Monetary Policy and Asset Price Volatility:

Should We Refill the Bernanke-Gertler Prescription?

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June 3, 2011

Abstract

Bernanke and Gertler's influential 1999 article "Asset Price Bubbles and Monetary Policy" made the case that monetary policy should respond to asset prices only to the extent that they have implications for future inflation. This paper revisits that prescription in light of the 2007–09 financial crisis. After reviewing the Bernanke-Gertler logic, the paper surveys the recent evolution of views on the appropriate policy response to asset price fluctuations, and discusses the conditions under which a proactive policy would be justified. There is almost no discernible relationship between interest rates and stock and property prices across countries during the years leading up to the crisis, however. While a theoretical case could be made to give some weight to financial stability in setting monetary policy, the evidence presented in the paper suggests that incremental interest rate adjustments are unlikely to be effective in restraining excessive asset price appreciation.

JEL codes: E52, E58, E44, G12

1 Introduction

Central banks have long struggled with the question of whether monetary policy should be used to dampen asset price booms. On June 29, 2005, for example, two years before the mid-2007 house price peak, members of the Federal Reserve's Federal Open Market Committee (FOMC) spent the afternoon debating the merits of a monetary policy response to the ongoing housing boom. Similar discussions took place during the great bull market of the mid-1990s amidst growing concerns

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Prepared for the conference, "New Perspectives on Asset Price Bubbles: Theory, Evidence and Policy," Loyola University Chicago, April 8 2011. Jalal Baghishov provided excellent research assistance.

about unsustainably high stock prices. During the FOMC meeting of February 5, 1997, Alan Greenspan articulated the Fed's quandary of balancing financial and macroeconomic objectives when he remarked that "product prices alone should not be the sole criterion if we are going to maintain a stable, viable financial system…" while adding:

> It is the real economy that matters. Finance is all very interesting and financial prices are quite important but only because they affect the real economy. Ultimately, that is what our charter is all about.[1]

New York Fed president Benjamin Strong grappled with exactly the same set of issues seventy years earlier during the stock market boom of the 1920s. Like Greenspan, Strong expressed misgivings about the stock market's lofty valuation, but lacking any tangible signs of product price inflation, resisted calls to tighten credit.[2]

Bernanke and Gertler's (1999) seminal article "Asset Price Bubbles and Monetary Policy," has framed much of the recent debate on the appropriate monetary policy response to asset price fluctuations. Its influence stems from its precise definition of the problem, and from the clarity of its prescription: monetary policy should respond to the macroeconomic effects of asset price fluctuations, but not to the fluctuations themselves:

> The inflation-targeting approach dictates that central banks should adjust monetary policy actively and pre-emptively to offset incipient inflationary or deflationary pressures. Importantly, for present purposes, it also implies that policy should not respond to changes in asset prices, except insofar as they signal changes in expected inflation.[3]

While couched in terms of inflation targeting, which Bernanke and Gertler viewed as a reasonable description of the Fed's policy framework, the conclusions apply broadly to any central bank seeking to minimize output and inflation volatility.

The 2007–09 financial crisis has understandably led to a reconsideration of the Bernanke-Gertler (henceforth BG) conclusion. In hindsight, one cannot help but wonder whether a pre-emptive policy of rate hikes might not have attenuated the housing bubble. This paper's goal is to summarize and critically re-examine the BG policy prescription in light of recent events. It begins

[1] From the transcript of the FOMC meeting of February 4-5 1997, p. 103.

[2] See Ahamed (2009), pp. 276–277.

[3] Bernanke & Gertler (1999, p. 18).

in section 2 with a recapitulation of the main elements of the BG argument. Section 3 discusses some of the ways in which views on the BG recommendation have evolved in light of the financial crisis. Section 4 presents some new evidence on the relationship between interest rates and the behavior of stock and real estate prices in the years preceding the financial crisis. Section 5 concludes with an assessment of the BG recommendations, and the viability of alternative policy options.

2 A review of the Bernanke-Gertler analysis

The core of the BG argument is the idea that "central banks should view price stability and financial stability as highly complementary and mutually consistent objectives."[4] This basic idea is neither new nor farfetched. Indeed, it would be hard to argue that macroeconomic *in*stability is good for the financial system.

The deleterious effects of inflation volatility are well understood. Unanticipated inflation reduces the value of long-dated assets, diminishing the net worth of those assets' owners. As noted by Brumbaugh *et al.* (1987), among others, this phenomenon was a major contributor to the U.S. thrift crisis of the 1980s, in which high inflation and the accompanying high interest rates eroded mortgage lenders' capital base. Similarly, according to Fisher's (1933) debt-deflation theory, unanticipated deflation increases the real debt burden of debtors, creates financial distress, and amplifies economic downturns.[5]

These views have been echoed by Schwartz (1995), who observed that price instability, and the attendant variability in monetary policy, would lead to defaults:

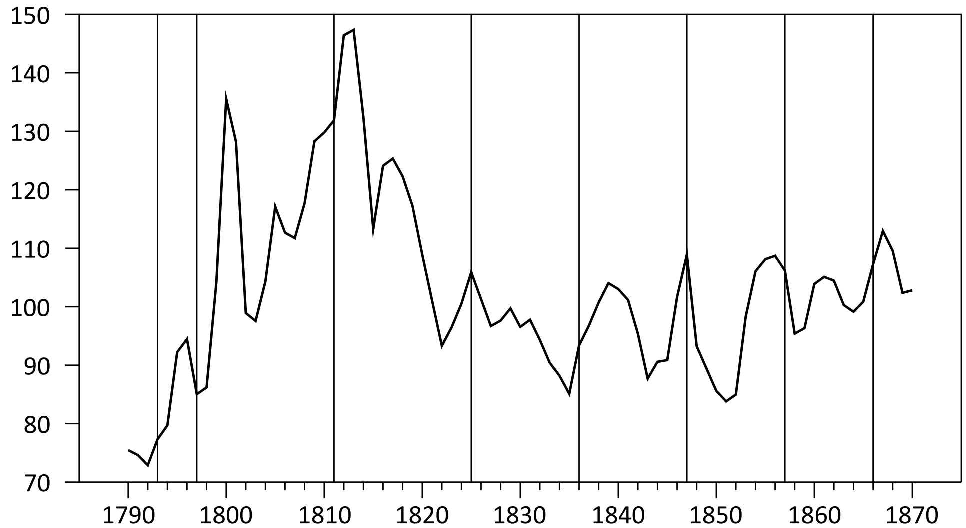
> [Borrowers and lenders] evaluate the prospects of projects by extrapolating the prevailing price level or inflation rate. Borrowers default on loans not because they have misled uninformed lenders but because, subsequent to the initiation of the project, authorities have altered monetary policy in a contractionary direction. The original price level and inflation rates are no longer valid. The change in monetary policy makes rate-of-return calculations based on the yield of projects, based on the initial price assumptions of both lenders and borrowers, unrealizable.[6]

[4] Bernanke & Gertler (1999, p. 18).

[5] Cargill *et al.* (1997), among others, argued that the decline in prices prolonged Japan's banking crisis in the mid-2000s, and this is one reason why some economists, including Bernanke (2000), called on the Bank of Japan to adopt an inflation target.

[6] Schwartz (1995, p. 24).

Figure 1: Retail prices and financial crises in the UK, 1790–1870



Notes: Data are from Officer (2010). Vertical lines mark the financial panics of 1793, 1797, 1811, 1825, 1836, 1847, 1857 and 1866.

The historical record generally supports the contention that price volatility breeds financial crises. Bordo & Wheelock (1998), for example, examined historical data from the U.S., the U.K. and Canada, in an investigation of what they termed the "Schwartz Hypothesis," after Schwartz (1995). Their main finding was that financial panics did tend to be associated with periods of high price volatility. This pattern is evident in figure 1, which plots the level consumer prices in Great Britain from the late 18th to the late 19th centuries. The major financial panics, marked by the vertical lines in the figure, often (but not always) follow periods of inflation, and precede episodes of deflation.

It is important to emphasize that factors other than price volatility are often responsible for financial crises. Bordo and Wheelock observed that a number 19th and early 20th century U.S. banking panics occurred during periods of price stability. The same can be said of the British panics of 1793, 1836, and 1890. And indeed, the 2007–09 financial crisis occurred in a global environment of low and stable inflation. The inescapable conclusion is that while macroeconomic and financial stability may be complementary, macroeconomic stability does not *gurantee* financial stability.[7]

[7] Issing (2003) made a similar point. Conversely, examining the experience of a number of countries, Posen (2003)

2.1 A review of the Bernanke-Gertler model

The core of the BG analysis is based on what has become the canonical New Keynesian (NK) macro model with the usual spending ("IS") equation, a dynamic aggregate supply relationship, and a policy rule specifying the central bank's reaction to expected inflation and output. Because asset prices do not appear explicitly in the standard NK model, Bernanke and Gertler augment the model with wealth and "financial accelerator" effects. These provide channels through which asset market booms and busts could affect aggregate spending: the former by affecting consumption spending, the latter by influencing the cost of external funds through collateral values.

Bubbles are modeled as realizations of an exogenous stochastic process. Each period, the bubble continues to grow with probability p, and bursts with probability $1-p$. The stock price is the sum of the fundamental value, determined by the marginal product of capital, and the bubble term. Asset prices affect aggregate consumption through households' consumption spending, and firms' investment expenditures. Bubbles are therefore essentially another source of aggregate demand shocks, albeit one that follows a nonstandard statistical distribution.

It is also worth noting that in the BG framework, promoting financial stability has nothing to do with the prevention or attenuation of asset price bubbles, which are exogenous and unaffected by interest rates. Instead, the role of monetary policy is to mitigate bubbles' impact on aggregate demand: appropriately calibrated rate hikes will limit the expansionary effects of asset price rises, while rate cuts will cushion the blow when prices fall. This would be the appropriate policy response to any demand shock, of course. What turns this into a model of financial stability is the inclusion of the financial accelerator, which provides the primary mechanism through which asset prices affect aggregate demand.

Monetary policy is modeled as a policy rule of the form

$$r_t^n = \bar{r}^n + \beta E_t \pi_{t+1} + \xi S_{t-1}/S \ ,$$

where S_{t-1}/S is the deviation of the stock price from its steady state value, and r^n is the nominal interest rate. The paper considers only a limited range of values for the two reaction function

concluded that a financial crisis is neither a necessary nor sufficient condition for the occurrence of deflation.

parameters: β values of 1.01 and 2.0 are used to represent accommodative and aggressive reactions to inflation. The ξ stock price response is either zero or 0.1. The question of whether the central bank should respond to asset prices boils down to whether the policy rule with $\xi = 0.1$ performs better than the rule in which $\xi = 0$.

The quantitative criteria used to assess the policy rules' performance are the unconditional variances of output and inflation, which are obtained by simulating the model for alternative values of ξ and β. These criteria are consistent with the conventional quadratic loss function,

$$L = E_t \sum_{i=1}^{\infty} \delta^i [(\pi_{t+i} - \bar{\pi})^2 + \lambda (y_{t+i} - y^*)^2] \tag{1}$$

where y is the log of real GDP, y^* is potential output, π is the inflation rate, $\bar{\pi}$ is the inflation target, δ is a discount factor, and λ is the weight attached to output fluctuations relative to deviations of the inflation rate from its target. This objective function, and particular the λ parameter, is a useful way to evaluate the tradeoffs between the (potentially conflicting) goals of output and inflation stability. BG's analysis of the alternative rules does not require using such an objective function, however. The reason is that, in their model, asset price bubbles create no tradeoff between output and inflation volatility: stabilizing inflation also stabilizes output, and vice versa.[8]

A critical assumption underlying the use of an objective function like 1, or BG's simpler variance criterion, is that financial instability has no economic costs in and of itself. Or to put it another way, financial crises affect economic well-being only to the extent that they create output or inflation volatility. The BG prescription of responding only to bubbles' impact on expected future inflation therefore follows naturally from the model structure, and the criterion used to evaluate alternative policy rules.

2.2 The key BG results

The baseline BG results appear in figure 2. Even without the inclusion of the stock price, the results are striking: by responding exclusively to expected inflation, monetary policy is able to stabilize inflation *and* output quite effectively. With an aggressive response to inflation, the bubble causes only a mild increase in output. The inflation rate is virtually unchanged. It is important to

[8] Blanchard (2004) referred to this property as a "divine coincidence."

Figure 2: The BG response of output and inflation to a bubble shock, baseline case

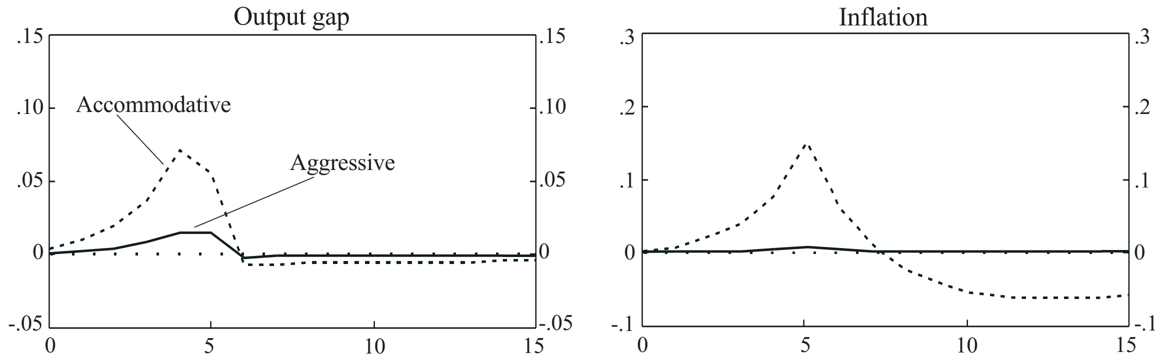
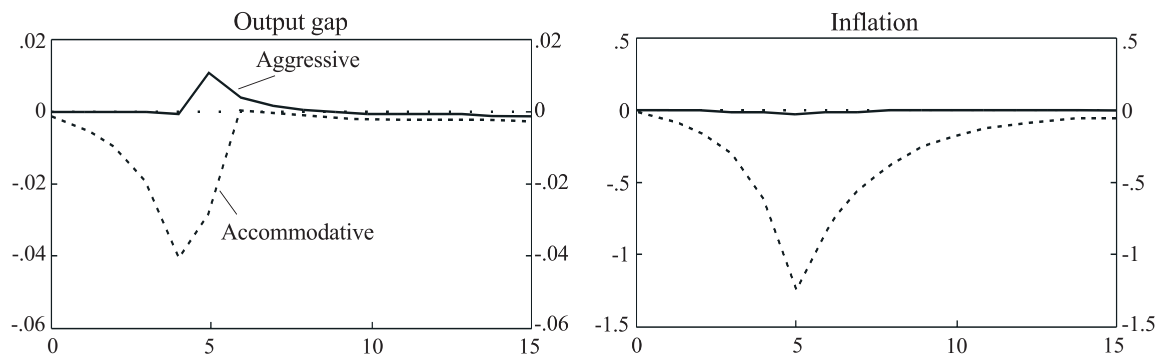


Figure 3: The BG response of output and inflation to a bubble shock, with stock price response



emphasize that these results are obtained despite the fact that monetary policy is having no effect on the bubble itself, which is exogenous: stock prices continue to rise, stimulating spending through wealth and financial accelerator effects. The central bank is able to largely neutralize these effects with higher interest rates.

Equally striking is the absence of any discernible post-crash fallout. The bursting of the bubble removes the stimulus, but inflicts no collateral damage. Monetary policy then returns to a neutral policy stance, and the economy goes on as before. The only way to obtain a post-bubble recession is to assume that positive bubbles are followed by *negative* bubbles, in which the asset price falls *below* the fundamental — but again, these aftereffects are easily combatted by responding aggressively to expected inflation.[9]

[9]Theoretical bubble models, like that of Allen & Gorton (1993), often appeal to short-selling constraints to limit investors' ability to bet against asset price declines. Since no such constraints exist for stock purchases, the theoretical basis for negative bubbles is less clear.

Figure 3 shows what happens when the policy rule includes a response to the stock price. The performance is demonstrably worse than in the case of no stock price response, especially when monetary policy is accommodative with respect to inflation. Puzzlingly, output *falls* in the accommodative case, presumably because policy is overreacting to the bubble and sending the economy into a recession. Consequently, inflation declines sharply in this model simulation.

The logical conclusion is that a direct policy response to asset prices can actually increase output and inflation volatility. This holds even when the bubbles are the only source of asset price fluctuations. The performance of the policy rule with $\xi > 0$ is even worse when asset price fluctuations are driven by fundamentals rather than bubble shocks. A policy response to asset prices is wholly counterproductive in this case, with the central bank tightening policy in a misguided effort to offset favorable technology shocks. The BG quantitative analysis therefore supports the "benign neglect" prescription: the monetary authority should ignore asset prices, except to the extent that they affect future inflation. Bursting bubbles may be bad for the economy, but they create no problems that cannot be solved with a few well-timed interest rate cuts.

This rationale for a benign neglect policy is further buttressed by a number of practical concerns. One is the difficulty inherent in distinguishing bubbles from fundamentals-driven asset price fluctuations. Assets' prices are readily observable, but the fundamentals are not, at least not in real time. Bernanke (2002) cited Campbell and Shiller's (1998) bubble warning as an example of how even the best minds in finance can get it wrong — or at least sound the alarm prematurely. And Irving Fisher's ill-timed 1929 pronouncement that "stock prices are low" is surely the best-known example of the opposite error.[10] Consequently, there will inevitably be mistakes in both directions, with the central bank sometimes attempting to offset asset price appreciations that are based on fundamentals, and at other times failing to react to irrational exuberance.

A second problem pointed out by Bernanke (2002), and others, is that it is hard to burst bubbles safely. Empirical estimates of interest rates' influence on asset prices suggest that small interest rate hikes are unlikely to be effective. Sharp interest rate hikes, on the other hand, run the risk of causing macroeconomic collateral damage. Indeed, the prevailing view, as articulated in Friedman

[10] Or *was* it an error? McGrattan & Prescott (2004) argued that the stock market boom of the late 1920s was in fact justified by economic fundamentals. This illustrates the difficulty of identifying asset price bubbles, even with 70 years' worth of hindsight.

& Schwartz (1963), and others, blames the onset of the Great Depression on the Federal Reserve's misguided attempt to pop what it perceived to be a stock price bubble in 1928–29.[11] Forty years earlier, the Bank of England's attempt pop a speculative bubble at the end of 1889 itself precipitated a panic, and in the end it did not prevent the Barings crisis a few months later.[12] A third issue is that central bankers are justifiably loath to be seen to be (or even *perceived* to be) passing judgment on the appropriate level of asset prices.

3 Evolving views of the Bernanke-Gertler prescription

Before the crisis, the question of whether monetary policy should to asset price fluctuations seemed to have been settled. The BG prescription of focusing exclusively on output and inflation forecasts had become the consensus view, and the policy worked well during the tech boom and bust earlier in the decade. And *ex post*, the Fed's response to the 1987 stock market crash, which focused on macro and financial damage control, has been interpreted as a successful application of the same policy.

Not surprisingly, the 2007–09 financial crisis fractured that consensus, reigniting the long-standing debate on the appropriate response to asset prices and financial conditions more broadly. Leijonhufvud (2007) argued that central banks' neglect of asset price inflation is dangerous, on the grounds that expansionary monetary policy can create asset price inflation even as prices of goods and services remain stable. DeGrauwe (2007) concluded that "the subprime crisis shows that central banks cannot avoid taking responsibilities that include the prevention of bubbles and the supervision of all institutions that are in the business of creating credit and liquidity." Giavazzi & Giovannini (2010) went further, and suggested that IT actually undermined financial stability by creating a "low-interest-rate trap" that encouraged excessive risk taking and increased the likelihood of crises.

At the risk of creating a set of Procrustean rubrics, it is useful to distinguish three ways in which economists' views have evolved in response to the crisis. Some maintain is that in spite of the financial crisis, the BG prescription remains fundamentally sound. Others take issue with the BG findings narrowly, arguing that a more proactive, "leaning against the wind" policy response to

[11] Bernanke (2002) includes a compact summary of these views.
[12] See Kuttner (2010).

asset prices (and financial conditions more broadly) can in fact contribute to macro stability. And some argue that financial stability should be a distinct policy objective, independent of output and inflation.

3.1 The BG prescription is fine as is

One view, articulated by Ito (2010) and Svensson (2010), and others, argues for the retention of the BG prescription, and the IT framework associated with it. Adherents to this view accept the key premise that output and inflation volatility are the correct objectives, and share BG's interpretation of bubbles as exogenous demand shocks. They also emphasize the practical objections, summarized above, concerning the difficulty of discerning bubbles and safely deflating them.

This is not to say that financial stability should *not* be a policy objective. Instead, those who argue for retaining the BG prescription argue that monetary policy is the wrong tool for the job, and that the central bank (or whatever the relevant authority happens to be) should adopt more robust macroprudential regulatory policies. The availability of a second policy tool solves the Tinbergen (1952) problem of having more targets than instruments, and allows the monetary authority to focus exclusively on macroeconomic objectives. The question, as discussed below, is whether an effective financial stability tool is available.

3.2 The BG prescription needs adjustment

A second view is that central banks should adopt a measured "leaning against the wind" strategy with respect to asset prices, or other measures of financial imbalances (e.g., leverage).[13] Prominent examples of papers advocating this approach include Cecchetti *et al.* (2000), Borio & Lowe (2002), Cecchetti *et al.* (2002), and Bordo & Jeanne (2002). While this view seems not (yet) to have been adopted by policymakers at the U.S. Federal Reserve, some within the International Monetary Fund are more open to the idea. In a recent issue of the *World Economic Outlook*, Fatás *et al.* (2009) contended that monetary policy should at times take a more active role in countering financial imbalances: "The evidence ... does not support the idea that central banks should react automatically to changes in asset prices, still less that they should try to determine some appropri-

[13] A vocal minority, including Roubini (2006) dismissed practical concerns about the detectability of bubbles and the dangers of trying to pop them, and argue for a much more aggressive policy response to asset prices. Posen (2006) offered a spirited rejoinder.

ate level for asset prices. But they should examine what is driving asset price movements and be prepared to act in response."

Significantly, proponents of this strategy generally do not question the central bank's objective of minimizing output and inflation volatility, as embodied in equation 1. Instead, their view is that the best way to further macroeconomic stability involves a systematic response to financial imbalances. As noted by Svensson (2010), to the extent that the ultimate objective is output and inflation stabilization, leaning against the wind is perfectly consistent with flexible inflation targeting. In this case, asset prices would merely serve as leading indicators of future output and inflation, just as in the BG framework. Crockett (2003), Issing (2003) and Svensson (2010) acknowledged that the possibility of long-term fallout from a financial crisis may call for lengthening the inflation targeting horizon.

Drawing on the model of Kent & Lowe (1997), Cecchetti *et al.* (2000) and Cecchetti *et al.* (2002) made a case for leaning against the wind that represents more of a departure from the BG framework. Their insight was that if expected future inflation were to remain unaffected by a bubble, which it would if the bubble were not expected to persist very long, then reacting only to expected inflation would fail to prevent bubble-induced macroeconomic volatility.[14] Cecchetti *et al.* (2000) reported numerical simulations demonstrating that including an asset price term in the monetary authority's policy rule can, by offsetting the demand pressures created by unsustainable asset price increases, actually reduce inflation and output volatility.[15] Bernanke & Gertler (2001) took issue with the Cecchetti *et al.* (2000) conclusions, however, arguing that their analysis attributed to the monetary authority an unrealistic amount of information on the existence and duration of the bubble shock.

An important limitation of the BG analysis is that by assuming the asset price bubble to exogenous, it rules out the possibility of monetary policy being able to affect financial stability *directly*. This necessarily limits the scope of monetary policy to responding to the fallout from asset price

[14] The same point may also apply to a situation in which the Phillips curve was very flat, or inflation expectations were firmly anchored by an inflation target.

[15] In a related line of research, Akram *et al.* (2007) and Akram & Eitrheim (2008) simulated an econometric model of the Norwegian economy in an effort to assess the performance of monetary policy rules that included asset prices. They found that responding to debt growth can contribute to financial stability, but this is offset by the destabilizing effects of interest rate volatility. The general conclusion is the advisability of such a policy depends on the source of the shocks.

booms and busts, rather than directly going after the source of instability. Relaxing this assumption could therefore justify a more active response to asset prices, for example by using interest rate hikes to reduce the size of the bubble, and limit the damage caused by its subsequent collapse. The model of Kent & Lowe (1997) has this feature, and they show that such a policy can, at least in principle, produce superior outcomes. This reasoning is consistent with that of with Friedman and Schwartz, who chided the Federal Reserve for following a policy "which was too easy to to break the speculative boom" in the years prior to 1928.[16]

Bean (2004) made a similar theoretical point in the context of a New Keynesian model, extended to include debt-financed capital accumulation and credit crunches. In that model, monetary policy did not affect the probability of a crunch, but it did influence the buildup of debt via its effects on the future output gap. Although Bean did not use the model to rationalize a response to asset prices *per se*, the model does suggest that that optimal monetary policy should respond aggressively to expected future output, instead of focusing narrowly on inflationary pressures.

Another rationale for pre-emptive rate hikes recognizes the complications created by the zero lower bound (ZLB) on the nominal interest rate. Robinson & Stone (2006) made this point using a model in which bubbles stimulated aggregate demand, just as in the BG framework. However they departed from BG in assuming that the central bank can reduce the expected duration of bubbles by raising the interest rate, and they also imposed the ZLB constraint on the policy rule. Their insight was that allowing a bubble to persist and grow increases the likelihood of a bust that would exceed the central bank's ability to offset with a non-negative interest rate. Consequently, if monetary policy can decrease the probability of the bubble's survival, central banks should react to asset price booms by raising interest rates, thus insuring against the undesirable ZLB outcome — even if it means accepting some additional near-term macroeconomic volatility.

3.3 The BG prescription has deeper problems

A third view is that monetary policy should respond to financial conditions *independently* of their impact on the output gap and inflation. Rationalizing such a response requires the plausible as-

[16] Friedman & Schwartz (1963, p. 290). There is some tension between this diagnosis and their contention that excessively contractionary monetary policy caused the depression. Their argument is apparently that monetary policy was too loose before 1928 and too tight thereafter.

sumption that financial instability is costly for reasons other than the volatility it introduces in inflation and the output gap. Several different ways to model these costs have been proposed, all of which involve resource misallocation and the attendant economic inefficiencies.

Bordo & Jeanne (2002) argued that the effects of asset price bubbles, and their collapse, have effects that go beyond their impact on aggregate demand. Their specific focus is on the effects of collateral constraints on the productive sector. In their framework, the reversal of an asset price bubble is the equivalent of adverse aggregate supply shock. Optimal monetary policy is therefore not just a matter of aggregate demand management. Instead, the appropriate policy response is to preempt asset price appreciation up to some point, but to revert to a more accommodative stance if the perceived probability of an improvement in fundamentals is high. Clearly, operationalizing such a nonlinear policy rule would present some serious challenges.

Like Bordo & Jeanne (2002), Dupor's (2002, 2005) model is one in which asset price bubbles create inefficiencies. His framework is one in which firms are not fully rational, and consequently mistake the bubble component of asset price movements for fluctuations in the fundamental value of capital. Bubbles can therefore lead to over-investment, and distort consumption-leisure and consumption-investment decisions. Monetary policy can be used to offset these distortions by raising the interest the interest rate when stock prices exceed their fundamental values. Naturally, this policy prescription requires that the monetary authority can observe stock price fundamentals.

Another approach is to include in the central bank's loss function a term involving financial distress,

$$L = E_t \sum_{i=1}^{\infty} \delta^i [(\pi_{t+i} - \bar{\pi})^2 + \lambda_y (y_{t+i} - y^*)^2 + \lambda_\Omega \Omega_{t+i}^2] \ , \qquad (2)$$

where the Ω term which captures the welfare losses associated with financial crises. Woodford (2010) sketched a model with a welfare criterion of this form. The model's distinguishing feature is that it includes borrowers and savers rather than a single representative agent. Intermediation is required to equate the two agents' marginal utilities of consumption. Crisis-induced disruptions are costly because they create a marginal utility "gap" between the two consumers. The probability of entering a credit-constrained regime depends on the amount of leverage in the economy, which is in turn a function of monetary policy. The model's implication is that optimal policy involves balancing a crisis prevention objective against the conventional goals of output and inflation stabilization. While this can be interpreted as an extension of the flexible IT framework, it runs counter to the BG desideratum of responding to financial conditions only to the extent that they affect future output and inflation.

Expanding the objective function in this way requires that the central bank use interest rate policy to manage not only the tradeoff between output and inflation, but also more subtle tradeoffs between financial and macroeconomic objectives. Although these objectives may sometimes be aligned, inevitably instances will arise in which mitigating financial distortions will require accepting more output or inflation variability. Benjamin Strong recognized this dilemma when in 1925, pressed to quash rampant stock speculation, asked: "Must we accept parenthood for every economic development in the country? That is a hard thing for us to do. We would have a large family of children. Every time one of them misbehaved, we might have to spank them all."[17]

Practical challenges abound, and it may be unrealistic to think that central bankers have enough information to operationalize a policy based in the minimization of equation 2. Unlike inflation and output, there is no clear empirical counterpart to the Ω that appears in equation 2. Moreover, the models used to motivate a financial term in the objective function differ as the relevant variable. In Woodford's framework, leverage is the appropriate variable, but it remains to be seen how a meaningful aggregate gauge of leverage can be constructed, especially in a financial system where so much leverage is disguised as derivatives and concealed in off-balance-sheet transactions. In the Dupor and Bordo-Jeanne models, on the other hand, the central bank should respond the deviations between the market and fundamental stock valuations, raising the perennial question of how such misalignments might be detected.

Another issue is determining the terms of the tradeoff between inflation (or output) and the likelihood of a crisis is one. Implementing a targeting rule requires an estimate of the likely impact on Ω of a one percentage point reduction in the inflation rate — or alternatively, how much of a deviation from the macro objectives would be needed for a given reduction in the probability of a credit crunch. Also unknown is the magnitude of the impact of the policy interest rate on financial fragility. Conventional econometric methods can be used to estimate of the impact of a 25 basis point rate hike on real GDP at a given horizon. Estimating the marginal effects of interest rate

[17] The passage is from a a letter from Strong to New York Fed economist Carl Snyder, May 21, 1925, quoted in Ahamed (2009, p. 277).

changes on the likelihood of entering a credit constrained regime is a much more daunting task.

Communication and accountability are also serious concerns, particularly for inflation targeting central banks. Because inflation and output are readily (if imperfectly) measured, it is straightforward to explain the central bank's monetary policy decisions in terms of the near-term tradeoffs between the two. Moreover, the regular release of inflation and GDP data make it possible to hold policymakers accountable, with a modest time lag, for macroeconomic outcomes. It is not clear how these modes of communication and accountability would apply to a criterion as hard to measure as expected crisis-induced welfare losses, especially when the "data" on crises appear irregularly, and at intervals measured in years.

3.4 Two additional considerations

Practical difficulties aside, it does not follow from the inclusion of the Ω term in the objective function that central banks should use monetary policy as a financial stability tool. That case rests on two additional arguments.

One is that other policy instruments for promoting financial stability are either unavailable or ineffective. If that were not the case, then those tools could be used to address financial imbalances, leaving the monetary authority free to concentrate on macroeconomic objectives. The question of these tools' efficacy is well beyond the scope of this paper, but recent experience suggests that the U.S. financial system has evolved in ways that have rendered regulatory measures much less effective. A great deal of lending takes place by unregulated financial institutions like mortgage brokers, for example. And even those that are nominally subject to prudential regulation have successfully used mechanisms like SIVs and "repo 105" transactions to partially circumvent capital requirements. The interest rate is the one policy tool that is difficult to evade.

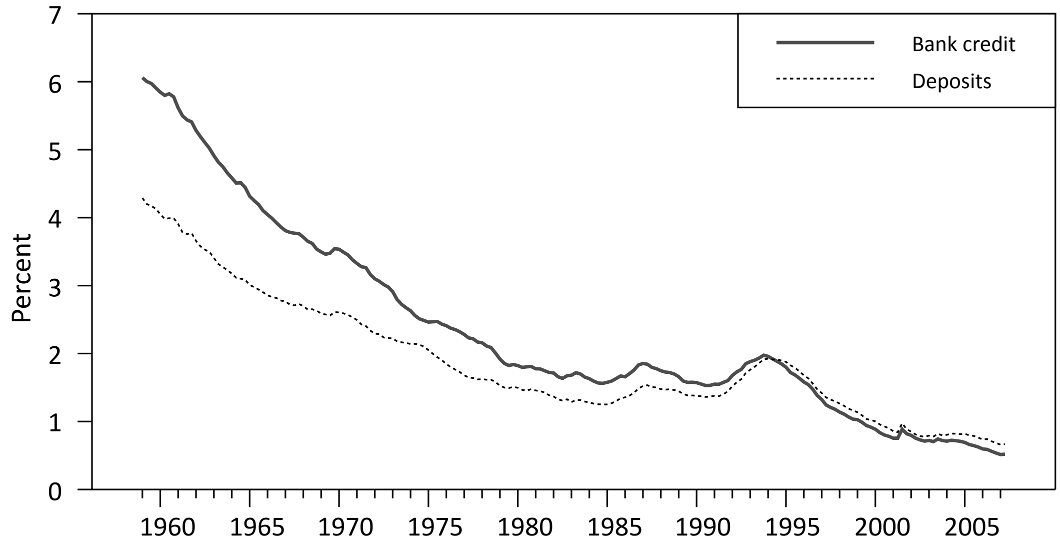
The second argument one would have to make in order to justify a monetary policy response to financial conditions is that such a policy could actually *do* something to affect financial stability. This could happen in at least four different ways. First, contractionary policy could reduce either the size or duration of any bubble by restricting the volume of credit supplied. Second, tighter monetary policy could limit financial fragility by decreasing the demand for credit as in Bordo & Jeanne (2002) and Woodford (2010). Third, if low interest rates lead to excess risk taking, as alleged by Borio & Zhu (2008) and Gambacorta (2009), then higher interest rates would discourage such risk taking while possibly dampening the bubble. Finally, higher interest rates could directly offset the sorts of distortions that arise in the Dupor (2002, 2005) model.

These channels' practical relevance is not well established, however. Part of the reason is that monetary policy is entirely absent from most bubble models, such as those of Allen & Gorton (1993) and Scheinkman & Xiong (2003). One that does include an explicit role for the central bank is Allen & Gale (2000), but it does so via the crude assumption that the central bank directly controls the supply of credit, up to a random shock realization. The assumption was justified on the grounds that the central bank controls the required reserve ratio and the supply of bank reserves, and these jointly determine the volume of credit available to investors.

While it may have been a reasonable characterization at some point in the past, this view of the link between monetary policy and credit supply is by now hopelessly dated. With the progressive reduction of the statutory required reserve ratio, and its further *de facto* reduction via the introduction of sweep accounts in the mid-1990s, reserves now constitute less than one percent of bank credit and deposits, as shown in figure 4. Of course the level of banking system reserves would not matter if a reliable link existed between reserves and bank credit. This turns out not to be the case, however. The solid line in figure 5 shows the logarithm of the ratio of bank loans to total reserves, interpretable as the log "loan multiplier," whose upward trend reflects the declining share of reserves in bank credit plotted in figure 4. The dotted line shows the residual from the regression of the logarithm of total loans on a constant, a linear time trend, and the log of total reserves, which can be interpreted as the error from a cointegration relationship. Standard tests fail to reject the null of no cointegration, suggesting no stable long-run link exists between reserves and bank credit.

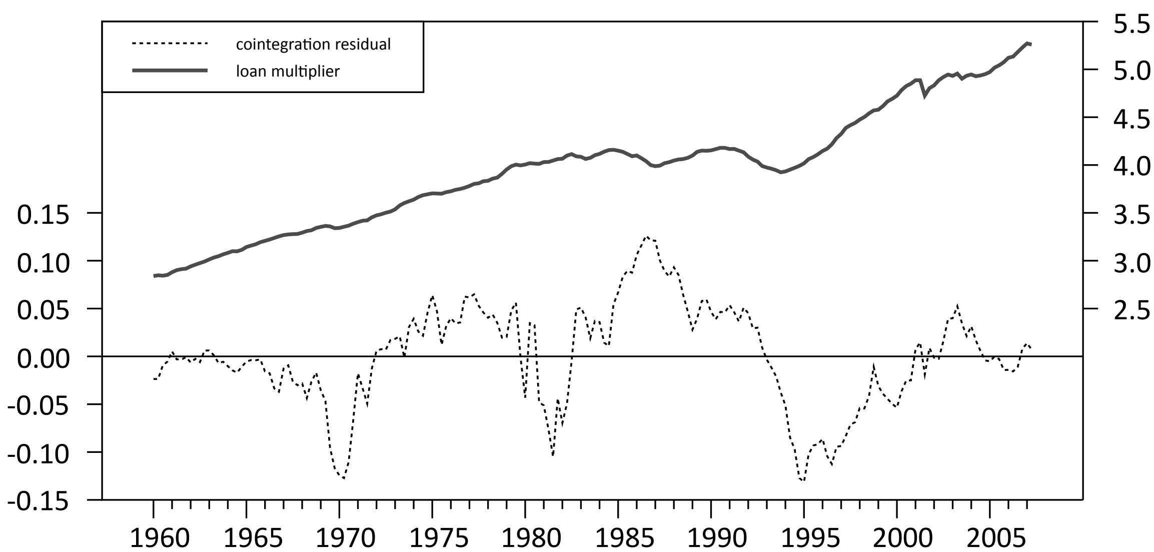
Moreover, as documented in Friedman & Kuttner (2010), policy rate changes by the U.S. Federal Reserve (and other major central banks as well) require virtually no changes in nonborrowed reserves, and hence will not meaningfully affect the aggregate size of the banking system's balance sheet. And in any case, banks' and thrifts' combined share of total credit has declined steadily from 45 percent in 1975 to only 18 percent in 2010. As shown in figure 6, expressed as a share of GDP credit extended by institutions not subject to any reserve requirement surpassed lending by banks and thrifts in the early 1980s. Indeed, very little of the pre-crisis lending boom can be attributed

Figure 4: Total reserves as a percentage of deposits and bank credit, U.S.



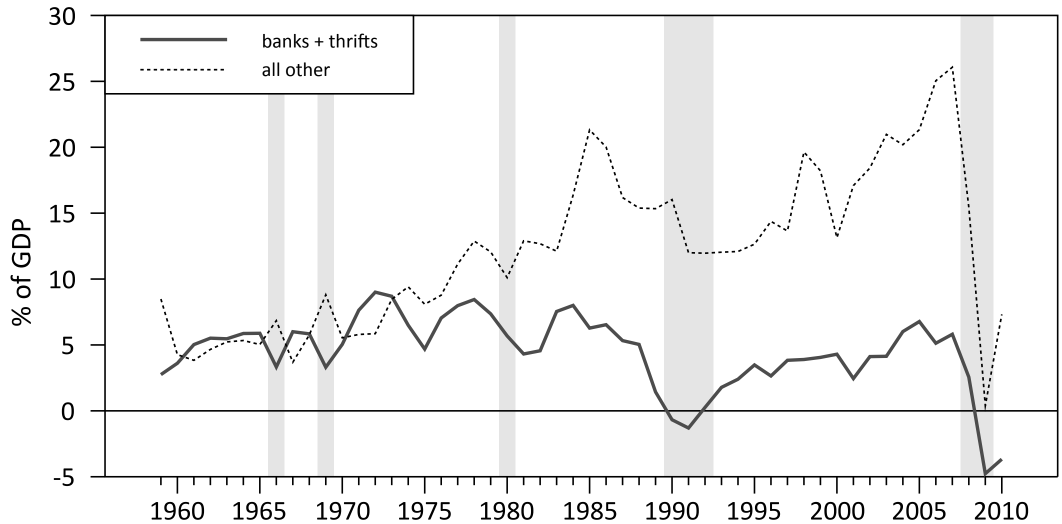
Notes: Data are from the Federal Reserve's H.8 release.

Figure 5: The loan multiplier and the loan-reserves cointegration residual, U.S.



Notes: Data are from the Federal Reserve's H.8 release, and author's calculations.

Figure 6: Lending by traditional intermediaries and others



Notes: Data are from the Federal Reserve's Z.1 release. Shaded areas are NBER-designated recessions.

to lending by traditional intermediaries. The inescapable conclusion is that changes in reserves or the required reserve ratio now affect only a small part of the financial system, and would therefore be unlikely to have a meaningful effect on credit supply.

4 Can interest rate policy dampen asset price booms?

With conventional monetary policy exerting very little direct influence over the volume of bank credit, much less the quantity of total credit, the burden of checking imbalances would presumably fall entirely on interest rates. Specifically, interest rates would presumably affect individuals' and institutions' demand for assets and credit, with higher interest rates tending to reduce asset prices and restraining credit growth.[18] This section considers the issue of whether interest rates can either contribute to or attenuate asset price growth — a critical question if interest rate policy is to be used to promote financial stability.

[18]This does not necessarily involve deflating or puncturing bubbles, of course. Leaving aside the possibility of bubbles, by shrinking the discount factor applied to future revenues, low interest rates increase the value of long-dated assets, *ceteris paribus*, while higher rates decrease those values.

4.1 Existing research

Empirical research on the topic has failed to document a large impact of short-term interest rates on stock prices, much less any connection to bubbles or crises. Campbell (1991) and Campbell & Ammer (1993) decomposed the variance of stock prices into components attributable to interest rates, dividends, and the equity premium, and found that interest rate fluctuations contributed only three percent of the variance. Bernanke & Kuttner (2005) looked specifically at the response of stock prices to unanticipated changes in the federal funds rate. Their main finding was that a 100 basis point surprise rate increase would lead to a stock market decline of roughly five percent.[19] This suggests that while monetary policy does have a quantitatively meaningful impact on the stock market, an extended campaign of rate hikes would be required to dampen a sustained, double-digit increase in equity prices like that experienced in the four years leading up to the crisis.

Given the role played by the real estate market in the 2007–09 crisis, it is not surprising that a large number of recent papers have sought to document a relationship between interest rates and property prices. These studies' findings are generally inconclusive, however. The Ahearne *et al.* (2005) descriptive analysis suggests that low interest rates do tend to precede housing price peaks, with a lead of approximately one to three years. Using a vector autoregression (VAR) that included interest rates, credit and money, Goodhart & Hofmann (2008) uncovered a "significant multidirectional link" between these variables and property prices, although the direction of causality was unclear. Focusing more narrowly in the impact of the federal funds rate, Dokko *et al.* (2009) found that deviations from the Taylor rule explained only a small portion of the pre-crisis rise in property prices. Jarociński & Smets (2008) reached similar conclusions using a Bayesian VAR. Using a dynamic factor model as an alternative to the VAR method, Del Negro & Otrok (2007) attributed a relatively small amount of variance to the aggregate national factor, suggesting a small role for interest rates. And using the Campbell (1991) decomposition, Campbell *et al.* (2009) found that interest rate fluctuations contributed very little to changes in real estate prices. Finally, Glaeser *et al.* (2010) employed a user-cost model of house prices, and concluded that only a small portion of the pre-2007 rise in real estate prices was due to low interest rates.

[19] Similar results were obtained by Rigobon & Sack (2003) and Gürkaynak *et al.* (2005).

4.2 A look the recent pre-crisis experience

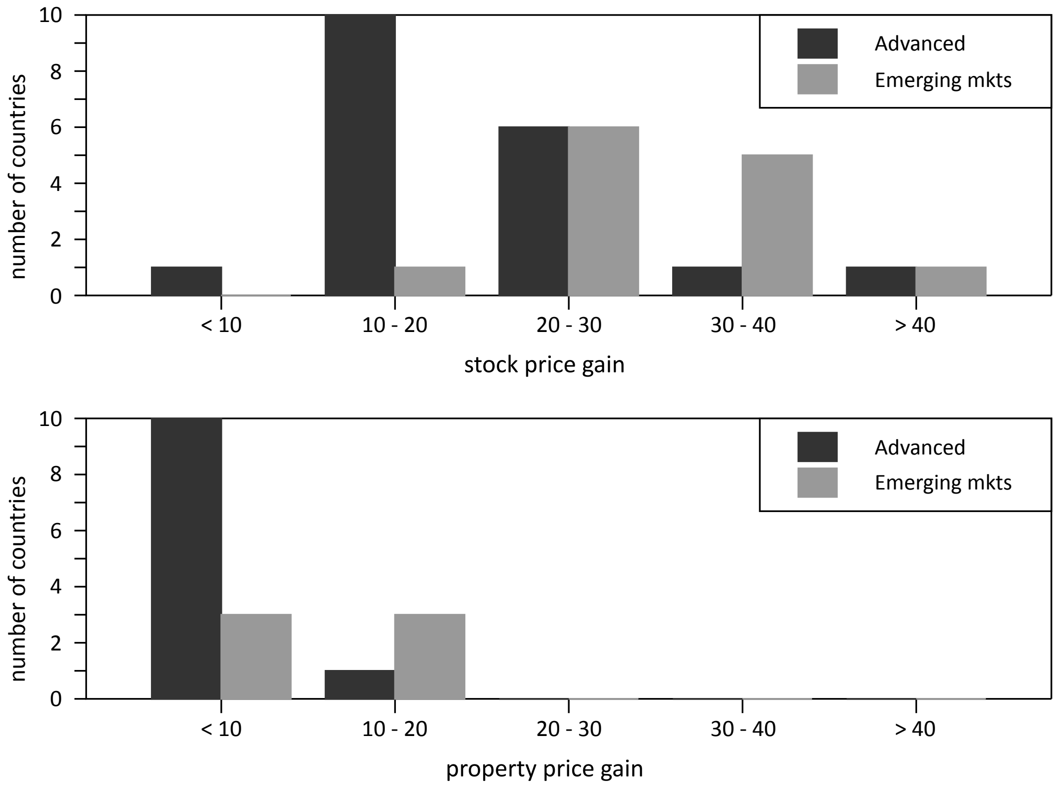
Discerning the impact of monetary policy on stock and property prices is not an easy task, in part because asset prices depend heavily on unobserved factors, such as risk premia and expectations. Ideally, one would run a randomized controlled trial in which different monetary policies (or policy rules) were assigned to different central banks, and observe the behavior of asset prices across countries. Lacking a controlled experiment, a highly imperfect alternative is to look across countries for a relationship between interest rates and stock and property prices during the period leading up to their peaks, which in most cases occurred in 2007 or 2008. If monetary policy were capable of moderating asset price booms, then one would expect to see those countries with higher short-term interest rates experiencing smaller asset price gains than those with lower interest rates.

To investigate this hypothesis, monthly data on stock prices, short-term policy interest rates, and consumer prices were obtained for 32 countries from the International Monetary Fund's *International Financial Statistics* database. The 32 countries included 12 from the euro area, seven non-euro developed countries, and 13 emerging market economies. Residential property prices were obtained from the Bank for International Settlements. These data are not consistently collected, however, and usable series were available for only 27 of the 32 countries. Quarterly or lower frequency data were interpolated to calculate monthly series. Although all are residential property prices, the specific coverage (e.g., single-family houses versus flats, new versus existing dwellings, etc.) varies across countries. The appendix contains additional information on the data.

Figure 7 shows the distribution of annualized real asset price growth over the four years leading up to the price peak. For equities, this occurred between May and November 2007, depending on the country. The peak dates for real estate prices were more dispersed: in the U.S. house prices peaked slightly before stock prices, while elsewhere (e.g., Greece and Italy) the decline did not commence until the end of 2008.[20] Stock price growth ranged from excellent to spectacular over this period, with all but one of the countries in the sample enjoying real double-digit growth, many in excess of 20 percent per year. The average for developed economies is 20 percent, and 29 percent for emerging market economies. Property prices generally grew more slowly, averaging

[20] In several of the European countries, such as Germany, real property prices were essentially flat over this period, and so the price increase would have been the same regardless of what peak date was chosen.

Figure 7: Distribution of real annualized stock and property price gains, four years pre-peak



Notes: Stock and consumer price data are from the IMF, property price data are from the BIS.

five percent per year in real terms for both sets of countries. Not surprisingly, Iceland holds the record for real estate exuberance, with an annual real growth rate over four years of 12 percent.

But before investigating the link between monetary policy and asset prices, it is useful to take a brief detour to characterize monetary policy over this period, and in particular to assess the claim that central banks were too slow to raise interest rates in the face of rising asset prices. One way to do this is to estimate an equation to describe the degree to which the countries in the sample tended to respond to inflation, which, as shown in figure 8, increased slightly over this period. The regression equation used is

$$r_i = \beta_0 + \beta_1 \pi_i + \beta_2 d_i^{em} + \varepsilon_i \tag{3}$$

where r_i is the short-term nominal interest rate (monetary policy instrument or operational target) for country i, π_i is the inflation rate, and d_i^{em} is a dummy variable for emerging market economies.

The interest and inflation rates are the averages for the two years prior to the stock market peak. Since its members share a common monetary policy, the euro area is treated as a single country, and the euro-area harmonized CPI is used to calculate the inflation rate. Naturally, it would be dangerous to interpret this equation as structural: over a two-year period, there is surely feedback from the interest rate to inflation, and the equation plainly omits other relevant determinants of the interest rate, such as the output gap.

The results from estimating equation 3 appear in table 1. Reassuringly, countries with higher inflation tended to set higher nominal interest rates, and taken at face value the inflation coefficient of 2.34 suggests that the reaction is more than two-for-one. However the estimated parameters are heavily influenced by Turkey and Brazil, which had much higher inflation and interest rates than the other countries in the sample. Excluding these two observations, the point estimate falls to a more reasonable 1.34. The coefficient on the emerging market dummy suggests these central banks set slightly lower interest rates, conditional on a given level of inflation, but the difference is not statistically significant.

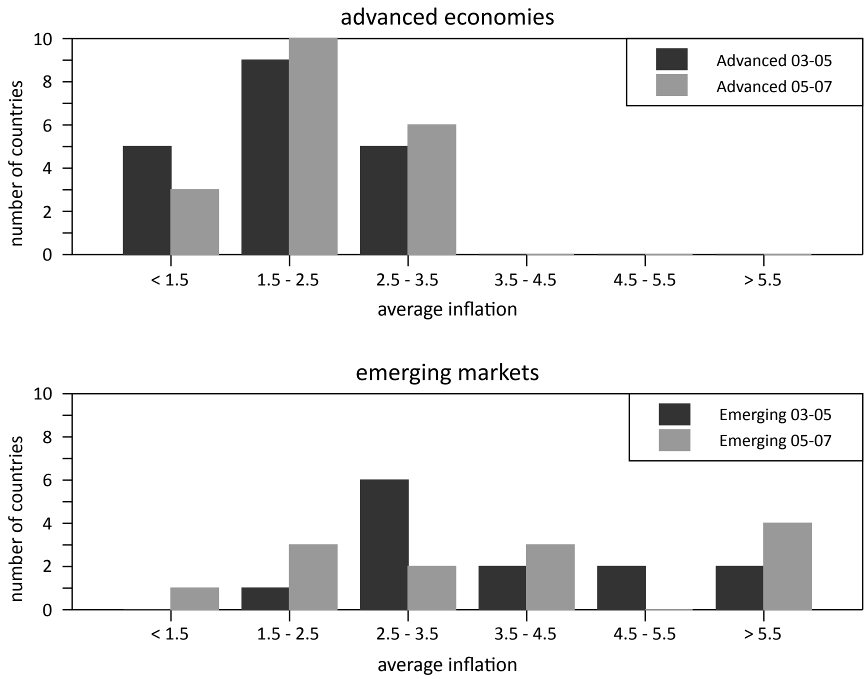
One issue with levels regressions like equation 3 is that the neutral interest rate may differ across countries, implying country-specific intercepts. One way around this is to look instead at the *change* in the interest rate over the year period, and to regress that on the corresponding change in the inflation rate,

$$\Delta r_i = \beta_0 + \beta_1 rr_i + \beta_2 \Delta\pi_i + \beta_3 d_i^{em} + \varepsilon_i \tag{4}$$

where rr_i is the beginning-of-period real interest rate (the nominal rate minus the 12-month lagging inflation rate) and $\Delta\pi_i$ is the change in the inflation rate over the two-year period. The reason for including the real interest rate is to allow for a kind of error-correction mechanism: a negative value of β_1 would imply that countries with high initial levels of the real rate would reduce the nominal rate (or raise it more slowly) than those with low initial real rates.

Table 2 displays estimates of equation 4, both including and excluding Turkey and Brazil. With adjusted R-squareds of 0.388 (0.715 with Turkey and Brazil included), the equation captures the cross-country pattern of interest rate changes reasonably well. The positive intercept is consistent with a general trend towards higher interest rates over this period, and central banks raised the policy rate roughly one-for-one with the inflation rate. These patterns are evident in figure 9, which

Figure 8: Distribution of annualized inflation rates, two and four years pre-peak



Notes: Consumer price data are from the IMF.

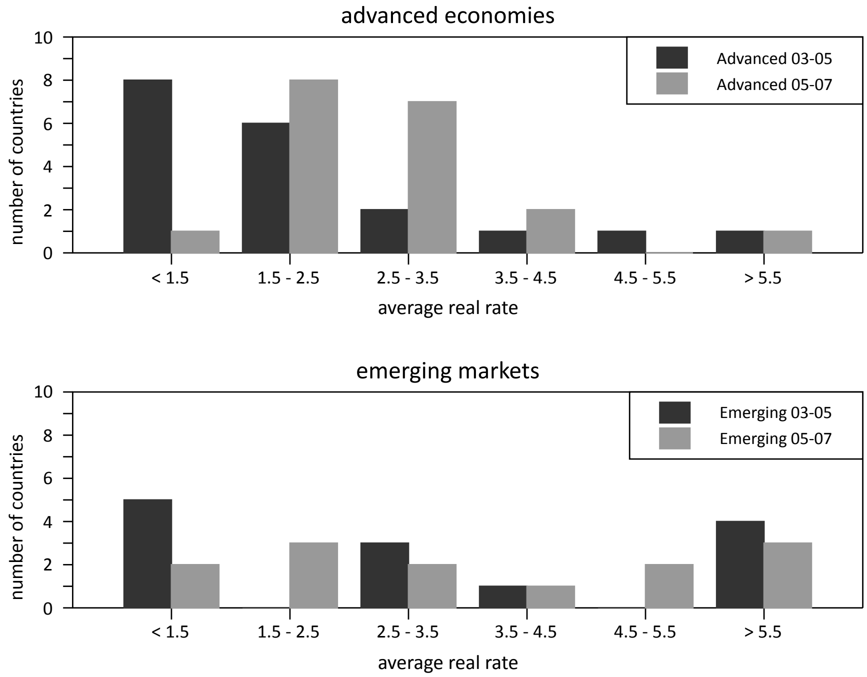
Table 1: The cross-country relationship between inflation and the interest rate

Dependent variable = short-term nominal interest rate

	Regressor				
	Intercept	Inflation	Emerging market	N	$\bar{R}^2$
Full sample	−1.15	2.35***	−0.30	21	0.468
	(0.56)	(4.02)	(0.14)		
Excluding Turkey & Brazil	1.21	1.32***	−0.70	19	0.374
	(1.03)	(3.43)	(0.62)		

Notes: The numbers shown are the estimated coefficients in an OLS regression of the short-term nominal interest rate on the variables listed during the two years prior to the peak on the listed variables. Asterisks denote statistical significance: *** for 1%, ** for 5%, and * for 10%, t-statistics are in parentheses.

Figure 9: Distribution of real interest rate levels, two and four years pre-peak



Notes: Consumer price and interest rate data are from the IMF.

Table 2: The cross-country relationship between inflation and interest rate changes

Dependent variable = short-term nominal interest rate change

	Regressor					
	Intercept	Lagged real rate	Inflation change	Emerging market	N	$\bar{R}^2$
Full sample	1.70***	−0.19***	1.10***	−0.33	21	0.715
	(3.83)	(3.55)	(4.02)	(0.14)		
Excluding Turkey & Brazil	1.75***	−0.22**	1.00***	−0.70	19	0.388
	(5.08)	(2.21)	(3.94)	(0.62)		

Notes: The numbers shown are the estimated coefficients in an OLS regression of the change in short-term nominal interest rate on the variables listed during the two years prior to the peak on the listed variables. Asterisks denote statistical significance: *** for 1%, ** for 5%, and * for 10%, *t*-statistics are in parentheses.

depicts the evolution of real rates over this period. There is a modest but pronounced rightward shift in the distribution for developed economies. Although the shift appears smaller for the emerging market economies, the coefficients on the emerging market dummies are statistically insignificant.

Together, the results in tables 1 and 2 suggest that the 21 central banks in the sample collectively reacted appropriately to gradually rising price pressures in the two years to the crisis — although with an estimated coefficient on inflation equal to or slightly greater than one, one could argue that they could have responded more aggressively.

Having summarized central banks' interest rate policies over this period, the next question is whether these policies made any difference to the behavior of asset prices in their respective countries. Three alternative regression equations were used to address this question. The first expresses the annualized real percentage change in the asset price Δy_i (representing either equities or real estate) as a function of the average nominal interest rate and the average inflation rate during the two years leading up to the crisis, along with a dummy for euro-area countries and another for emerging market economies,

$$\Delta y_i = \beta_0 + \beta_1 r_i + \beta_2 \pi_i + \beta_3 d_i^{em} + \beta_4 d_i^{eu} + \eta_i \ . \tag{5}$$

A second specification replaces the levels of the interest and inflation rates with their changes,

$$\Delta y_i = \beta_0 + \beta_1 \Delta r_i + \beta_2 \Delta \pi_i + \beta_3 d_i^{em} + \beta_4 d_i^{eu} + \eta_i \ . \tag{6}$$

A third uses as regressors the real interest rate prevailing two years prior to the peak, rr_i and the estimated residual from equation 4, $\hat{\varepsilon}_i$, as a gauge of the degree to which (conditional on inflation) monetary policy was tighter or looser than average,

$$\Delta y_i = \beta_0 + \beta_1 rr_i + \beta_2 \hat{\varepsilon}_i + \beta_3 d_i^{em} + \beta_4 d_i^{eu} + \eta_i \ . \tag{7}$$

It goes without saying that these regression equations could provide at best circumstantial evidence on how monetary policy affects asset prices. For one thing, there would be simultaneous equation bias if central banks responded to asset price appreciation with higher interest rates. But since this would result in a positive correlation between asset price growth and the interest rate, the net effect would be an upward bias in the (negative) interest rate coefficient(s). Similarly, the level of economic activity may affect asset prices and the interest rate (via a policy reaction function), but the regression does not include any variable that would capture this effect. This would also tend to reduce the likelihood of finding a significant negative coefficient on the interest rate.

None of the three equations is at all successful at explaining cross-country patterns in stock price movements. As shown in table 3, the only statistically significant parameter estimates are the intercepts, and in the specification involving the real interest rate (specification 3) the coefficients on the emerging market dummies. The adjusted R-squareds are negative for two of the specifications, and a paltry 0.04 for the equation involving the interest and inflation rate changes (specification 2). In this equation, the coefficients on the interest rate and inflation rate changes have signs (negative for the interest rate, positive for inflation) that are consistent with the hypothesis that tighter monetary policy reduces asset price appreciation. Unfortunately, they are not statistically significant, either individually or jointly.

The property price regressions fare slightly better than those for the stock price, but the results are still quite weak. As shown in table 4, other than the intercepts and those on the dummy variables, only two of the estimated coefficients are statistically significant at even the 10 percent level. The statistically significant -1.93 coefficient on the real interest rate in specification 3 suggests an inverse relationship between real interest rates and property prices. The quantitative effect is modest, however, with a one percentage point increase in the real rate reducing the rate of appreciation by two percentage points. The marginally significant -2.82 coefficient on inflation in specification 2 goes the other way, however.

Taken together, these rough-and-ready regression results lend little support to the view that marginal interest rate adjustments can meaningfully dampen asset price bubbles, corroborating the Reinhart & Reinhart (2011) analysis of the U.S. historical experience. The 21 central banks in the sample were not collectively "behind the curve" in responding to consumer price inflation, and yet most of the countries experienced spectacular stock price booms and many (though by no means all) saw sharply rising property prices. The observed cross-country differences in real interest rates are relatively small, however, and the estimates' imprecision may be due to the lack of variance

Table 3: The effect of interest rates on stock prices

Dependent variable = pre-peak annualized stock price gain

	Specification		
Regressor	(1)	(2)	(3)
Intercept	21.6***	21.6***	18.1***
	(4.0)	(4.6)	(4.2)
Euro area dummy	4.1	5.3	4.9*
	(0.7)	(1.0)	(0.9)
Emerging market dummy	9.9	7.1	7.2
	(1.7)	(1.3)	(1.3)
Average interest rate 2 years pre-peak	0.46		
	(0.78)		
Average inflation 2 years pre-peak	−2.15		
	(1.11)		
Interest rate change from 2 years prior		−2.39	
		(1.57)	
Inflation change from 2 years prior		4.85	
		(1.64)	
Real interest rate 2-4 years pre-peak			0.31
			(0.70)
Interest rate deviation from fitted rule			−2.40
			(1.08)
Adjusted R-squared	−0.016	0.043	−0.001

Notes: The numbers shown are the estimated coefficients in an OLS regression of the annualized percent change in stock prices on the listed variables during the two years prior to the peak. Asterisks denote statistical significance: *** for 1%, ** for 5%, and * for 10%, t-statistics are in parentheses. The total number of usable observations is 32.

Table 4: The effect of interest rates on property prices

Dependent variable = pre-peak annualized property price gain

	Specification		
Regressor	(1)	(2)	(3)
Intercept	9.2**	3.9	8.8***
	(2.1)	(1.3)	(3.1)
Euro area dummy	−3.7	−1.7	−5.9*
	(1.0)	(0.5)	(1.7)
Emerging market dummy	5.7	9.3**	4.9
	(1.2)	(2.2)	(1.4)
Average interest rate 2 years pre-peak	−1.03		
	(1.43)		
Average inflation 2 years pre-peak	0.32		
	(0.23)		
Interest rate change from 2 years prior		1.26	
		(0.93)	
Inflation change from 2 years prior		2.82*	
		(1.74)	
Real interest rate 2-4 years pre-peak			−1.93**
			(2.53)
Interest rate deviation from fitted rule			2.28
			(1.51)
Adjusted R-squared	0.148	0.178	0.283

Notes: The numbers shown are the estimated coefficients in an OLS regression of the annualized percent change in property prices on the listed variables during the two years prior to the peak. Asterisks denote statistical significance: *** for 1%, ** for 5%, and * for 10%, t-statistics are in parentheses. The total number of usable observations is 27.

in the independent variables. Bolder policy experiments — rate hikes of one or two percentage points — surely would have been more informative than the incremental adjustments that took place over this period. The search continues for a definitive link between interest rates and asset price bubbles.

5 *Conclusions*

Two lessons from the financial crisis of 2007–09 are uncontroversial. One is that macroeconomic stability, and price stability in particular, does not guarantee financial stability. The second is that because the bursting of asset price bubbles can wreak havoc on the real economy, the central bank's financial stability objective should not be overlooked. The critical question is what, if anything, monetary policy should do to further that objective.

The Bernanke & Gertler (1999) monetary policy prescription is essentially to treat the symptoms of financial instability by counteracting the effects of booms and busts on aggregate demand, rather than attempt to deflate the asset price bubbles that create the instability. The conclusion was based on a macro model with exogenous asset bubbles, and no welfare costs to financial instability other than its effects on output and inflation volatility. Model simulations demonstrated that varying the policy interest rate in response to asset price fluctuations would lead to more more volatile output and inflation, even if the asset price fluctuations were known to be caused by bubbles.

The recent financial crisis has reopened the question of whether financial stability considerations should shape monetary policy. A case can be made for using monetary policy in such a capacity if it can in fact dampen asset price booms, and if bubbles impose economic costs that are not entirely reflected in output gaps and inflation fluctuations. The recent crisis has surely lent support to the proposition that financial crises create significant economic inefficiencies, such as the misallocation of resources to the construction of unsold houses, not to mention the costs associated with litigation and liquidation. These considerations could be used to justify moving away from the BG prescription and towards a policy intended to attenuate to financial booms.

The results reported in this paper (and elsewhere) provide scant empirical support for the efficacy of modest monetary policy interventions in restraining asset price growth, however. Moreover, such a strategy would present a number of practical difficulties. One obstacle is the measurement of financial imbalances. Common gauges, such as asset prices and aggregate leverage are both imperfect indicators of the likelihood of a financial crisis. A second challenge is communication: it is not easy to explain why tighter policy is imperative when price inflation is subdued. A third problem is judging the policy's success, since no amount of leaning against the wind will entirely prevent financial crises. Finally, the political economy dimension of the problem should not be overlooked. Given the disproportionate share of households' wealth held in the form of home equity, it would be dangerous for the Federal Reserve to try to dampen property price appreciation. The mere perception that the Fed was following such a policy would surely give rise to calls to curtail its independence.

Ultimately, the decision to deviate from the BG prescription may hinge on the availability of alternative, non-monetary policies for dealing with financial system risk. Regulatory measures, and macroprudential regulation in particular, are unquestionably better suited than interest rate policy to the promotion of financial stability. The timidity of the financial reforms enacted in the U.S. thus far is not encouraging, however. Basel III may eventually introduce some macroprudential element into banking regulation, but its weakness is that it would apply only to banks. Monetary policy may be the only available tool for dealing with the markets and unregulated financial institutions that were at the epicenter of the 2007–09 crisis in the U.S. Lacking a viable alternative policy tool, it would not be surprising if some central banks chose to hedge their bets, and give greater weight to asset prices in the conduct of monetary policy.

Data appendix

The following table lists the countries included in the analysis, the months during which stock and property prices peaked, and the coverage and frequency of the property price statistics.

	Peak month			
Country	Stock	Property	Coverage	Freq
Australia	Oct 2007	Mar 2008	8 cities	Q
Austria	May 2007	Sep 2007	X Vienna	Q
Belgium	May 2007	Sep 2008	Existing dwellings	Q
Brazil	Dec 2007			
Canada	Jul 2007	May 2008	Existing dwellings	
Chile	Oct 2007			
Czech Republic	Oct 2007	Sep 2008	Existing flats	Q
Denmark	Oct 2007	Sep 2007	Single family	Q
Estonia	Jul 2007	Jun 2007	All flats	Q
Finland	Oct 2007	Jun 2008	Existing dwellings	Q
France	May 2007	Sep 2008	Existing dwellings	M
Germany	Jun 2007	Dec 2007	New W. Germany	A
Greece	Oct 2007	Dec 2008	Urban x Athens	Q
Hungary	Jul 2007	Jun 2008	Existing Budapest	Q
Iceland	Jul 2007	Oct 2007	Reykjavik	M
Ireland	May 2007	Dec 2006	All dwellings	Q
Israel	Oct 2007	Jul 2007	Owner occupied	M
Italy	May 2007	Dec 2008	All dwellings	H
Korea	Oct 2007	Sep 2008	All dwellings	M
Mexico	Oct 2007			
Netherlands	Jul 2007	Aug 2008	All dwellings	M
New Zealand	May 2007	Dec 2007	All dwellings	Q
Norway	Jul 2007	Jun 2008	All dwellings	Q
Poland	Jul 2007			
Slovak Republic	Nov 2007	Jun 2008	Existing dwellings	Q
Slovenia	Aug 2007	Mar 2008	Existing dwellings	Q
Spain	Oct 2007	Mar 2008	All dwellings	Q
Sweden	May 2007	Sep 2008	Owner occupied	Q
Switzerland	May 2007	May 2007	1-family	Q
Turkey	Oct 2007			
United Kingdom	Jun 2007	Aug 2007	All dwellings	M
United States	Jul 2007	Mar 2007	Existing 1-family	

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