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QUANTITATIVE POLICY IMPLICATIONS OF NEW NORMATIVE MACROECONOMIC RESEARCH[†]

Should Central Banks Respond to Movements in Asset Prices?

By BEN S. BERNANKE AND MARK GERTLER[*]

In recent decades, asset booms and busts have been important factors in macroeconomic fluctuations in both industrial and developing countries. In light of this experience, how, if at all, should central bankers respond to asset price volatility?

We have addressed this issue in previous work (Bernanke and Gertler, 1999). The context of our earlier study was the relatively new, but increasingly popular, monetary-policy framework known as *inflation-targeting* (see e.g., Bernanke and Frederic Mishkin, 1997). In an inflation-targeting framework, publicly announced medium-term inflation targets provide a nominal anchor for monetary policy, while allowing the central bank some flexibility to help stabilize the real economy in the short run. The inflation-targeting approach gives a specific answer to the question of how central bankers should respond to asset prices: Changes in asset prices should affect monetary policy *only* to the extent that they affect the central bank's forecast of inflation. To a first approximation, once the predictive content of asset prices for inflation has been accounted for, there should be no additional response of monetary policy to asset-price fluctuations.[1]

In use now for about a decade, inflation-targeting has generally performed well in practice. However, so far this approach has not often been stress-tested by large swings in asset prices. Our earlier research employed simulations of a small, calibrated macroeconomic model to examine how an inflation-targeting policy (defined as one in which the central bank's instrument interest rate responds primarily to changes in expected inflation) might fare in the face of a boom-and-bust cycle in asset prices. We found that an aggressive inflation-targeting policy rule (in our simulations, one in which the coefficient relating the instrument interest rate to expected inflation is 2.0) substantially stabilizes both output and inflation in scenarios in which a bubble in stock prices develops and then collapses, as well as in scenarios in which technology shocks drive stock prices. Intuitively, inflation-targeting central banks automatically accommodate productivity gains that lift stock prices, while offsetting purely speculative increases or decreases in stock values whose primary effects are through aggregate demand.

Conditional on a strong policy response to expected inflation, we found little if any additional gains from allowing an independent response of central-bank policy to the level of asset prices. In our view, there are good reasons, outside of our formal model, to worry about attempts by central banks to influence asset prices, including the fact that (as history has shown) the effects of such attempts on market psychology are dangerously unpredictable. Hence, we concluded that inflation-targeting central banks need not respond to asset prices, except insofar as they affect the inflation forecast.

In the spirit of recent work on robust control, the exercises in our earlier paper analyzed the performance of policy rules in worst-case

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[1] As discussed in what follows, an additional response is warranted in theory if changes in asset prices affect the natural real rate of interest, though we find this effect to be quantitatively small in our simulations. Also, this prescription is not intended to rule out short-term interventions to protect financial stability.

scenarios, rather than on average. However, the more conventional approach to policy evaluation is to assess the expected loss for alternative policy rules with respect to the entire probability distribution of economic shocks, not just the most unfavorable outcomes. That is the approach taken in the present article. We conduct stochastic simulations of the same model we used earlier to evaluate the expected performance of alternative policy rules. We consider stock-price "bubble" shocks, technology shocks, and the two in combination. Although the policy-evaluation approach is different from our previous work, the results of these simulations are complementary to what we found earlier. We find again that an aggressive inflation-targeting rule stabilizes output and inflation when asset prices are volatile, whether the volatility is due to bubbles or to technological shocks; and that, given an aggressive response to inflation, there is no significant additional benefit to responding to asset prices.

I. The Model and the Simulation Method

The model we use is essentially the same as in Bernanke and Gertler (1999), which in turn was an extension of the framework developed in Bernanke et al. (2000). Broadly, the model is a standard dynamic new-Keynesian model, augmented in two ways. First, it incorporates an informational friction in credit markets, by means of the assumption that monitoring of borrowers by lenders is costly. This credit-market friction gives the model a "financial accelerator," a mechanism by which endogenous changes in borrowers' balance sheets enhance the effects of exogenous shocks. For example, in our model a boom in stock prices raises output not only via conventional wealth and Tobin's q effects, but also by increasing the net worth of potential borrowers. As borrowers become wealthier and thus more able to self-finance, the expected deadweight losses of external finance decline, further increasing investment and output.

The second modification, introduced in Bernanke and Gertler (1999), is to allow an additive, non-fundamental component in stock prices. We model this non-fundamental component as an exogenous stochastic process. Innovations to this process are drawn randomly each period from a normal distribution. The effect of a given innovation on stock prices persists into the subsequent period with fixed probability, set equal to one-half in our simulations. If an innovation persists, it grows at a rate equal to a fixed parameter a times the fundamental rate of return on capital, divided by the probability of continuation. If the parameter a were to equal 1.0, the non-fundamental component would be a rational bubble, in the sense of Olivier Blanchard and Mark Watson (1982). To preserve long-run stationarity, we choose instead $a = 0.99$, so that the non-fundamental component has a weak mean-reverting tendency. Agents are assumed to know the statistical process that drives bubbles, though they do not know in advance their ultimate magnitude or duration. The primary effect of a bubble is to increase aggregate demand, by increasing consumers' wealth and by improving the balance sheets of borrowers.

The model is calibrated as in Bernanke and Gertler (1999), except that here we have increased the elasticity of Tobin's q with respect to investment from 0.5 to 2.0, as is consistent with the evidence. In addition, to introduce more realistic persistence in the response of Tobin's q to productivity shocks, we introduce diminishing returns into the production of new capital goods, though this modification does not materially affect the results.

We considered simulations of the model, under alternative monetary-policy rules, for (i) random draws of the bubble process, (ii) random draws of the technology shock, and (iii) combinations of shocks to the bubble and to technology. As described earlier, the duration and hence the maximum size of each bubble are stochastic. Because our linear approximation becomes less accurate as the bubble becomes very large, we assume that bubbles that have lasted five periods collapse with certainty in the sixth period. Depending on the monetary-policy rule, a positive one-standard-deviation initial bubble shock that lasts the full five periods can cause stock prices to rise 25–30 percent above their steady-state values. Experiments confirmed that our qualitative results are not affected by allowing the bubble to run for a maximum of seven periods (the unconditional probability of a bubble lasting more than seven periods is less than 1 percent). Technology shocks are modeled as permanent shifts in total factor productivity (TFP). The standard devia-

TABLE 1—BUBBLE SHOCKS ONLY

Policy rule (π, s, y)	σ_y	σ_π
1.01, 0, 0	0.83	2.85
1.01, 0.05, 0	0.45	9.44
1.01, 0.1, 0	0.76	14.77
1.01, 0, 0.5	0.37	4.11
2, 0, 0	0.34	0.10
2, 0.05, 0	0.33	0.17
2, 0.1, 0	0.32	0.42
2, 0, 0.5	0.32	0.09
3, 0, 1	0.29	0.07

TABLE 2—TECHNOLOGY SHOCKS ONLY

Policy rule (π, s, y)	σ_y	σ_π
1.01, 0, 0	0.73	6.23
1.01, 0.05, 0	0.18	25.06
1.01, 0.1, 0	0.48	42.24
1.01, 0, 0.5	0.28	2.79
2, 0, 0	0.24	0.14
2, 0.05, 0	0.22	0.28
2, 0.1, 0	0.19	0.62
2, 0, 0.5	0.22	0.05
3, 0, 1	0.21	0.05

TABLE 3—BUBBLE AND TECHNOLOGY SHOCKS

Policy rule (π, s, y)	σ_y	σ_π
1.01, 0, 0	3.47	40.84
1.01, 0.05, 0	1.92	94.13
1.01, 0.1, 0	3.91	180.77
1.01, 0, 0.5	1.08	19.49
2, 0, 0	0.80	0.64
2, 0.05, 0	0.68	1.26
2, 0.1, 0	0.58	2.89
2, 0, 0.5	0.70	0.44
3, 0, 1	0.68	0.23

tion of innovations to TFP is assumed to be 1 percent of its initial level.

As for policy rules, we considered simple rules relating the central bank's nominal interest rate to next period's expected inflation, the current level of the stock market, and the output gap (defined as actual output less output under flexible prices and with no credit frictions). The response of the interest rate to expected inflation was varied between 1.01 and 3, the response to log stock prices between 0 and 0.2, and the response to the output gap between 0 and 2. For each choice of rule parameters, we calculated the unconditional variances of the output gap and inflation, as well as the overall loss, as measured by various quadratic loss functions in the output gap and inflation.

II. Simulation Results

Representative simulation results are shown in the tables. For each table, in the first cell of each row, the triple of numbers indicates the policy rule being evaluated. The first number of the triple is the response of the nominal interest rate to expected inflation (π), the second number is the response of the interest rate to the log of the price of capital, or Tobin's q (s), and the third number is the response of the interest rate to the output gap (y). The second and third columns show the unconditional variances of the output gap, σ_y, and inflation, σ_π, both in percentage points. With no discounting, quadratic losses for each policy can be calculated directly as linear combinations of these variances. Table 1 shows results for the case of bubble shocks only, Table 2 covers the case of technology shocks only, and Table 3 reports results for simulations in which both bubble shocks and technology shocks are drawn in each period. For the last case, we assumed that the correlation of bubble shocks and technology shocks is 0.9, to capture the idea that bubbles may be more likely to develop when fundamentals are also strong. However, the results were similar when this correlation was set to other values, including zero.

The clearest conclusion to be drawn from Tables 1–3 is that "aggressive" inflation-targeting rules, in which the response of the nominal interest rate to expected inflation is 2 or 3, strongly dominate "accommodative" rules, in which the response to expected inflation is 1.01 (a value that barely satisfies the stability condition that real interest rates rise when expected inflation rises). The superiority of aggressive inflation-targeting holds for both types of shocks and their combination. The reduction in inflation variability from aggressive inflation-targeting is particularly striking, as might be expected, but in nearly all cases variability of the output gap is also reduced.

Our simulations suggest that good policy rules will react sensitively to expected inflation, but consistent with the widely held view that inflation-targeting should be applied "flexibly," they show that policy should respond to the output gap as well. Indeed, with equal weighting of the output gap and inflation in the loss function, we find that the policy (3, 0, 1) performs best across the different scenarios (conditional on a relatively coarse grid search). Notice that this policy involves zero weight on stock prices.

Although the optimal policy (for equal weighting of output and inflation) never involves a response to stock prices, we can see from Tables 1–3 that adding a stock-price response to a rule that targets only inflation typically leads to a small reduction in variability of the output gap. Compare, for example, the policies (2, 0, 0), (2, 0.05, 0), and (2, 0.1, 0) in each of Tables 1–3. Our interpretation of this effect is as follows: A shock to stock prices (either from a bubble or from technology) may temporarily change the natural real rate of interest, a change that in principle should be accommodated by a fully optimal policy rule. Putting a small weight on stock prices therefore may help a bit, at least in some circumstances and on some dimensions.

However, shocks to stock prices are not unique in this regard; by the same logic, monetary policy should respond to *any* shock that changes the natural real rate of interest; there is no theoretical justification for singling out the stock market. Indeed, as noted, the simulations show that allowing the policy rule to respond to the output gap eliminates any benefits of responding to stock prices. Admittedly, the output gap is difficult to measure, but we are more confident in economists' ability to measure the output gap than to measure the fundamental component of stock prices; the percentage standard deviation of estimates of stock-price fundamentals surely far exceeds that of potential output. In addition, the behavior of inflation provides a real-time indicator of the magnitude of the output gap, whereas there is no analogous indicator to provide confirmation of estimates of stock fundamentals.

In any case, our simulations show that the small benefits in terms of reduced output-gap variability of responding to stock prices are likely to be outweighed by the associated increase in inflation variability. For example, in the case of technology shocks (Table 2), the policy (2, 0.1, 0) is to be preferred to (2, 0, 0) only if the loss-function weight on output-gap variability exceeds 0.9, and to the policy (3, 0, 1) only if the weight on output-gap variability exceeds 0.96. Similar results obtain for the other scenarios. We conclude that for plausible parameter values the central bank should not respond to asset prices.

III. Relation to the Literature

There has been considerable debate on the appropriate role of asset prices in the formulation of monetary policy. Recent contributions include Charles Goodhart (2000), Nicoletta Batini and Edward Nelson (2000), and Andrew J. Filardo (2000). The paper most closely related to our work, however, is by Stephen Cecchetti et al. (2000). Indeed, a portion of their paper employs simulations of the model of Bernanke and Gertler (1999), the same model used in this paper. Contrary to our findings, however, Cecchetti et al. claim to find strong support for including stock prices in the central bank's policy rule. What accounts for this striking difference in conclusions?

In computing their preferred policy rules, Cecchetti et al. do not take into account either the probabilistic nature of the bubble or the possibility that shocks other than a bubble may be driving asset prices. Specifically, Cecchetti et al. "optimize" the policy rule with respect to a single scenario, a bubble shock lasting precisely five periods, rather than with respect to the entire probability distribution of shocks, including shocks other than bubble shocks. Effectively, their procedure yields a truly optimal policy only if the central bank (i) knows with certainty that the stock-market boom is driven by non-fundamentals and (ii) knows exactly when the bubble will burst, both highly unlikely conditions.[2] In contrast, we find (Table 1) that,

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[2] Even so, under reasonable parametrizations, our aggressive inflation-targeting rule performs nearly as well as the optimal policy based on these extraordinary information assumptions. It appears otherwise in Cecchetti et al. (2000) because they report the loss under our rule divided by the loss under their optimal rule, where the latter is a number close to zero. However, by any reasonable metric, the *absolute* difference in losses is very small.

even if the central bank is certain that a bubble is driving the market, once policy performance is averaged over all possible realizations of the bubble process, by any reasonable metric there is no consequential advantage of responding to stock prices. Moreover, a too-aggressive response to stock prices can create significant harm in that scenario.[3] Batini and Nelson (2000) find an analogous result for bubbles in the real exchange rate.

A deficiency of the literature to date is that the nonfundamental component of stock prices has generally been treated as exogenous. Our own view is that the macroeconomic stability associated with inflation-targeting is likely to reduce the incidence of panic-driven financial distress that could destabilize the economy, but this question is clearly deserving of further research.

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[3] In results not reported here, we find that the harm from targeting stock prices can rise significantly if the nonfundamental component of stock prices affects spending less than does the fundamental component, as seems consistent with the evidence.

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