists' wealth share ($\frac{dQ_2(\alpha)}{d\alpha} > 0$ for $\alpha \in (0,1)$). If the depreciation rate satisfies $\delta(\eta) = \bar{\delta}$, then, for $\alpha \in [0,1]$,

$$\frac{1}{Q_2(\alpha)} = \frac{\alpha}{Q_2^o} + \frac{1-\alpha}{Q_2^p}, \tag{18}$$

where Q_2^i is the asset price with only i-type investors, with $\lambda_{2\to3}^i(1 - \frac{Q_2^i}{Q^*}) = -(\rho + g_2 - \bar{\delta})$.[18]

During the recession, the asset price satisfies the risk-balance condition (17). Using the instantaneous return (10), we have

$$\underbrace{\rho + g_2 - \delta(\frac{Q_{t,2}}{Q^*}\eta^*) + \frac{\dot{Q}_{t,2}}{Q_{t,2}}}_{\substack{\text{Instantaneous return on capital} \\ \text{if recession continues}}} + \underbrace{\bar{\lambda}_{2\to3}(\alpha_{t,2}^o)\left(1 - \frac{Q_{t,2}}{Q^*}\right)}_{\substack{\text{Risk-adjusted return upon recovery,} \\ \text{conditional on } Q_{t,2}}} = r_{t,2}^f. \tag{19}$$

To achieve an efficient asset price $Q_{t,2} = Q^*$ in the recession, the risk-free rate would have to equal the (negative) neutral rate $r_{t,2}^* = \rho + g_2 - \delta(\eta^*) < 0$. Hence, the ZLB binds ($r_{t,2}^f = 0$), and the asset price $Q_{t,2} < Q^*$ is determined by Eq. (19).[19] Utilization during the bust is therefore below its efficient level and increasing in optimists' wealth share.

In the case of $\delta(\eta) = \bar{\delta}$, the asset price is the harmonic mean of the all-optimist and all-pessimist prices, with weight $\alpha_{t,2}^o$ on the all-optimist price.[20] The closed-form solution is used in Section 5.3 to provide a stark characterization of the anticipation effect.

In the remainder of the paper, we often drop the time and investor-type indices and denote optimists' wealth share as α. The remaining variables are described as functions of optimists' wealth share. If optimists' wealth share just prior to the transition from s to s' is equal to α, we denote the wealth share at the start of s' as $\alpha_{s\to s'}(\alpha)$.

Monetary policy in the boom. We assume that, as the boom begins ($s = 0$), the central bank follows a conventional output-stabilization policy and sets the risk-free rate equal to the neutral rate, $r_0^f(\alpha) = r_0^*(\alpha)$, that implies utilization and the asset price equal to the levels that would be obtained absent nominal rigidities (Eq. (11)). This risk-free rate is:

$$r_0^f(\alpha) = \rho + g_0 - \delta(\eta^*) - \frac{(1-\alpha)\lambda_{0\to2}^p}{1 - \alpha_{0\to2}(\alpha)}\left(\frac{Q^*}{Q_2(\alpha_{0\to2}(\alpha))} - 1\right), \tag{20}$$

[18] This tractable case involves firms choosing their utilization rate $\eta_{t,s} \in [0,1]$ with the depreciation rate $\bar{\delta}$ invariant to utilization. See Supplemental Appendix B.

[19] We assume that the central bank sets the interest rate in the recession state according to the conventional output-stabilization policy $r_{t,2}^f = \max\{r_{t,2}^*, 0\}$. With $r_{t,2}^* < 0$, the ZLB binds.

[20] The closed-form solution for $Q_2(\alpha)$ is obtained by recognizing that, with $\delta(\eta) = \bar{\delta}$, Eq. (19) is a Bernoulli equation, as described in the proof in the Supplemental Appendix.

where optimists' wealth share if the bust arrives, $\alpha_{0\to 2}(\alpha)$, is obtained using (13). Expression (20) is itself obtained from (14), applied to pessimists, for whom the leverage limit never binds. The neutral rate is strictly positive during the boom under assumptions about asset valuation parameters.[21] Setting the risk-free rate equal to the neutral rate during $s = 0$ achieves output at potential ($\eta_{t,0} = \eta^*$), but this policy can still be described as somewhat accommodative because it disregards financial vulnerabilities associated with compressed risk premia and high leverage.

In the $s = 1$ boom, the neutral rate, for a given optimists' wealth share, is identical to the neutral rate in $s = 0$. The central bank in $s = 1$ could continue to follow a conventional output-stabilization policy. However, in $s = 1$, the central bank can alternatively choose to lean, tightening the stance of monetary policy and setting the policy rate to achieve a lower asset price. As shown in Supplemental Appendix A, conditional on optimists' wealth share just prior to the recession, a policy that reduces the asset price during the boom can soften the decline in optimists' wealth share upon recession.

We represent leaning as a choice of the boom-time asset-price schedule $Q_1(\alpha)$; Eq. (21) (just below) provides the policy-rate rule that implements it. We consider Q-targeting rules satisfying $Q_1(\alpha) \leq Q^*$ for $\alpha \in [0, 1]$. If this condition holds with equality for all values of optimists' wealth share (i.e., $Q_1(\alpha) = Q^*$), then the Q-targeting rule coincides with conventional monetary policy. We restrict attention to Q-targeting rules $Q_1(\alpha)$ that are continuous and right-differentiable.

The central bank implements the Q-targeting rule $Q_1(\alpha)$ by setting the risk-free rate equal to the risk-adjusted return on capital (using (14) applied to pessimists):

$$r_1^f(\alpha) = \underbrace{\rho + g_1 - \delta\left(\frac{Q_1(\alpha)}{Q^*}\eta^*\right) + \frac{d\ln(Q_1(\alpha))}{d_+\alpha}\dot{\alpha}_1(\alpha)}_{\substack{\text{Return on capital absent recession arrival, } r_1(\alpha) \\ \text{Equation (10)}}} - \underbrace{\frac{(1-\alpha)\lambda^p_{1\to 2}}{1-\alpha_{1\to 2}(\alpha)}\left(\frac{Q_1(\alpha)}{Q_2(\alpha_{1\to 2}(\alpha))} - 1\right)}_{\substack{\text{Recession risk term,} \\ \text{Eq. (14)}}}, \tag{21}$$

where optimists' wealth share if the bust arrives, $\alpha_{1\to 2}(\alpha)$, and optimists' wealth share growth absent transition, $\dot{\alpha}_1(\alpha)$, are obtained using (13) and (15). The expression $\frac{d\ln(Q_1(\alpha))}{d_+\alpha}$ is the right-derivative of $\ln Q_1(\alpha)$.

Lower boom-time asset prices are central to leaning, making Q-targeting rules a

[21] See Supplemental Appendix A.

natural way to describe leaning policies. Allowing the Q-targeting rule to depend on the state variable α aligns with calls to incorporate credit quantity measures into monetary policy rules (e.g., Gourio et al. 2018). In our setting, when optimists' leverage limit binds, their wealth share α is proportional to credit-to-total assets and credit-to-GDP because credit-to-total-assets is $(\bar{\omega}-1)\alpha$, and the output-asset price relation implies total assets are proportional to output. We require Q-targeting rules to have the "cure no worse than the disease" property: $Q_1(\alpha) \geq Q_2(\alpha)$, for $\alpha \in [0,1]$. A rule $Q_1(\cdot)$ has this property if it induces an asset price weakly above the price in the bust.

Welfare. To study the welfare implications of leaning and characterize optimal policy, we use the gap value function of Caballero and Simsek (2020b) that captures expected losses from (demand-driven) output below potential. It is an exact version of the quadratic-loss measure used in the New Keynesian literature. The gap value uses a measure of instantaneous welfare losses from underutilization agreed upon by all agent types despite differing beliefs about state transition rates. In the $s=1$ boom, the gap value w_1^{pl} under the planner's beliefs satisfies

$$\rho w_1^{pl}(\alpha) = \underbrace{W(Q_1(\alpha))}_{\substack{\text{Welfare flow}\\ \text{from utilization}}} + \lambda_{1\to 2}^{pl} \underbrace{\left(w_2^{pl}(\alpha_{1\to 2}(\alpha)) - w_1^{pl}(\alpha)\right)}_{\substack{\text{Welfare loss}\\ \text{upon recession}}} + \underbrace{\frac{\partial w_1^{pl}(\alpha)}{\partial \alpha}\dot{\alpha}_1(\alpha)}_{\substack{\text{Welfare gain}\\ \text{absent recession}}}, \tag{22}$$

where $W(Q) \equiv \ln \frac{Q}{Q^*} - \frac{1}{\rho}(\delta(\frac{Q}{Q^*}\eta^*) - \delta(\eta^*))$ is strictly concave with maximum value $W(Q^*) = 0$. This function $W(Q)$ captures welfare losses when the asset price—and, hence, utilization—deviate from their efficient levels. The $W(Q)$ function has a component related to the output gap (with log utility, $\ln \frac{Q}{Q^*}$) and a component related to depreciation. In the gap value equation (22), monetary policy affects three terms directly: the asset price $Q_1(\alpha)$ and thus the instantaneous utilization measure $W(Q_1(\alpha))$, the change in optimists' wealth share upon recession $\alpha_{1\to 2}(\alpha)$, and the growth rate of optimists' wealth share $\dot{\alpha}_1(\alpha)$.

Relation with Caballero–Simsek. Our benchmark model differs from Caballero and Simsek (2020a) in two main ways. First, we have added state 0, a boom with Wicksellian policy. Second, a change in the monetary policy (Q-targeting) rule in $s=1$ endogenously affects optimists' wealth share. To arrive at the Caballero–Simsek framework, one would delete state 0 and allow the $Q_1(\cdot)$ rule to vary without affecting optimists' wealth share. Thus, their analysis studies *preannounced* leaning in a one-cycle model, whereas our

benchmark model features *unexpected* leaning.

After presenting the calibration (Section 2), our announcement-effect analysis in Section 3 examines positive and normative implications of different Q-targeting rules. Section 4 states the planner's problem and characterizes optimal policy.

2. Calibration

Our calibration uses U.S. business-cycle data over 1952–2023. Recessions and expansions are labeled using the NBER business cycle chronology (National Bureau of Economic Research 2026). The average expansion length is five years (we set the planner's belief accordingly, with $\lambda^{pl}_{0\to 2} = 0.2$) and the average recession length is one year ($\lambda^{pl}_{2\to 3} = 1$). The household discount rate is $\rho = 4\%$, a standard value in the literature and in line with empirical estimates of the yearly marginal propensity to consume from stock and housing wealth (Guren et al. 2020; Chodorow-Reich et al. 2021).

To calibrate the risk premium parameters and optimists' and pessimists' beliefs, we focus on the returns on risky assets upon recession and recovery. Our model features a single risky asset (representing a claim on all output) and therefore a single risky return. We accordingly use data on the return on risky assets from Jordà et al. (2019, 2022).[22]

To recover the risk premium parameters and perceived transition rates, we build on the observation that the return upon recovery is highest in the all-pessimist economy (a gross return of $\frac{Q^*}{Q_2^p}$) and lowest in the all-optimist economy (a gross return of $\frac{Q^*}{Q_2^o}$). In the all-pessimist recession, asset prices are low and determined by the most bearish (or most risk-averse) investors. In the all-optimist recession, asset prices are determined by the most bullish investors. During the recovery, the asset price is high and equal to Q^*, regardless of optimists' wealth share. Therefore, the range of returns upon recovery is informative about belief differences regarding the recovery arrival rate. One challenge is that returns alone, without additional restrictions, are insufficient to identify perceived transition rates because returns also reflect stochastic discount factors (Borovicka et al. 2016). We use the structure of the model to address this issue, as we describe next.

[22] Jordà et al. (2019) define the return on risky assets as a weighted average of the returns on equities and housing. A second calibration, presented in Supplemental Appendix C, takes a cross-country approach and emphasizes the Global Financial Crisis, utilizing Jordà et al.'s (2019) data for 18 countries.

2.1 Asset valuations, belief differences, and returns

We parametrize belief differences regarding the transition from state s to s' by $\xi_{s\to s'}$,

$$\xi_{s\to s'} \equiv \frac{|\lambda^o_{s\to s'} - \lambda^p_{s\to s'}|}{\frac{1}{2}(\lambda^o_{s\to s'} + \lambda^p_{s\to s'})}. \tag{23}$$

We denote by $r^i_{s\to s'} = \frac{Q^i_{s'}}{Q^i_s} - 1$ the net return upon transition from s to s' when investors with beliefs $i \in \{o, p\}$ hold all the wealth. In addition, $r^{i,adj}_{s\to s'}$ is the *risk-adjusted* return when investors with beliefs i hold all the wealth. The risk-adjusted return upon transition from s to s' is the return multiplied by the ratio of the marginal lifetime utility of wealth in s' to the marginal lifetime utility of wealth in s.[23] We assume that the planner's beliefs are an average of the optimists' and pessimists', with $\lambda^{pl}_{s\to s'} = \frac{1}{2}(\lambda^o_{s\to s'} + \lambda^p_{s\to s'})$. That is, the planner's beliefs, used to calculate the gap value in Eq. (22), are in the middle of optimists' and pessimists'. (We relax this approach in Supplemental Appendix E.4, when we vary the planner's belief, holding all else constant.)

The arrival of recovery is always "good news"—and more so in the view of an investor who expected a recession of greater duration. Consistent with this intuition, we show in Supplemental Appendix C (using Eqs. (10) and (14)) that belief differences about the transition rate from recession to recovery, parameterized by $\xi_{2\to 3}$, satisfy[24]

$$\xi_{2\to 3} = \frac{r^{p,adj}_{2\to 3} - r^{o,adj}_{2\to 3}}{\frac{1}{2}(r^{p,adj}_{2\to 3} + r^{o,adj}_{2\to 3})}. \tag{24}$$

Greater dispersion in risk-adjusted returns about the arrival rate of recovery corresponds to greater belief differences. However, this expression cannot directly be used to determine the belief differences $\xi_{2\to 3}$ because risk-adjusted returns are not observable. To make progress, we take advantage of the simple form of the risk-adjustment term in the all-optimist and all-pessimist economies. We show in Supplemental Appendix C the equality of the magnitudes of the *risk-adjusted* return upon recovery and the *non-risk-adjusted* return upon recession under Wicksellian policy in the all-optimist and all-pessimist economies. This result obtains because of two features of the model: (1) Absent state transition, the all-optimist and all-pessimist economies are "steady states" (i.e.,

[23] See Eq. (IA.27) in Supplemental Appendix C for a formal definition of the risk-adjusted return. Returns in the all-optimist and all-pessimist economies, $r^i_{s\to s'}$, have no time subscript because such economies feature no dynamics absent a state transition (i.e., with $\alpha \in \{0, 1\}$, $\dot{\alpha}_s(\alpha) = 0$).

[24] Eqs. (24)–(27) are very good approximations in our calibrated model, and Eqs. (24), (25), and (27) hold exactly if depreciation $\delta(\eta) = \bar{\delta}$, as explained in Supplemental Appendix C.1.

$\dot{\alpha}_s(\alpha) = 0$), implying that the gross return upon a bust, $\frac{Q_2(\alpha)}{Q^*}$, is the inverse of the gross return upon recovery, $\frac{Q^*}{Q_2(\alpha)}$, for $\alpha \in \{0, 1\}$, and (2) lifetime utility increases logarithmically with an investor's wealth. Using this result, Eq. (24) can be written as:

$$\xi_{2\to3} = \frac{r^p_{0\to2} - r^o_{0\to2}}{\frac{1}{2}(r^p_{0\to2} + r^o_{0\to2})}. \tag{25}$$

This expression is in terms of observable returns on the risky asset (upon recession).

Similarly, we obtain an expression for the bust asset valuation parameter g_2,

$$g_2 = \frac{1}{2}\left(\lambda^o_{2\to3} r^o_{0\to2} + \lambda^p_{2\to3} r^p_{0\to2}\right). \tag{26}$$

Low values of g_2 (low asset valuations in a bust) are associated with a low (belief-weighted) average of the best and worst bust returns, reflecting that a low asset valuation exacerbates bust severity under all agents' beliefs. We also derive an expression for belief differences about the bust arrival rate as a function of the return upon recovery, with

$$\xi_{0\to2} = \frac{1}{\frac{1}{2}(r^o_{2\to3} + r^p_{2\to3})}\left(r^o_{2\to3} - r^p_{2\to3} + \frac{1}{\lambda^{pl}_{0\to2}}\left(r^{f,o}_0 - r^{f,p}_0\right)\right), \tag{27}$$

where $r^{f,i}_0$ is the risk-free rate during the boom, under Wicksellian policy, when all investors have beliefs i. To proxy for the return upon recession in the all-pessimist economy, we use the lowest (-18%) real return on risky assets across the years corresponding to the beginning of recession. For the return upon expansion in the all-pessimist economy, we use the highest (17%) real return on risky assets at the beginnings of expansions. For the boom-time real risk-free rate in the all-optimist economy, we use the highest real Treasury bill rate (6%) during an expansion year. For the risky return upon recovery in the all-optimist economy, we use 1%, in line with the lowest return at the start of an expansion.[25] We set the asset-valuation parameter for boom states to 8%; conditional on a Q-targeting rule, the asset valuation parameter for boom states, g_s for $s \in \{0, 1, 3\}$, does not affect the dynamics of optimists' wealth share or utilization, so long as the Q-targeting rule can be implemented with a positive interest rate.[26]

We set the leverage limit $\bar{\omega} = 4.3$ to match the sensitivity of intermediary capital to declines in risky asset prices at the start of recessions using Eq. (13) and data from He et al. (2017, 2026). The budget-constraint arithmetic is presented in Supplemental Appendix

[25] The return upon recession in the all-optimist economy is set similarly to -1%.

[26] The risk-free rate for the $s = 1$ boom is given by Eq. (21), which, with suitable modification, applies as well for other boom states, as shown in Supplemental Appendix A. A higher boom-time asset-value parameter shifts up the risk-free rate, $r^f_s(\alpha)$, by the same amount for any α.

Table 1: **Parameter values**

Parameter	Description	Value
ρ	Discount rate	0.04
$g_0 = g_1 = g_3$	Growth rate of capital during boom and recovery	0.08
g_2	Growth rate of capital during recession	-0.02
$(\lambda^o_{s\to 2},\ \lambda^{pl}_{s\to 2},\ \lambda^p_{s\to 2})$	Transition rate from boom ($s \in \{0,1\}$) to recession	(0.07, 0.20, 0.33)
$(\lambda^o_{2\to 3},\ \lambda^{pl}_{2\to 3},\ \lambda^p_{2\to 3})$	Transition rate from recession $s = 2$ to recovery $s = 3$	(1.89, 1.00, 0.11)
$\bar{\omega}$	Leverage limit	4.3

C. We use the functional form and parametrization for the depreciation function $\delta(\eta)$ from Caballero and Simsek (2020a), $\delta(\eta) = \underline{\delta} + \left(\overline{\delta} - \underline{\delta}\right) \frac{(\eta - \underline{\eta})^{1+1/\epsilon}}{1+1/\epsilon}$ for $\eta \geq \underline{\eta}$ with $\underline{\eta} = 0.97$, $\underline{\delta} = 0.04$, and $\epsilon = 20$. The depreciation elasticity parameter ϵ controls the convexity of the relation between utilization and depreciation (when utilization η is above $\underline{\eta}$). Conditional on these parameter values, the normalization $\eta^* = 1$ implies that $\overline{\delta} = 0.087$. The resulting depreciation function is consistent with the assumption that depreciation is weakly increasing and weakly convex, and strictly so for $\eta > \underline{\eta}$.

Table 1 lists parameter values. Section 5.4 reports several sensitivity analyses.

2.2 Illustrating the macroprudential benefit of leaning

Next, we use the calibrated model to quantify a benefit of leaning. We begin by characterizing outcomes conditional on optimists' wealth share in state 1 after leaning is adopted, highlighting the macroprudential channel in Caballero and Simsek (2020a). We study a simple yet general Q-targeting rule: a convex combination of the asset price under conventional monetary policy and the bust asset price. The rule is

$$Q_1(\alpha) = \psi Q_2(\alpha) + (1 - \psi) Q^*, \tag{28}$$

for $\psi \in [0,1]$, where higher ψ indicates more aggressive leaning.[27] Figure 1, top-left panel, plots this rule for $\psi = 0.5$. To reduce the asset price, the implementing policy rate (top-right panel) exceeds the neutral rate. The bottom panels show a macroprudential benefit—upon recession, optimists' wealth share falls less—and an intertemporal cost—slower growth of optimists' wealth share during the boom. The next section examines

[27] This rule shares properties with Caballero and Simsek's (2020a) "PMP" rule; see Supplemental Appendix C.

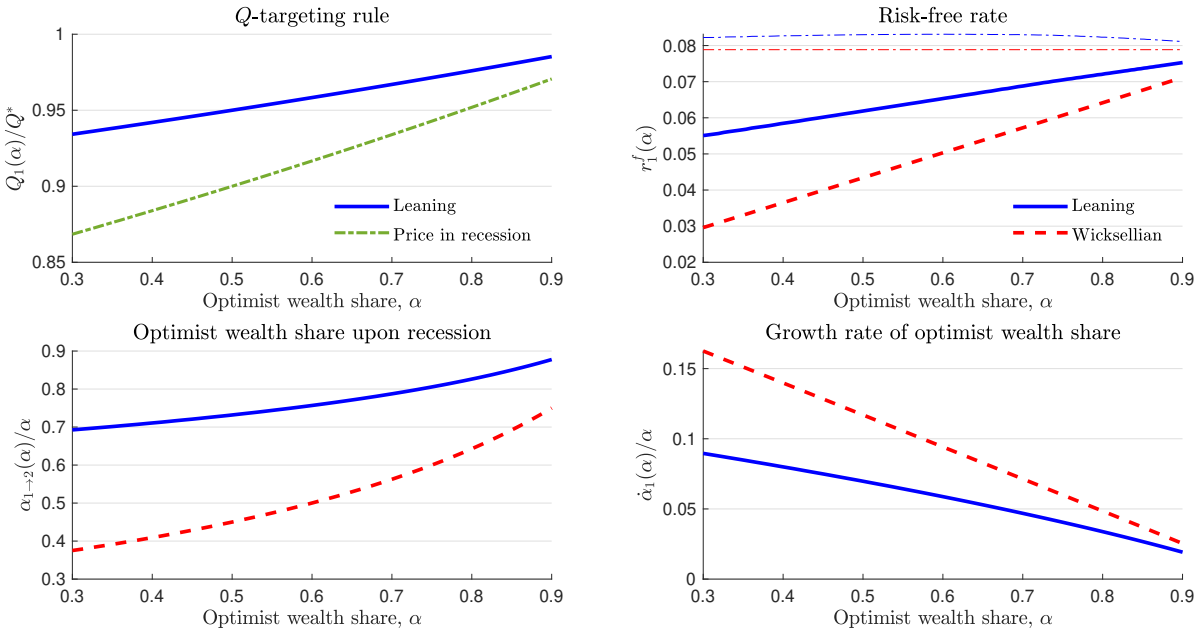


Figure 1: **Leaning monetary policy: An illustration**. *Top row:* The leaning rule Eq. (28) and implementing risk-free rate are shown by the solid blue lines. In the right panel, the thin dashed lines show the return on capital absent bust arrival. *Bottom row:* A macroprudential benefit (left panel) and cost (right panel) are shown.

the case when leaning is announced unexpectedly.

3. Announcement effect

This section analyzes what can go wrong when a central bank unexpectedly announces leaning. We consider leaning rules that depress the asset price throughout the boom and hence deliver a macroprudential benefit—conditional on the pre-recession optimists' wealth share, these rules soften the fall in optimists' wealth share and the asset price upon recession. Announcing such a rule during the boom reduces optimists' wealth share on impact and lowers the subsequent growth of optimists' wealth share. The persistent announcement effect induces a first-order welfare loss, even for small doses of leaning.

When leaning is announced, any asset price fall immediately reduces optimists' wealth share, because optimists have a levered position in the risky asset. Let $\bar{\alpha}$ denote optimists' wealth share just before the monetary-policy announcement. The post-announcement optimists' wealth share $\alpha_{0\to1}(\bar{\alpha})$ induced by Q-targeting rule $Q_1(\cdot)$ solves:

$$\alpha_{0\to1}(\bar{\alpha}) = \bar{\alpha}\left[1 - (\omega_0^o(\bar{\alpha}) - 1)\left(\frac{Q^*}{Q_1(\alpha_{0\to1}(\bar{\alpha}))} - 1\right)\right]. \tag{29}$$

From the perspective of the central bank choosing a monetary policy in $s = 1$, optimists'

wealth share and leverage prior to announcement ($\bar{\boldsymbol{\alpha}}$ and $\omega_0^o(\bar{\boldsymbol{\alpha}})$ in Eq. (29)) are predetermined. Optimists have a levered position in the risky asset, with $\omega_0^o(\bar{\boldsymbol{\alpha}}) > 1$, so long as the economy features a mix of optimists and pessimists (i.e., $\bar{\boldsymbol{\alpha}} \in (0,1)$). The asset price before announcement (in the numerator of the right-hand side) is Q^* because, by assumption, the central bank follows conventional policy in $s = 0$. As shown in Supplemental Appendix D, under certain parameter restrictions, there exists a unique solution $\alpha_{0\to1}(\bar{\boldsymbol{\alpha}})$ to Eq. (29). The next result establishes the effect on optimists' wealth share of announcing leaning.

Proposition 1 (Announcement effect)

(i) For $\bar{\boldsymbol{\alpha}} \in (0,1)$, announcing a leaning monetary policy with $Q_1(\bar{\boldsymbol{\alpha}}) < Q^*$ causes an immediate decline in optimists' wealth share, $\alpha_{0\to1}(\bar{\boldsymbol{\alpha}}) < \bar{\boldsymbol{\alpha}}$.

(ii) Announcing a leaning monetary policy with $Q_1(\bar{\boldsymbol{\alpha}}) = Q^*$ causes no decline in optimists' wealth share, $\alpha_{0\to1}(\bar{\boldsymbol{\alpha}}) = \bar{\boldsymbol{\alpha}}$.

Part (i) shows how an announcement with bite—an immediate fall in the asset price—"sows the wind" by cutting optimists' wealth share on impact. Part (ii) shows that an announcement without bite—and, hence, without a macroprudential benefit if a recession arrives immediately—leaves the wealth distribution unchanged. Both results are key for the design of optimal policy in the presence of announcement effects (Section 4).

Speculative lull. We next turn to leaning's dynamic implications. To facilitate the analysis, we introduce the possibility of a "speculative lull." If a lull occurs at t, investors delever for an instant, with $\omega_{t,0}^o = 1$. If the transition from $s = 0$ to $s = 1$ (a policy change) coincides with a lull, then announcing leaning with $Q_1(\bar{\boldsymbol{\alpha}}) < Q^*$ does not reduce optimists' wealth share. The speculative lull is economically relevant because the positive and normative implications of leaning policies announced during a speculative lull are the same as if leaning policy were systematic or "preannounced" before the $s = 0$ boom.[28]

Dynamic implications of leaning. The announcement effect has persistent real and financial consequences. With the announcement effect, optimists' wealth share is lower in both the boom $(s = 1)$ and bust $(s = 2)$ than with a speculative lull, regardless of

[28] Formally, announcing leaning at a lull when the pre-announcement optimists' share is $\bar{\boldsymbol{\alpha}}$ is observationally equivalent to preannouncing the same policy at time 0 with initial condition $\alpha_{t=0} = \bar{\boldsymbol{\alpha}}$, which is exogenous to monetary policy.

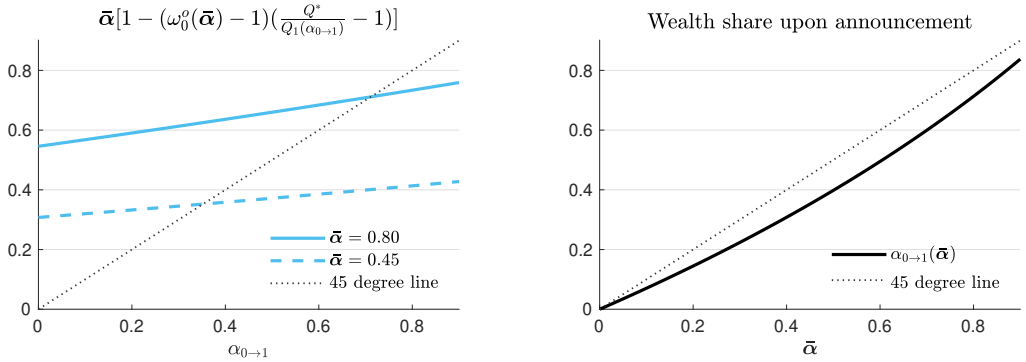


Figure 2: **Announcement effect: Equilibrium decline in optimists' wealth share**. The left panel illustrates the fixed-point condition (29), for two different values of optimists' wealth share $\bar{\boldsymbol{\alpha}}$. The right panel shows the fixed point as a function of $\bar{\boldsymbol{\alpha}}$.

when the recession arises, as shown in Proposition IA.2 of Supplemental Appendix D. Accordingly, the announcement effect deepens the recession. If in addition $Q_1(\alpha)$ is weakly increasing (so that the asset price is nondecreasing over time during the boom), the announcement effect also implies lower utilization during the boom and lower welfare. The welfare impact of the announcement effect is $\Delta w_1^{pl}(\bar{\boldsymbol{\alpha}}) \equiv w_1^{pl}(\alpha_{0\to1}(\bar{\boldsymbol{\alpha}})) - w_1^{pl}(\bar{\boldsymbol{\alpha}}) < 0$.

Welfare costs of leaning. The welfare losses from the announcement effect are first order, even for small amounts of leaning, as is formalized in Proposition IA.3. First-order welfare losses arise from lower utilization in the bust, when utilization is strictly below its efficient level (consistent with Q^*). By contrast, lower utilization during the boom implies only a second-order welfare loss from small doses of leaning because utilization is at its efficient level during the boom under Wicksellian policy.

Quantitative analysis. We illustrate the announcement effect using a leaning rule in which the boom asset price is the average of the conventional-policy price and the bust price (Eq. (28)). Figure 2 quantifies the fall in optimists' wealth share at announcement, and Figure 3 shows the persistent effects on optimists' wealth share and the asset price.[29]

The welfare implications are shown in Figure 4. As shown in the left panel, moderate doses of preannounced leaning (or leaning adopted in a speculative lull, dotted green

[29] Figure 2, right panel, shows that the announcement-induced drop in optimists' wealth share is largest at intermediate pre-announcement values of that share. Because optimists' wealth share rises over the course of a boom, the magnitude of the announcement effect depends on when the policy is announced. Supplemental Appendix D quantifies this timing dependence.

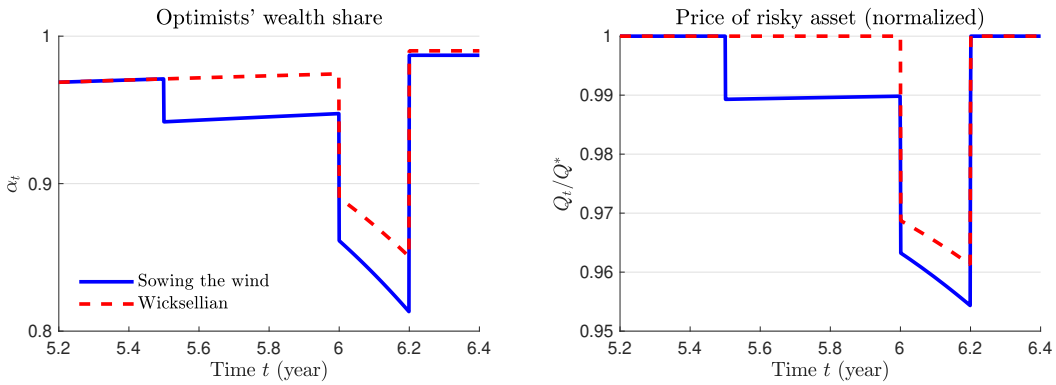


Figure 3: **Equilibrium paths under alternative policies**. This figure shows the economy's simulated path with a recession at $t = 6$ years and recovery at $t = 6.2$. The dashed red lines correspond to conventional policy. The solid blue lines show paths when the central bank adopts leaning at $t = 5.5$ years.

line) increase welfare.[30] However, when leaning is announced unexpectedly, even small doses reduce welfare relative to conventional policy and large doses much more so (solid blue line). Next we study the optimal Q-targeting rule of the form (28). We examine gap values when the strength of leaning ψ is set equal to the value $\psi^*(\bar{\boldsymbol{\alpha}})$ that maximizes the gap value, conditional on optimists' wealth share $\bar{\boldsymbol{\alpha}}$ just prior to the announcement and taking into account the announcement effect. Define

$$\psi^*(\bar{\boldsymbol{\alpha}}) = \arg\max_{\psi} w_1^{pl}(\alpha_{0\to 1}(\bar{\boldsymbol{\alpha}};\psi),\psi), \tag{30}$$

where $\alpha_{0\to 1}(\bar{\boldsymbol{\alpha}};\psi)$ is the solution to Eq. (29) conditional on the Q-targeting rule $Q_1(\alpha;\psi)$. Similarly, within this class, the optimal strength of leaning with a speculative lull is

$$\psi^{*,\text{lull}}(\bar{\boldsymbol{\alpha}}) = \arg\max_{\psi} w_1^{pl}(\bar{\boldsymbol{\alpha}};\psi). \tag{31}$$

As shown in the right panel of Figure 4, at a lull the central bank optimally chooses to lean. However, with the announcement effect, for each $\bar{\boldsymbol{\alpha}}$, for this general class of targeting rules, the central bank would not lean (at all).

4. Optimal policy with the announcement effect

We now show that optimal policy leans by phasing in tightening over time, mitigating the announcement effect by temporarily postponing leaning's macroprudential benefit.

[30] When displaying the welfare criterion, Eq. (22), we show the gap value rate, or the gap value divided by the expected length of time until recovery (in percent).

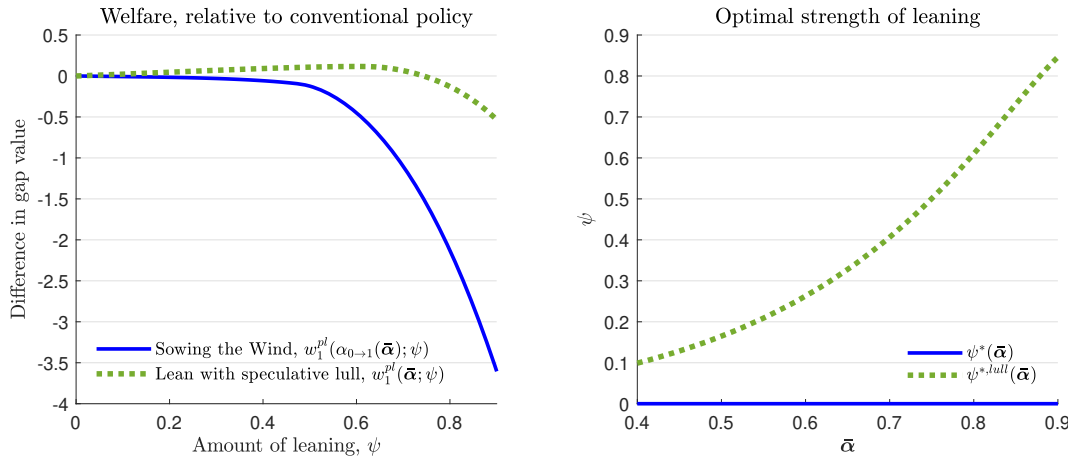


Figure 4: **Leaning and welfare**. The left panel shows the gap value under leaning, relative to that under conventional policy, with the announcement effect (solid blue line) and when it is announced during a lull (dotted green line), with $\bar{\boldsymbol{\alpha}} = 0.8$. The right panel illustrates optimal leaning within a class of simple rules, with the announcement effect (solid blue line) and with a lull (dotted green line).

4.1 Planner's problem

Given optimists' wealth share $\bar{\boldsymbol{\alpha}}$ prior to the transition to $s = 1$, the planner chooses the Q-targeting rule $Q_1(\alpha) : [0,1] \to \mathbb{R}^+$ to maximize the post-announcement gap value. As before, we restrict attention to continuous and right-differentiable Q-targeting rules. The set of such rules is denoted by $\mathcal{C}_r$ and these rules are implemented by setting the risk-free rate according to Eq. (21). Let $w_1^{pl}(\alpha)$ denote the gap value in $s = 1$ conditional on optimists' wealth share α. The planner's problem is

$$\sup_{Q_1(\cdot)\in\mathcal{C}_r} w_1^{pl}(\alpha_{0\to1}) \tag{32}$$

subject to

$$\alpha_{0\to1} = \bar{\boldsymbol{\alpha}}\left(1 - (\omega_0^o(\bar{\boldsymbol{\alpha}}) - 1)\left(\frac{Q^*}{Q_1(\alpha_{0\to1})} - 1\right)\right) \tag{33}$$

$$\dot{\alpha}_1(\alpha) = \alpha\frac{1-\alpha}{1-\alpha_{1\to2}(\alpha)}\lambda_{1\to2}^p\left(1 - \frac{\alpha_{1\to2}(\alpha)}{\alpha}\right), \forall\alpha\in[0,1], \tag{34}$$

with $\alpha_{1\to2}(\alpha)$ satisfying Eq. (13) and the Q-targeting rule satisfying $Q_1(\alpha) \in [Q_2(\alpha), Q^*], \forall\alpha \in [0,1]$.[31] The post-announcement optimists' wealth share $\alpha_{0\to1}$ must be consistent with the sowing-the-wind transition equation (33).

We first consider the case in which $s = 1$ arrives during a speculative lull (akin to "preannounced" leaning, which is the focus of Caballero and Simsek 2020a). In this

[31]The constraint $Q_1(\alpha) \geq Q_2(\alpha)$ requires that the optimal policy satisfies the cure-no-worse-than-the-disease principle (Section 1). The maximand, $w_1^{pl}(\cdot)$, is the solution to Eq. (22), conditional on $Q_1(\alpha)$.

case, adopting leaning does not redistribute wealth. Formally, we replace the sowing channel Eq. (33) with $\alpha_{0\to 1} = \bar{\boldsymbol{\alpha}}$. We denote the optimal rule with a lull as $Q^{\text{lull}}(\alpha)$ and the associated gap value as $w_1^{\text{lull}}(\alpha)$. The rule $Q^{\text{lull}}(\alpha)$ does not depend on $\bar{\boldsymbol{\alpha}}$.[32] The rule reflects a tradeoff: Lower $Q_1(\alpha)$ weakly increases optimists' wealth share if a recession arrives ($\alpha_{1\to 2}(\alpha)$ rises) at the expense of lower boom-time utilization ($W(Q_1(\alpha))$ falls) and slower growth of optimists' wealth share ($\dot{\alpha}_1(\alpha)$ falls).

The planner's problem once the boom is underway, however, is quite different because of the announcement channel. The central bank has to take into account how the announcement affects optimists' wealth share.

4.2 Optimal leaning

A natural strategy to mitigate the announcement effect is to minimize the asset price decline at the time of announcement (the start of $s = 1$). Then, over time, as optimists' wealth share rises, the central bank could begin to lean and reduce the asset price. Eventually, the central bank could set the asset price using the mapping $Q^{\text{lull}}(\alpha)$ that it would have chosen absent the announcement-effect channel in Eq. (33).

Accordingly, we explore Q-targeting rules that follow this strategy, of the form:

$$Q(\alpha; \bar{\boldsymbol{\alpha}}, \hat{\alpha}) = \begin{cases} Q^*, & \text{if } \alpha \leq \bar{\boldsymbol{\alpha}} \\ Q^* - \left(Q^* - Q^{\text{lull}}(\bar{\boldsymbol{\alpha}} + \hat{\alpha})\right) \frac{\alpha - \bar{\boldsymbol{\alpha}}}{\hat{\alpha}}, & \text{if } \alpha \in (\bar{\boldsymbol{\alpha}}, \bar{\boldsymbol{\alpha}} + \hat{\alpha}) \\ Q^{\text{lull}}(\alpha), & \text{if } \alpha \geq \bar{\boldsymbol{\alpha}} + \hat{\alpha}. \end{cases} \tag{35}$$

The parameter $\hat{\alpha}$ captures how much optimists' wealth share grows during the adjustment period, before the central bank follows the rule $Q^{\text{lull}}(\alpha)$. By avoiding an asset price decline on impact, the rule in Eq. (35)—even though announced unexpectedly—does not reduce optimists' wealth share. Over time, the asset price falls, generating a macroprudential benefit (i.e., optimists' share upon recession $\alpha_{1\to 2}(\alpha)$ is higher than under conventional policy).[33] However, this subsequent fall in the asset price is *expected* and hence does not reduce optimists' wealth share. We denote the gap value under this rule by $w_1^{pl}(\alpha; \bar{\boldsymbol{\alpha}}, \hat{\alpha})$.

Announced unexpectedly, Q-targeting rules that phase in leaning according to Eq. (35)

[32] The planner's problem with a lull can be written recursively and solved numerically using standard methods.

[33] The asset price equals Q^* immediately upon adoption. It subsequently falls if there is an $\alpha > \bar{\boldsymbol{\alpha}}$ such that optimal policy without the announcement channel involves leaning (i.e., $Q^{\text{lull}}(\alpha) < Q^*$).

achieve welfare benefits arbitrarily close to the welfare gains when the announcement occurs during a speculative lull and the optimal policy with a lull, Q^{lull}, is announced.

Proposition 2 (Optimal policy with announcement effect).

(i) If $Q^{\text{lull}}(\bar{\boldsymbol{\alpha}}) = Q^*$, then an optimal policy, announced unexpectedly, is $Q_1^{\text{opt}}(\alpha; \bar{\boldsymbol{\alpha}}) = Q^{\text{lull}}(\alpha)$ for $\alpha \geq \bar{\boldsymbol{\alpha}}$, with $Q_1^{\text{opt}}(\alpha; \bar{\boldsymbol{\alpha}}) = Q^*$ for $\alpha < \bar{\boldsymbol{\alpha}}$. This policy achieves the same gap value as optimal policy with a speculative lull.

(ii) If $Q^{\text{lull}}(\bar{\boldsymbol{\alpha}}) < Q^*$, then, in the limit as the adjustment length $\hat{\alpha}$ goes to zero, phased-in leaning (Eq. (35)) achieves the same gap value as optimal policy with a speculative lull:

$$\lim_{\hat{\alpha} \to 0^+} w_1^{pl}(\alpha_{0\to 1}(\bar{\boldsymbol{\alpha}}); \bar{\boldsymbol{\alpha}}, \hat{\alpha}) = w_1^{\text{lull}}(\bar{\boldsymbol{\alpha}}). \tag{36}$$

When optimal policy with a lull calls for no immediate fall in the asset price (part (i)), an optimal unexpected Q-targeting rule can be chosen to coincide (for $\alpha \geq \bar{\boldsymbol{\alpha}}$) with the optimal rule with a lull $Q^{\text{lull}}(\alpha)$.[34] The central bank eventually leans, with $Q_1(\alpha) < Q^*$, once α rises sufficiently.[35] Thus, when $Q^{\text{lull}}(\bar{\boldsymbol{\alpha}}) = Q^*$, optimal leaning, announced unexpectedly, achieves the same welfare benefits as optimal leaning during a speculative lull. When this case does not apply, unexpected leaning can achieve a level of welfare arbitrarily close to that of optimal leaning during a lull, per part (ii).

The planner's problem with unexpected leaning is the same as the planner's problem with a speculative lull, except that the speculative-lull problem switches off the announcement-effect restriction (Eq. (33)) by imposing $\alpha_{0\to 1} = \bar{\boldsymbol{\alpha}}$. Hence, Proposition 2 characterizes optimal unexpected leaning.[36]

Implementation. Optimal leaning involves no asset price fall upon announcement. It achieves this by "bear steepening" the yield curve. The central bank commits to hiking the policy rate over time if the speculative boom continues (i.e., absent a recession); the expectation of these hikes rotates the yield curve upward. In contrast, the expected policy rate over short horizons falls to avoid an immediate asset price decline from future hikes.

[34] The property, $Q^{\text{lull}}(\bar{\boldsymbol{\alpha}}) = Q^*$, holds for $\bar{\boldsymbol{\alpha}} < 0.25$ in our calibrated model.

[35] The central bank eventually leans if there is an $\alpha > \bar{\boldsymbol{\alpha}}$ such that optimal policy without the announcement-effect channel involves leaning (i.e., $Q^{\text{lull}}(\alpha) < Q^*$).

[36] That is, Proposition 2 implies that the supremum in the planner's problem Eq. (32) equals $w_1^{\text{lull}}(\bar{\boldsymbol{\alpha}})$. Proposition 2 also provides ϵ-optimal policies: for any $\epsilon > 0$, there exists $\hat{\alpha}_\epsilon > 0$ such that the Q-targeting rule Eq. (35) generates gap value $w_1^{pl}(\alpha_{0\to 1}(\bar{\boldsymbol{\alpha}}); \bar{\boldsymbol{\alpha}}, \hat{\alpha}_\epsilon) \geq w_1^{\text{lull}}(\bar{\boldsymbol{\alpha}}) - \epsilon$.

Consider the expected policy rate at time t in state s over horizon $h > 0$:

$$\bar{r}^{i}_{h,t,s} \equiv \frac{1}{h}\mathbb{E}^{i}_{t,s}\left[\int_{t}^{t+h} r^{f}_{\tau,\tilde{s}}d\tau\right], \tag{37}$$

where $\mathbb{E}^{i}_{t,s}[\cdot]$ is the expectation operator under belief type $i \in \{o, p, pl\}$.[37] We denote the expected risk-free rate under phased-in leaning (Eq. (35)) by $\bar{r}^{\text{opt},i}_{h,t,s}$. The expected risk-free rate with a lull, under the optimal policy ignoring the announcement effect, is denoted by $\bar{r}^{\text{lull},i}_{h,t,s}$. The next result characterizes the implementation of optimal policy.

Proposition 3 (Optimal leaning and the expected path of the policy rate). *Under optimal leaning, at the time of announcement τ_1, the expected policy rate curve under any belief $i \in \{o, p, pl\}$ is lower and steeper than under optimal policy without taking into account the sowing channel:*

$$\lim_{\hat{\alpha}\to 0^{+}} \bar{r}^{\text{opt},i}_{h,\tau_1,1} = \bar{r}^{\text{lull},i}_{h,\tau_1,1} - \frac{1}{h}\ln\left(\frac{Q^{*}}{Q^{\text{lull}}(\bar{\boldsymbol{\alpha}})}\right). \tag{38}$$

If $Q^{\text{lull}}(\bar{\boldsymbol{\alpha}}) < Q^{*}$, then $\bar{r}^{\text{opt},i}_{h,\tau_1,1} < \bar{r}^{\text{lull},i}_{h,\tau_1,1}$ ("lower") *and $\frac{d\bar{r}^{\text{opt},i}_{h,\tau_1,1}}{dh} > \frac{d\bar{r}^{\text{lull},i}_{h,\tau_1,1}}{dh}$* ("steeper") *in the limit as $\hat{\alpha} \to 0^{+}$.*

Optimal policy taking into account the announcement effect requires a looser stance of monetary policy (with fewer hikes in the short run), relative to optimal policy with a lull. If optimal policy with a lull involves immediately reducing the asset price (leaning, with $Q^{\text{lull}}(\bar{\boldsymbol{\alpha}}) < Q^{*}$), then the expected policy rate curve when the phased-in policy is announced is strictly lower and strictly steeper than under optimal policy with a lull. The lower the asset price targeted under the optimal policy with a lull—that is, the more aggressive the leaning—the greater the yield-curve steepening under the phased-in policy.[38]

Quantitative analysis: optimal leaning. For numerical analysis of optimal policy, we use the Q-targeting rule in Eq. (35) with the value of $\hat{\alpha}$ fixed but small—an approximation of optimal policy shown by the solid blue line in Figure 5, top-left panel. This rule smooths the transition from Wicksellian policy ($Q_1(\alpha) = Q^{*}$, dashed red line) to the optimal policy with a lull ($Q^{\text{lull}}(\alpha)$, dotted green line).[39] We set $\hat{\alpha} = 0.01$ and, for this panel,

[37] The expected policy rate curve is the expectations component of the zero-coupon yield curve.

[38] The difference between the expected policy rate paths in Eq. (38) is the same under all agents' beliefs, because all agent types anticipate a decline in the asset price of the same magnitude and same timing.

[39] Optimal leaning with a lull involves stronger leaning at intermediate values of α. There is no macroprudential benefit to leaning in the all-pessimist or all-optimist economies, which feature no speculation.

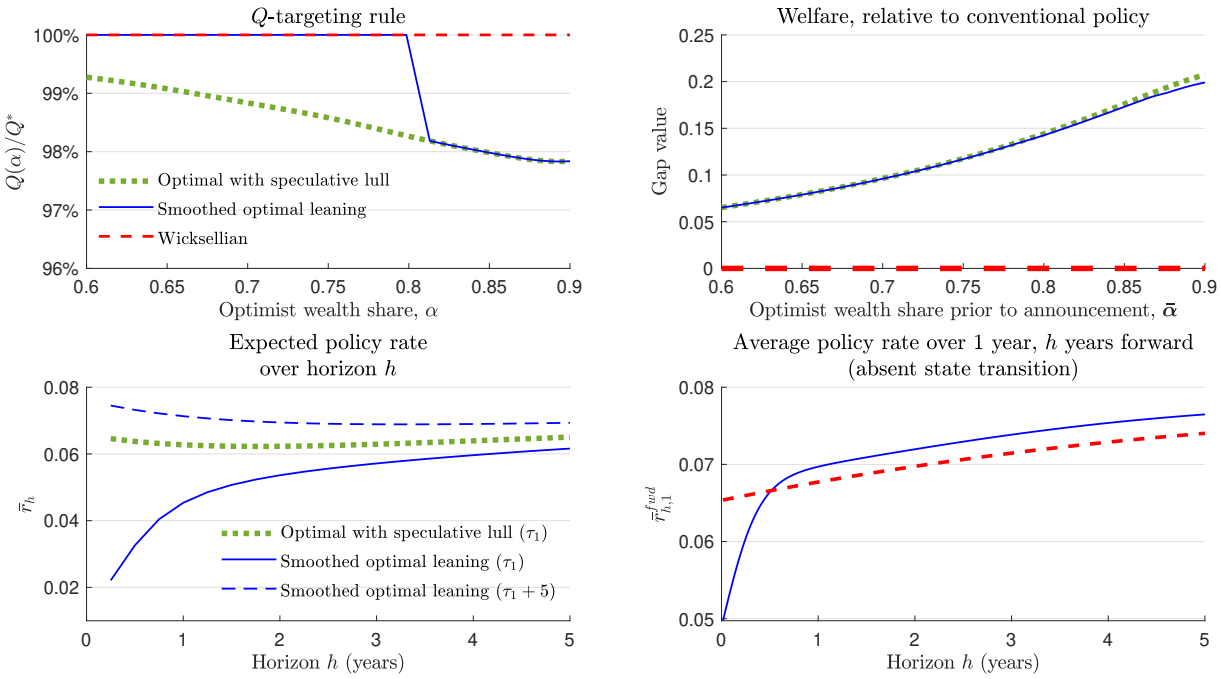


Figure 5: **Optimal leaning achieves welfare benefits by phasing in monetary tightening**.

optimists' wealth share before announcement is $\bar{\alpha} = 0.8$. The rule $Q^{\text{lull}}(\cdot)$ is obtained with standard recursive methods (value function iteration).

Smoothed optimal leaning delivers welfare gains that are nearly indistinguishable from those under a speculative lull, as shown in the top-right panel of Figure 5. The panel shows the relation between the gap value and optimists' pre-announcement wealth share, $\bar{\alpha}$. The solid blue line is the post-announcement gap value under smoothed optimal leaning, Eq. (35). The dotted green line is the post-announcement gap value if the announcement occurs during a speculative lull and the optimal policy with a lull, $Q^{\text{lull}}(\alpha)$, is announced. Both are reported relative to the Wicksellian benchmark (dashed red line).

The bottom panels of Figure 5 display the implementation of optimal leaning and the consequences for the expected path of the policy rate. The left panel shows the expected policy rate over various horizons, $\bar{r}_h$, under alternative policies and at different times. The dotted green line is the expected policy rate under optimal leaning when the central bank announces it during a lull and can ignore the announcement effect. The solid blue line is the expected policy rate curve immediately following the announcement of optimal leaning. Accounting for the announcement effect implies less leaning—with $\bar{r}_h$

lower at all horizons—and also a much steeper expected policy rate curve, consistent with Proposition 3. That is, monetary tightening is "backloaded." Five years after the announcement (blue dashed), if the speculative boom persists, the central bank raises the policy rate and the expected policy rate curve "bear flattens" (i.e., the dashed line is uniformly above the solid line, with larger increases at shorter horizons).

To further illustrate the implementation of optimal leaning, the bottom-right panel shows the *forward* rate curve, a leading indicator of policy's future stance. The forward rate (at τ_1) over m years, beginning h years ahead and conditional on no state transition, is

$$\bar{r}^{fwd}_{h,m} = \frac{1}{m}\int_{\tau_1+h}^{\tau_1+h+m} r^f_{t,1}dt. \tag{39}$$

For simplicity, Eq. (39) conditions on remaining in the boom state.[40] Under conventional policy (dashed red line), the forward curve is upward sloping because the neutral rate of interest rises with optimists' wealth share during the boom. Under smoothed optimal leaning (solid blue line), the forward curve exhibits a bear steepening. Forward rates exceed those under conventional policy, except at very short horizons.

5. Extensions and robustness

5.1 Endogenous bust probability

Leaning against a boom might reduce bust risk, consistent with the observation that elevated market sentiment is associated with a subsequent downturn (López-Salido et al. 2017). We next study leaning in an extension of the model in which the bust arrival rate is endogenous. We assume that, in the $s = 1$ boom with targeting rule $Q_1(\cdot)$, the bust arrival rate is $\gamma^i(Q_1(\cdot))\lambda^i_{1\to 2}$ under belief $i \in \{o, p, pl\}$. We refer to the function $\gamma^i(\cdot)$ as the bust arrival-rate multiplier.[41] We normalize $\gamma^i(Q_1(\cdot)) = 1, \forall i$, for Wicksellian policy with $Q_1(\alpha) = Q^*, \forall \alpha$. The benchmark model with exogenous bust risk is nested with $\gamma^i(Q_1(\cdot)) = 1$ for all Q-targeting rules, $Q_1(\cdot)$.

To begin, we analyze a given leaning policy's benefits and costs when bust risk is endogenous; the results are presented in Supplemental Appendix E.1. Leaning continues

[40] A version of the forward rate that takes into account the possibility of state transitions is provided in Supplemental Appendix C. The results are qualitatively similar.

[41] We allow the bust multipliers to depend on the entire $Q_1(\cdot)$ targeting rule.

to attenuate the fall in optimists' wealth share upon recession. Moreover, when optimists and pessimists agree about the bust multiplier or when the leverage limit binds, a given leaning rule mitigates the fall in optimists' wealth share by the same magnitude as in the benchmark model. However, an endogenous bust probability introduces a new and intertemporal cost of leaning if leaning reduces the arrival rate of the bust under pessimists' beliefs: slower boom-time growth of optimists' wealth share.

An endogenous bust arrival rate affects the boom-time growth rate of optimists' wealth share for two reasons. First, conditional on leverage, the growth rate of optimists' wealth share is increasing in pessimists' bust arrival rate (Eq. (15)). This channel reflects the fact that the leverage limit never binds for pessimists, and, hence, asset prices equate pessimists' risk-adjusted expected return on capital with the risk-free rate.[42] Second, optimists' leverage may change if belief dispersion increases. With homogeneous bust multipliers or a binding leverage limit, leverage is unchanged and only the first channel is present. In this case, a lower bust arrival rate (under pessimists' beliefs) reduces the excess return received by optimists and thereby slows the boom-time growth of optimists' wealth share.

These observations raise the question: Does leaning reduce the probability of a bust? Empirical evidence from López-Salido et al. (2017) and others suggests that elevated sentiment and high asset values are associated with subsequent slumps. Thus, phased-in leaning, by reducing asset prices without a drop in optimists' wealth share at announcement, might reduce bust risk ($\gamma^i < 1$), reinforcing the benefits of phased-in leaning. However, Schularick et al. (2021) present evidence that unexpectedly raising the policy rate to lean increases the risk of a bust ($\gamma^i > 1$).[43] This evidence suggests an *additional* type of "sowing" announcement effect: Unexpected "simple" leaning may sow by raising bust risk.

We next study optimal policy with endogenous bust risk. We assume that a Q-targeting rule $Q_1(\cdot)$ that lowers optimists' wealth share upon announcement ($Q_1(\bar{\boldsymbol{\alpha}}) < Q^*$) raises the bust arrival rate by a factor of $\gamma^i > 1$ under beliefs i. In contrast, a $Q_1(\cdot)$ rule that

[42] Asset prices satisfy Eq. (14), applied to pessimists. Optimists' beliefs about recession arrival still affect asset prices, because pessimists' risk adjustment reflects their equilibrium leverage and hence their belief differences with optimists.

[43] Relatedly, Jiménez et al. (2025) show that monetary-policy rate hikes materially increase the risk of a slump, if they are preceded by accommodative monetary policy.

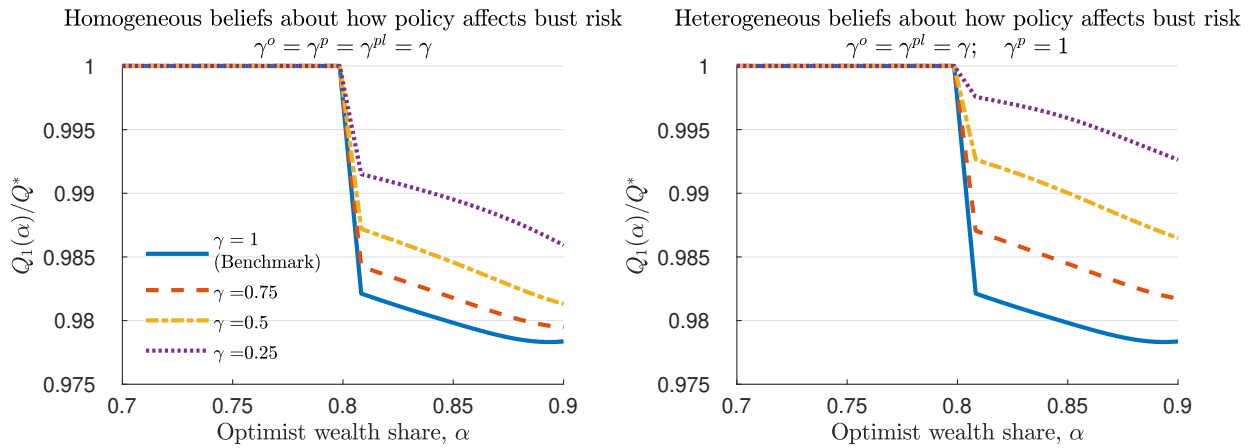


Figure 6: **Optimal policy for homogeneous and heterogeneous beliefs about how policy affects bust risk**. In both panels, the solid blue line shows the (approximately) optimal Q-targeting rule for the benchmark model with an exogenous bust arrival rate ($\gamma^i = 1, \forall i$ for all Q-targeting rules). Each remaining line shows the optimal Q-targeting rule with endogenous bust risk. Lower values of γ correspond to lower bust risk. The pre-announcement wealth share is $\bar{\boldsymbol{\alpha}} = 0.8$.

avoids the announcement effect ($Q_1(\bar{\boldsymbol{\alpha}}) = Q^*$) and subsequently leans (with $Q_1(\alpha) < Q^*$) is assumed to lower the bust arrival rate by a factor $\gamma^i < 1$. Thus, by construction, front-loaded leaning raises bust risk, whereas phased-in leaning reduces it. We characterize optimal policy under this assumption in Supplemental Appendix E.1.

Under this assumption, optimal policy still leans, despite the additional cost (present when leaning lowers the bust rate perceived by pessimists) of slower growth in optimists' wealth share during booms, as illustrated in Figure 6. By phasing in tightening, the policy mitigates the announcement effect and reduces bust risk. With endogenous bust risk, optimal policy leans less aggressively than in the benchmark model (that is, it delivers a smaller reduction in the asset price) because the resulting longer expected boom raises the cumulative welfare cost of keeping boom-time output below potential. Figure 6 shows that this moderation is more pronounced in the heterogeneous-multiplier case, in which policy reduces the perceived bust rate more for optimists than for pessimists ($\gamma^o < \gamma^p$). Intuitively, leaning's macroprudential benefit—a higher $\alpha_{1\to 2}(\alpha)$ mapping—slows the growth of optimists' wealth share during the boom. Equation (15) implies that, for a given policy-induced increase in this mapping, the resulting slowdown is larger when pessimists perceive a higher bust arrival rate, raising the marginal cost of leaning.

We explore quantitatively the performance of different leaning rules with endogenous bust risk. We study a simple leaning rule and the optimal one. For the simple rule, we

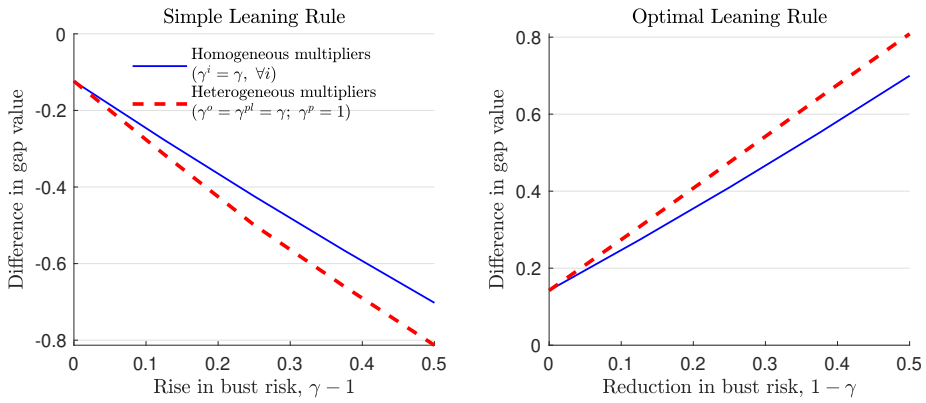


Figure 7: **Endogenous bust probability and welfare**. Each panel shows the gap value for leaning, less the gap value under Wicksellian policy.

use the class studied in Section 2 with $Q_1(\alpha) = \psi Q_2(\alpha) + (1-\psi)Q^*$ and we set $\psi = 0.5$. The left panel of Figure 7 shows that unexpectedly adopting the simple leaning rule generates larger welfare losses when the announcement effect increases bust risk ($\gamma > 1$).[44] The right panel shows the welfare implications of optimal leaning as a function of the reduction in bust risk, $1-\gamma$. Unexpectedly adopting the smoothed optimal policy raises welfare—and to an even greater extent if the bust risk endogenously declines. These results reflect the fact that an endogenous decline in bust risk directly increases welfare (by increasing the expected length of the boom) while leaving the recession-dampening benefit unchanged, consistent with our qualitative results for the case of binding leverage limits. The welfare gains from optimal policy are similar with homogeneous and heterogeneous beliefs.

5.1.1 Interest rate smoothing

An endogenous decline in bust risk from optimal leaning has implications for the implementation of leaning. Figure 8, left panel, shows the expected policy rate curve implementing the optimal policy, under different assumptions about a reduction in bust risk (with common beliefs about policy's effect on bust risk, $\gamma^o = \gamma^p = \gamma^{pl} = \gamma$). With a decline in bust risk, implementing optimal policy calls for a rise in the expected policy

[44] Estimates in Schularick et al. (2021) point to as much as a 5 percentage point increase in the risk of a bust, from an unexpected policy rate hike of 1 percentage point during a credit boom. For the simple leaning policy we study in Figure 7, left panel, this magnitude implies that γ is approximately equal to 1.25.

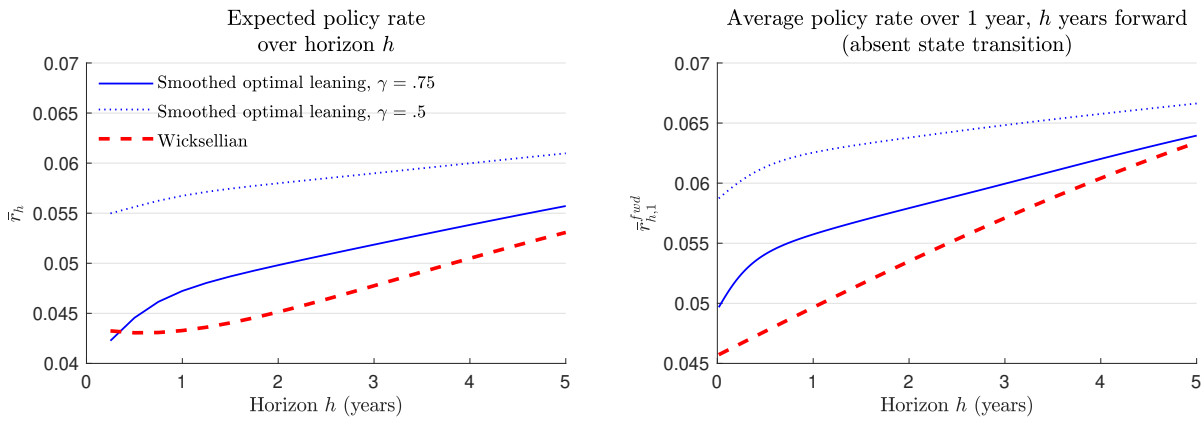


Figure 8: **Expected policy rate and leaning, with an endogenous bust arrival rate**. The dashed red lines correspond to Wicksellian policy. The blue lines correspond to leaning, with different degrees of reduction in the bust arrival rate. $\gamma = 0.75$ corresponds to a 25% reduction in bust risk. Optimists' wealth share prior to announcement is $\bar{\alpha} = 0.5$.

rate curve. Similarly, the forward rate curve rises, as shown in the right panel.[45] Thus, incorporating an endogenous decline in the bust arrival rate implies that the central bank, when leaning, may be shifting the expected policy rate curve upward.

5.2 Good booms, bad booms

Many speculative booms end in a bust ("bad booms"), but other speculative booms ("good booms") do not (Gorton and Ordoñez 2019). We therefore extend the model so that, from a speculative boom, the economy can transition into a bust (as in the benchmark model) or into a non-speculative boom. Non-speculative booms eventually turn into a bust, but without the endogenous amplification from the fall in optimists' wealth share when the bust arrives.[46] We assume that the central bank cannot distinguish whether a boom is good or bad, and hence must use the same Q-targeting rule across booms. The presence of good booms dilutes the gains from leaning, because leaning's costs (below-potential output during booms and slower growth of optimists' wealth share) are sometimes paid without the offsetting benefit of softening the recession.

Formally, we begin with Section 1's benchmark model, in which leaning is adopted unexpectedly in $s = 1$, with a bust in $s = 2$. We add a new state $1'$ (the non-speculative boom), which arrives at rate $\lambda^i_{1\to 1'}$ under belief type i. We assume that investors agree

[45] The expected policy-rate and forward-rate curves in Figure 8 are calculated, for each γ value, to implement an approximation to the optimal policy conditional on γ.

[46] When a non-speculative boom ends, optimists' and pessimists' wealth falls by the same factor, implying optimists' wealth share is unchanged.

about this arrival rate: $\lambda^o_{1\to 1'} = \lambda^p_{1\to 1'}$. Our results are contingent upon this strong assumption, which preserves the model's tractability.[47] The new state has a high growth rate of capital (as in the speculative boom) but no speculation among optimists and pessimists. Supplemental Appendix E.2 presents the model extension in detail and derives several results. The two principal implications are as follows.

The first implication is that, in the bad boom $s = 1$, optimists' wealth share upon recession falls by the same magnitude as in the benchmark model, which has no good boom. That is, leaning's recession-dampening benefit is unchanged. This result reflects the assumption that optimists and pessimists disagree about the recession arrival rate, but not about the rate at which speculation dissipates and the bad boom turns into a good boom.

We also study a particular phased-in leaning rule; we do not solve the full optimal-policy problem in this environment. The specific rule mimics the recession-dampening benefit of tighter regulation (Caballero and Simsek 2020a).[48] With unexpected leaning and uncertainty about boom type, small, phased-in doses of this leaning rule imply first-order welfare gains from mitigating recessions, while imposing only second-order costs from below-potential output during both good and bad booms. This is a local result, characterizing welfare effects of a small deviation from Wicksellian policy. The result underscores that non-optimal leaning rules can improve welfare, even with a mix of boom types, if leaning is applied in small doses with the announcement effect addressed by a phased-in design.

5.3 Anticipation effect

We now study systematic leaning across business cycles. Non-optimal leaning policies that depress asset prices throughout booms generate an anticipation effect: In recessions, investors reduce demand for risky assets because they anticipate that leaning will cap asset prices in subsequent booms. This channel can depress recessionary asset prices and utilization by lowering expected recovery-state valuations. However, optimal systematic

[47] If investors also disagreed about the rate at which speculation dissipates, their equilibrium portfolio positions would generally change. The fall in optimists' wealth share at a bust therefore need not coincide with its benchmark counterpart, and the welfare effects of the regulation-mimicking leaning rule may differ. We do not characterize that case.

[48] That is, under "prudential monetary policy," the fall in optimists' wealth share upon recession is ameliorated, in a way that is identical to what can be achieved by tightening the leverage limit.

policy leans and alleviates the anticipation effect, with a design that mirrors optimal unexpected leaning.

A two-cycle model—boom-bust, boom-bust, followed by a recovery—is sufficient to understand the anticipation effect. We modify the benchmark model by assuming that, from the $s = 2$ bust, the economy enters a boom in $s = 3$, followed by a bust in $s = 4$, with a recovery in $s = 5$. Because we are interested in a systematic policy applied across business cycles, rather than a policy adopted unexpectedly during a boom, the previous $s = 0$ state becomes unnecessary. Instead, the monetary policy that will be in place during each boom is preannounced prior to $t = 0$, with full commitment and no opportunity for the central bank to change monetary policy. We assume monetary policy is Wicksellian (and constrained) during the busts $s \in \{2, 4\}$.[49] The Q-targeting rules during the boom states can differ from Wicksellian policy.

Let $\underline{\boldsymbol{\alpha}}$ denote optimists' wealth share in the bust state $s = 2$ immediately before the transition into the $s = 3$ boom. Prior to $t = 0$, the central bank chooses a state-contingent Q-targeting rule for the $s = 3$ boom, denoted $Q_3(\alpha; \underline{\boldsymbol{\alpha}})$. When choosing this rule, the central bank does not know what optimists' wealth share will be just prior to the boom's arrival ($\underline{\boldsymbol{\alpha}}$), but the rule can depend on this value, which is realized at the transition to $s = 3$. Once the $s = 3$ boom arrives, the initial optimists' wealth share is $\alpha_{2\to3}(\underline{\boldsymbol{\alpha}}) = \frac{\lambda^o_{2\to3}}{\bar{\lambda}_{2\to3}(\underline{\boldsymbol{\alpha}})}\underline{\boldsymbol{\alpha}}$ as implied by Eq. (16).

The asset price in the recession, $Q_2(\alpha)$, satisfies the risk-balance condition, Eq. (17). Therefore, $Q_2(\alpha)$ is the solution to the differential equation:

$$\rho + g_2 - \delta\left(\frac{Q_2(\alpha)}{Q^*}\eta^*\right) - \frac{Q_2'(\alpha)}{Q_2(\alpha)}\alpha(1-\alpha)(\lambda^o_{2\to3} - \lambda^p_{2\to3}) + \bar{\lambda}_{2\to3}(\alpha)\left(1 - \frac{Q_2(\alpha)}{Q_3(\alpha_{2\to3}(\alpha); \alpha)}\right) = 0, \quad (40)$$

and the boundary condition for $Q_2(0)$, the asset price in the all-pessimist economy.[50] The risk-balance condition with two cycles, Eq. (40), differs from the risk-balance condition for the one-cycle model, Eq. (19), only because of the term in red. In the two-cycle model, when the $s = 2$ recession ends, the economy arrives at a boom with Q-targeting rule $Q_3(\cdot)$ rather than a recovery with $Q_3 = Q^*$. Correspondingly, the asset price $Q_2(\cdot)$ is the same in the one-cycle and two-cycle models if the two-cycle planner follows Wicksellian policy

[49] Parametric assumptions described in the Supplemental Appendix imply that the capital growth rate g_s for these bust states is sufficiently low that the ZLB binds. Also, Supplemental Appendix E.3 studies the anticipation effect in a recurrent-cycle version of the model.

[50] This boundary condition is given by Eq. (40) for $\alpha = 0$.

in the second boom (i.e., $Q_3(\alpha;\underline{\boldsymbol{\alpha}}) = Q^*$). If instead the two-cycle planner leans (with $Q_3(\alpha;\underline{\boldsymbol{\alpha}}) < Q^*$), this leaning affects the $s = 2$ asset price, as shown by Eq. (40).

The anticipation effect can be seen very clearly when the depreciation rate satisfies $\delta(\eta) = \bar{\delta}$ and the Q-targeting rule is $Q_3(\alpha) = (1-\chi)Q^*$. Higher χ implies more aggressive leaning, with $\chi = 0$ corresponding to Wicksellian policy. Denote by $Q_2^{Wick}(\alpha)$ the equilibrium asset price in the $s = 2$ bust when investors anticipate Wicksellian policy in the $s = 3$ boom.[51] The ratio $Q_2(\alpha)/Q_2^{Wick}(\alpha)$ captures the anticipation effect: How much lower is the asset price $Q_2(\alpha)$ when investors anticipate leaning (with strength χ), relative to the asset price when investors anticipate Wicksellian policy.

Proposition 4 (Anticipation effects). *Suppose that $\delta(\eta) = \bar{\delta}$ and $Q_3(\alpha) = (1-\chi)Q^*$. More aggressive leaning in the $s = 3$ boom (equivalently, higher χ) depresses the asset price in $s = 2$, with*

$$\frac{Q_2(\alpha)}{Q_2^{Wick}(\alpha)} = 1 - \chi \quad \text{for any } \alpha \in [0,1]. \tag{41}$$

Hence, more aggressive leaning in $s = 3$ reduces utilization in $s = 2$. Conditional on optimists' wealth share $\alpha_{\tau_2,2}$ at the start of the first bust, the time-paths for the asset price and utilization, $\{Q_{\tau,2}, \eta_{\tau,2}\}_{\tau>\tau_2}$, are strictly lower.

The anticipation effect is a cost of (non-optimal) leaning policies that lean throughout the boom; and the anticipation effect is stronger when leaning is more aggressive. However, even non-optimal systematic leaning policies might still improve welfare by softening the fall in optimists' wealth share upon recession and (in the extension where leaning affects bust risk) through an endogenous reduction in the probability of a bust.[52]

Optimal systematic leaning. Optimal systematic leaning, which we study next, avoids the anticipation effect. To preview the mechanism: In Eq. (40), the anticipation channel operates through the expected recovery-state price at the transition, $Q_3(\alpha_{2\to3}(\underline{\boldsymbol{\alpha}});\underline{\boldsymbol{\alpha}})$; setting this equal to Q^* (for all $\underline{\boldsymbol{\alpha}}$) eliminates that channel.

The planner chooses Q-targeting rules for the boom states $s \in \{1,3\}$ to maximize the $s = 1$ gap value, subject to the equilibrium conditions, including the risk-balance

[51] The asset price $Q_2^{Wick}(\alpha)$ corresponds exactly to the expression in Eq. (18) in Lemma 1.

[52] In Supplemental Appendix E.3, we provide a more general form of this result: For any continuous, right-differentiable Q-targeting rules that can be ranked according to a definition of aggressiveness, more aggressive leaning in $s = 3$ reduces the asset price and utilization in $s = 2$.

condition (40) that generates the anticipation effect. The optimal policy is defined as the supremum of the $s = 1$ gap value over the set of admissible policies.[53] Our characterization of optimal policy utilizes $s = 3$ rules that exert no downward pressure on the asset price at boom arrival:

$$Q_3(\alpha_{2\to3}(\underline{\boldsymbol{\alpha}});\, \underline{\boldsymbol{\alpha}}) = Q^*. \tag{42}$$

For $\alpha > \alpha_{2\to3}(\underline{\boldsymbol{\alpha}})$, the rule transitions (linearly, with adjustment length $\hat{\alpha} > 0$) to the single-cycle optimum without announcement or anticipation effects, becoming

$$Q_3(\alpha; \underline{\boldsymbol{\alpha}}) = Q^{\text{lull}}(\alpha) \quad \text{for } \alpha \geq \alpha_{2\to3}(\underline{\boldsymbol{\alpha}}) + \hat{\alpha}. \tag{43}$$

Proposition 5 (Optimal policy with anticipation effects). *Let $Q^{\text{lull}}(\cdot)$ denote the optimal boom rule in the single-cycle economy (no announcement or anticipation effects). Fix $\underline{\boldsymbol{\alpha}} \in [0,1]$ and write $\alpha' \equiv \alpha_{2\to3}(\underline{\boldsymbol{\alpha}})$ (Eq. (16)).*

(i) If $Q^{\text{lull}}(\alpha') = Q^*$, then the optimal $s = 3$ rule equals the single-cycle rule: $Q_3^{\text{opt}}(\alpha; \underline{\boldsymbol{\alpha}}) \equiv Q^{\text{lull}}(\alpha)$ for all $\alpha \in [0,1]$.

(ii) If $Q^{\text{lull}}(\alpha') < Q^*$, then the optimal $s = 3$ rule exerts no downward pressure at boom arrival, $Q_3(\alpha'; \underline{\boldsymbol{\alpha}}) = Q^*$, and subsequently transitions to leaning as in the single-cycle optimum. For phased-in rules satisfying (42)–(43) with adjustment length $\hat{\alpha} > 0$,

$$\lim_{\hat{\alpha}\to 0^+} \; w_1^{pl}(\alpha_{t=0};\, Q_3(\cdot; \underline{\boldsymbol{\alpha}}, \hat{\alpha})) = \sup_{Q_3 \in \mathcal{C}_r} \; w_1^{pl}(\alpha_{t=0};\, Q_3)\,,$$

where $\mathcal{C}_r$ is the set of admissible (jointly continuous, right-differentiable) rules.

While the planner's problem in the two-cycle model (with the anticipation effect) is different from the problem in the unexpected-policy one-cycle model (with the announcement effect), the solutions, perhaps surprisingly, have important commonalities. Optimal policy sets the asset price equal to Q^* initially (at the start of the boom, for systematic policy, or at the time of announcement, for unexpected leaning during the boom). After leaning is phased in, optimal policy leans in a way that reflects (only) the balancing of the macroprudential benefits and costs in a one-cycle model with a speculative lull. The implications for the expected path of the policy rate are also similar: As shown in Supplemental Appendix E.3, the expected policy rate curve is lower and steeper than under the single-cycle optimal rule that ignores the anticipation channel.

[53] The characterization uses the condition that relaxing the bound $Q_1 \leq Q^*$ would not change the optimum in the relevant conditional boom problems; see Supplemental Appendix E.3.

Supplemental Appendix E.3 studies optimal policy quantitatively. Under the optimal systematic rule, the central bank leans in both booms ($s \in \{1,3\}$) and mitigates the anticipation channel via a phased-in design. In an extension where leaning endogenously lowers bust risk, the optimal intensity of leaning is slightly reduced while welfare gains are larger. A limitation of our optimal-policy analyses of systematic leaning is that they are conducted in two-cycle economies rather than recurrent-cycle economies.

5.4 Robustness

Supplemental Appendix E.4 analyzes the sensitivity of selected results to parameter values. We vary the bust arrival rate $\lambda^{pl}_{1\to 2}$, the belief difference $\xi_{1\to 2}$, the leverage limit $\bar{\omega}$, and other parameters. Across a range of parameter values: (i) the unexpected simple leaning policy studied in Figures 1–4—which depresses the asset price throughout the boom—is detrimental to welfare; and (ii) optimal policy leans, has welfare benefits relative to Wicksellian policy, and mitigates the announcement effect at low welfare cost by temporarily postponing macroprudential benefits. Welfare gains from optimal policy are larger when a boom's expected length is shorter or when belief differences are greater.

6. Conclusion

In a model of speculative booms and demand recessions, optimal monetary policy leans against booms and thereby mitigates recessions, even when leaning begins unexpectedly and surprises investors. This policy phases in tightening during booms, with the policy rate rising if speculation continues to build. By limiting asset price declines when leaning is announced, optimal policy ameliorates losses for leveraged investors. This approach is implemented by steepening the expected path of the policy rate—a "bear steepening." Such a phased-in design is optimal both when leaning is unexpectedly adopted during a boom and when, under systematic policy, a speculative boom is incipient. With a mix of good and bad booms, our result is narrower: a particular phased-in rule delivers the welfare benefits of a local tightening of the leverage limit (macroprudential regulation), and we leave the full optimal-policy problem for future work. A direction for further research is optimal leaning in settings that combine risk-centric features (aggregate demand externalities, speculation among heterogeneous investors, and a focus on how monetary policy affects the risk-absorption problem) with endogenous crises that could arise, for

example, from the interaction of non-financial shocks and informational frictions in credit markets.

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