Why the Fed Should Ignore the Stock Market

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INTRODUCTION

Equity Prices and Monetary Policy Rules

The dramatic movements in equity prices in the United States during the last decade or so have focused considerable attention on stock markets as a barometer of economic well-being. Separately, there has been growing interest in the use of nominal interest rate feedback rules for the conduct of monetary policy since the publication of Taylor (1993).[1] These two developments have led to a debate over whether equity prices possibly belong in a policy rule of the type that Taylor recommended. One way to pose this question is to ask, "Should monetary policymakers using Taylor-type rules include in the rule a reaction to movements in the level of equity prices?"[2] Another way to pose this question is to use the language that a variable included in a reaction function of the policy authority is a "target" variable. Then we can ask, somewhat more provocatively, "Should monetary policymakers target the level of equity prices?"[3]

As an empirical matter, Rigobon and Sack (2001) report that the Federal Reserve does in fact react to changes in stock market valuations when adjusting its instrument, the intended nominal federal funds rate. The main finding of Rigobon and Sack is that an increase of 5 percent in the value of the Standard & Poor's 500 stock index raises the probability of a 25-basis-point increase in the intended federal funds rate by about one half. Their findings are symmetric with respect to a decrease in the level of equity prices. According to these results, then, if the probability of a decision to raise the intended federal funds rate by 25 basis points had been 20 percent and the S&P 500 unexpectedly increased by 5 percent, the probability of the decision to raise the rate would rise to 70 percent. Thus the Federal Reserve does appear to react to movements in stock market valuations with some vigor.

We study a simple, small dynamic model of the U.S. macroeconomy suggested by Woodford (1999). We follow Rotemberg and Woodford (1998) in examining the consequences of Taylor-type monetary policy rules in this context. The first rule we consider is similar to Taylor's (1993) original rule and does not involve adjusting the nominal interest rate in response to equity price movements. A second rule we consider is exactly like the first, but with an additional term which describes the monetary authority's reaction to stock prices. We are interested in ascertaining, in some generality, how the economy would perform under the second rule as opposed to how it would perform under the first rule.

Main Results

Our main finding is that adding equity prices to the policymaker's Taylor-type rule and leaving all else constant, in general, will not improve economic performance and might possibly do considerable harm, relative to a policy of simply ignoring fluctuations in equity prices altogether. We also find that if policymakers place substantial weight on the asset price component of their policy rule, leaving all else constant, they will encounter indeterminacy of rational expectations equilibrium. Actual macroeconomic outcomes would then be unpredictable because of the multiplicity of equilibria. Finally, we note that an alternative interpretation of our findings suggests a certain *irrelevance* of whether equity prices are included in the policy rule.[4]

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[1] For an introduction to Taylor-type monetary policy rules, see Taylor (1999).

[2] Taylor rules are normally viewed as applying to questions of business cycle fluctuations and the associated stabilization policy. In the event of a financial crisis, the Fed does watch equity price developments closely and has at times provided substantial liquidity to markets. We do not consider financial crises in this paper.

[3] Svensson (2002) argues for the language that "target" variables are those that appear in loss functions and not necessarily those in reaction functions. We have no quarrel with this in general. In this paper, however, we discuss issues that are prior to the specification of a loss function for the monetary authority. In addition, our results may be easily interpreted if we think of the authorities who include equity prices in the policy rule as "targeting" the level of equity prices.

[4] We will show that, in this model, an increase in the weight policymakers place on equity prices in the policy rule could be accompanied by increases in the weights placed on inflation deviations and the output gap, such that ultimately the policy rule is unchanged.

The intuition behind our main finding is compelling and may be quite general. In models like the one we study, policymakers are using their influence over an asset return—a short-term nominal interest rate—in order to try to minimize inflation and output variability. Financial markets in the model are closely linked by arbitrage relationships. By including additional asset prices—equity prices—in the policy rule, policymakers are in effect saying that they will use their influence over one asset price to help control or "target" other asset prices. But, due to arbitrage in financial markets, any movements in short-term nominal interest rates actually *add* to the volatility of these other asset prices, even as they may be necessary to stabilize inflation and output. Thus, while the inflation and output components of the Taylor-type policy rule call for the policy authority to move the short-term nominal interest rate around in response to events, this actually *conflicts* with the effect of the equity price component of the policy rule, which calls for the policy authority to keep the short-term nominal interest rate relatively constant. In the limiting case where all the weight in the policy rule is on the equity price component, the policy rule we derive calls for an interest rate peg—that is, no movement in short-term nominal interest rates whatsoever! An interest-rate-peg policy produces indeterminacy of rational expectations equilibrium in the model we analyze here and is known to produce indeterminacy in a host of closely related models. Viewed from this perspective, it does not appear that including equity prices in a monetary policy rule is to be recommended.

Recent Related Literature

Bernanke and Gertler (1999, 2001) use a model with a financial market friction that produces a "financial accelerator," a mechanism that magnifies the effects of exogenous shocks. They calibrate their model, including a stochastic process for exogenous "nonfundamental" shocks to equity returns, and use the results of simulations to argue that there is little or no gain from including equity prices in the Taylor-type policy rule of the monetary authority. Bernanke and Gertler (1999, 2001) take the position that reactions to equity price movements are warranted only to the extent that they contain information concerning expected inflation.

Cecchetti et al. (2000) use a methodology similar to Bernanke and Gertler (1999, 2001), and, in fact, at times simulate the same model as Bernanke and Gertler. But Cecchetti et al. (2000) conclude that central banks could derive some benefit from including significant reactions to asset price movements when making monetary policy. Bernanke and Gertler (2001, p. 257) comment on the divergent findings, saying that while the models used are much the same, the nature of the shock process for nonfundamental stock prices is significantly different. In effect, Cecchetti et al. (2000) assume that the policymaker knows with certainty that observed stock price movements are not fundamental in nature and, importantly, when the exogenous bubble is going to burst. With this knowledge in hand, the policymaker can improve economic performance by reacting to stock price movements. Bernanke and Gertler (2001) suggest that these conditions are unlikely to be met in actual economies.

The present paper differs from the Bernanke and Gertler (1999, 2001) line of research in several ways. While the model we use here is essentially very similar, we abstract from any credit market frictions inducing "financial accelerator" effects and concentrate instead on what standard models have to say about asset market arbitrage relationships. We are able to isolate some analytic conditions that we think are quite revealing about the nature of policy regimes which include reactions to equity prices. Our results are not dependent on a particular calibration of the economy we study. And our results do not depend on the idea that there are movements in asset prices which are of unknown origin from the perspective of the model.

Goodhart (2000) suggests that better monetary policy performance might result if policymakers used broader measures of inflation that include a more explicit account of the prices of assets such as housing and equities. Goodhart's (2000) logic is based on work by Alchian and Klein (1973). In a survey of this issue, Filardo (2000) finds that U.S. economic performance would probably not be enhanced by a switch to such inflation measures.

Bordo and Jeanne (2001) employ a simple dynamic model somewhat different from the one used in this paper. Their model includes collateral constraints. If the economy has an uncertain trend rate of growth, then the value of the assets in the model will fall sharply in value once news arrives that a lower trend rate of growth is likely. This event then has further effects in financial markets because the value of the economy's collateral has been diminished. In the present paper, we abstract from collateral constraints.

Whether the Federal Reserve should respond aggressively to movements in equity prices has also been debated less formally. The current conventional wisdom in the United States, as reflected in a great deal of financial market commentary, seems to be that movements in stock prices "provide information" on the state of the economy that is not otherwise available, so that the central bank properly reacts to equity price movements by adjusting its short-term nominal interest rate target. In this connection there has been considerable discussion of a wealth effect on consumption of higher levels of stock prices. However, there is an older, currently less popular, conventional wisdom that asserts that central banks would be "looking in the mirror" if they attempted to react to equity price movements. This view emphasizes asset market linkages and stresses that stock market investors do not have any private information that is not available to the central bank. Our results can be viewed as a formalization of this older conventional wisdom.

ENVIRONMENT

Aggregate Relationships

Rotemberg and Woodford (1999) analyze an economy characterized by a continuum of households maximizing utility over an infinite horizon, in which utility is defined over consumption and the disutility of production. Each household produces a single differentiated good, but consumes a Dixit-Stiglitz aggregate of all goods produced in the economy. Output is sold at a utility-maximizing price under the "sticky price" constraint that only a fraction of the goods prices may be changed in any given period and that other prices must be left at their previous period values. The solution of the households' problem, suitably linearized and simplified as in Woodford (1999), dictates equations (1) and (3) below which describe how output and inflation evolve in this economy. The first equation is given by

$$z_t^d = E_t z_{t+1}^d - \sigma^{-1}\left[r_t^d - E_t \pi_{t+1}^d\right] + \sigma^{-1} r_t^n, \tag{1}$$

where π_t^d is the deviation of the inflation rate from a target value π^*, z_t^d is the output gap at t, r_t^d is the deviation of the short-term nominal interest rate from a target value r^*, $\sigma > 0$ is a parameter related to the intertemporal elasticity of substitution in the households' problem, and r_t^n is a shock term that follows an AR(1) process

$$r_t^n = \alpha r_{t-1}^n + \omega_t, \tag{2}$$

where $0 < \alpha < 1$ is white noise. Inflation is determined according to

$$\pi_t^d = \kappa z_t^d + \beta E_t \pi_{t+1}^d, \tag{3}$$

where $\kappa > 0$ relates to the degree of price stickiness in the economy and $0 < \beta < 1$ is the common household discount factor.

We close the model with a Taylor-type policy rule:

$$r_t^d = \gamma_\pi \pi_t^d + \gamma_z z_t^d, \tag{4}$$

where $\gamma_\pi > 0$ and $\gamma_z > 0$ are parameters chosen by the monetary authority. This particular policy rule has the nominal interest rate reacting to current-period values of inflation and output deviations and is the most commonly studied rule. We could also comment on our results under many other assumptions about the nature of this rule, such as the case where the policy authority reacts to lagged values of output and inflation deviations. Generally, however, the exact nature of this Taylor-type rule is not crucial for the points we make in this paper, and so we just use equation (4).

We assume rational expectations.

Equity Prices

We wish to understand the consequences of policymakers using a rule of the form of equation (4), but with the percentage deviation of equity prices from a rationally priced benchmark included. To do so, we must first define an equity price consistent with the Rotemberg and Woodford (1999) microfoundations.

In the Rotemberg and Woodford (1998) framework, as in many dynamic stochastic general equilibrium frameworks, arbitrage relationships can be used to price any asset that might be held by households in the model, thanks in part to their assumption that financial markets are complete.[5] This means that a financial claim to a random nominal quantity X_T has value at t of $E_t[\delta_{t,T} X_T]$, where $\delta_{t,T}$ is the stochastic discount factor given by

$$\delta_{t,T} = \frac{\beta u'(C_T)}{u'(C_t)} \tag{5}$$

[5] Also see Rouwenhorst (1995) for a discussion of asset pricing in dynamic stochastic general equilibrium models.

and where $u(C_t)$ is the common period utility function of a household. The gross nominal interest rate on a nominal one-period bond is then given by

$$(6) \qquad R_t = E_t\left[\delta_{t,t+1}\right]^{-1}$$

as in Rotemberg and Woodford (1998, p. 12).

Since the stochastic discount factor prices all assets in this model, let us denote the price of a share of aggregate equity by p_t and note that $p_t = 1/R_t$. Rotemberg and Woodford define the short-term nominal interest rate r_t as $r_t = \ln R_t$. We note that

$$(7) \qquad \ln R_t = \ln 1 - \ln p_t = -\ln p_t \,.$$

We conclude that

$$(8) \qquad r_t = -\ln p_t$$

and that, when the nominal interest rate is at the target value r^*, the price of a share of aggregate equity must be at a corresponding long-run equilibrium level denoted by p^*, with the relationship between the two given by

$$(9) \qquad r^* = -\ln p^* \,.$$

A Policy Rule with Equity Prices

We now assume that policymakers wish to include the percentage deviation of the general level of equity prices from the long-run equilibrium level in their policy reaction function. Thus they wish to adjust nominal interest rates in reaction to

$$(10) \qquad \frac{p_t - p^*}{p^*} \approx \ln p_t - \ln p^* \,.$$

The form of the policy rule we wish to study is therefore

$$(11) \qquad r_t^d = \gamma_\pi \pi_t^d + \gamma_z z_t^d + \gamma_a (\ln p_t - \ln p^*)$$

with $\gamma_a \geq 0$. Importantly, equation (11) can be rewritten as follows:

$$(12) \qquad r_t - r^* = \gamma_\pi \pi_t^d + \gamma_z z_t^d - \gamma_a (r_t - r^*)$$

or

$$(13) \qquad r_t - r^* = \frac{\gamma_\pi}{1+\gamma_a}\left(\pi_t - \pi^*\right) + \frac{\gamma_z}{1+\gamma_a}\left(z_t - z^*\right).$$

If we set $\gamma_a = 0$, then the rule collapses to the one described by equation (4). Thus we see that the central bank wishing to target the deviation of the level of equity prices from a long-run equilibrium can be viewed as a central bank that uses an ordinary Taylor-type rule in which the coefficients of the original Taylor rule have been reduced by a factor of $1 + \gamma_a$

Of course in deriving the modified policy rule equation (13), we have relied heavily on the arbitrage relationships that are assumed to exist in this model and that drive asset pricing in many models of this type. We think this is a logical first step in trying to understand the implications of equity price movements for monetary policy.[6]

We now turn to drawing out the implications of this finding for the conduct of monetary policy.

Main Results

The model given by equations (1), (2), (3), and (13) can be viewed as the same one that has been studied by Woodford (1999) and Bullard and Mitra (2002),[7] provided one relates the Bullard and Mitra Taylor rule coefficients φ_π and φ_z to the Taylor rule coefficients in equation (13) via

$$(14) \qquad \varphi_\pi = \frac{\gamma_\pi}{1+\gamma_a}$$

and

$$(15) \qquad \varphi_z = \frac{\gamma_z}{1+\gamma_a} \,.$$

Of course, since γ_a enters equation (13) in such a simple way, it is perhaps easiest to just remember that as the value of γ_a increases, it tends to drive the coefficients on inflation deviations and the output gap to zero in the Taylor rule and otherwise leave the model specification unaffected. We will thus simply import some results from Bullard and Mitra (2002) to discuss and then provide an analysis of the consequences of lower values for their φ_π and φ_z coefficients in that analysis.

One of the first questions we would like to ask about this model is under what conditions a unique rational expectations equilibrium exists. We can write the system as

$$(16) \qquad y_t = \alpha + B y_{t+1}^e + \chi r_t^n \,,$$

[6] It is well known that the class of models we are considering do not explain equity price movements very well; on the other hand, how to adequately explain equity price movements is a particularly vexing open question in financial economics. In addition, it strikes us as unwise to design monetary policy rules that call for the monetary authority to react to the component of equity price movements that is unexplained by current theory.

[7] See their sections on contemporaneous data rules.

where $y_t = [z_t, \pi_t]', \alpha = 0$,

$$(17) \qquad B = \frac{1}{\sigma + \varphi_z + \kappa\varphi_\pi} \begin{bmatrix} \sigma & 1 - \beta\varphi_\pi \\ \kappa\sigma & \kappa + \beta(\sigma + \varphi_z) \end{bmatrix},$$

and where the form of χ is omitted since it is not needed in what follows. Both z_t and π_t are free variables in this system, and as a result both of the eigenvalues of B must be inside the unit circle for a unique, or determinate, rational expectations equilibrium to exist. Otherwise, the equilibrium will be indeterminate. Bullard and Mitra (2002) show that the necessary and sufficient condition for determinacy is[8]

$$(18) \qquad \kappa(\varphi_\pi - 1) + (1 - \beta)\varphi_z > 0 .$$

When condition (18) fails, equilibrium is indeterminate. Bullard and Mitra (2002) also show that when condition (18) is met, the rational expectations equilibrium is learnable in a specific sense.[9]

Using equations (14) and (15) we can rewrite condition (18) as

$$(19) \qquad \kappa\left(\frac{\gamma_\pi}{1+\gamma_a} - 1\right) + (1 - \beta)\frac{\gamma_z}{1+\gamma_a} > 0 .$$

This condition is a statement of the Taylor principle, as discussed by Bullard and Mitra (2002) and by Woodford (2001). Since (i) $0 < \beta < 1$ can be interpreted as the common discount factor of the households in the model and (ii) $\kappa > 0$, we can conclude that, for fixed values of γ_a, determinacy will obtain provided the coefficient γ_π is sufficiently large. In particular, if $\gamma_a = \gamma_z = 0$, then the condition is simply that $\gamma_\pi > 1$. That is, the nominal interest rate must be adjusted more than one-for-one with deviations of inflation from target in order for a determinate rational expectations equilibrium to exist. The consequence of setting a lower value for γ_π is that the rational expectations equilibrium is indeterminate.

Now consider fixed values of γ_π and γ_z and suppose the monetary authority wishes to begin including a reaction to equity price movements in its policy rule by setting $\gamma_a > 0$. Such a policy clearly works against satisfaction of condition (19), in that a large enough value of γ_a—enough emphasis by the monetary authority on reacting to equity price movements—will cause condition (19) to fail and indeterminacy to arise.

Condition (19) also suggests that as $\gamma_a \to \infty$ with all else constant, indeterminacy will occur without question. Thus, as the weight in the policy rule on asset prices gets very large relative to the weight on inflation deviations and the output gap, indeterminacy is ensured. Another look at equation (13) can help the interpretation of this finding. In the situation where $\gamma_a \to \infty$ with all else constant, the monetary authority is following an interest rate peg—there is no reaction to inflation deviations or the output gap at all. The intuition behind this result is very clear. A very large value of γ_a means that the policy authority wishes to target the level of asset prices much more than it wishes to stabilize inflation and output. The way to keep asset prices relatively constant, given arbitrage relationships, is to keep the short-term interest rate relatively constant. A very large value of γ_a inducing an interest rate peg is just the extreme form of this logic.

There is another, perhaps brighter, interpretation of these results. Typically, parameters such as κ and β have been regarded as part of the preferences and technology underlying the economy, and thus beyond the scope of influence of the monetary authority. The parameters γ_π, γ_z, and γ_a, however, can be set by the central bank. So long as these parameters are chosen to satisfy condition (19), the economy will possess a determinate rational expectations equilibrium. There are obviously many combinations of these parameters that will satisfy this condition. Among these possibilities, some will induce better economic performance than others, according to any criterion that the monetary authority might wish to adopt. Rotemberg and Woodford (1999) discuss in great detail optimal policy rules in this class of simple linear Taylor rules for this model, based on a variety of possible criteria, including the utility of a representative household.

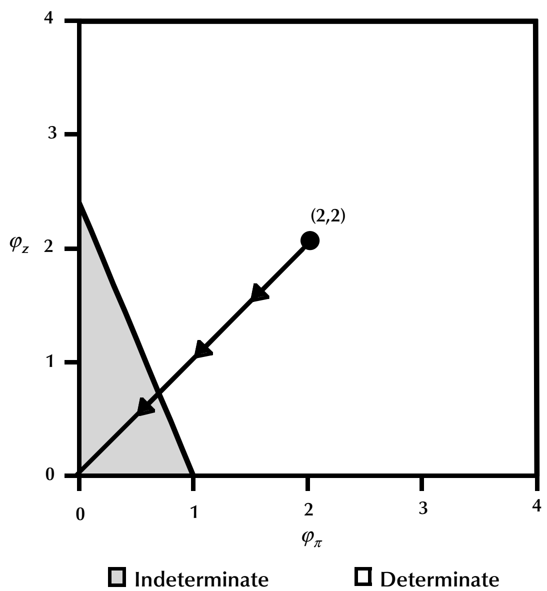
But now consider equation (13) in the context of optimal policy. The monetary authority actually needs to choose only two coefficients, the one on inflation deviations and the one on the output gap, even though they have three parameters, namely γ_π, γ_z, and γ_a, with which to adjust these coefficients. Thus any given value of γ_a *could* be associated with the *optimal* policy in this class of policy rules, provided the policy authority is willing to set γ_π and γ_z appropriately to achieve the optimal coefficients on inflation deviations and the output gap. Thus if we ask, "Could the optimal monetary policy involve an explicit reaction to the level of asset prices in this economy?" the answer is actually, "Yes, it could."

8 Provided $\kappa(\varphi_\pi - 1) + (1 - \beta)\varphi_z \neq 0$.

9 See Bullard and Mitra (2002) for details.

Figure 1

The Effects of Including Equity Prices in a Taylor Rule



NOTE: As the weight placed on $\gamma_a \rightarrow \infty$, any given policy rule shrinks toward the origin in the diagram, which is associated with an interest rate peg. This region is also associated with indeterminacy.

We conclude that it is not quite valid to think that a central bank that is reacting strongly to equity price movements is necessarily following the wrong policy.

However, we think the spirit of the discussion concerning equity prices and monetary policy rules has been one where the responses to inflation deviations and the output gap (i.e., γ_π and γ_z) are considered fixed, and the question is whether any policy improvements could be made by adding a response to equity price movements. Thus it is probably better to think of setting values of γ_a while leaving values of γ_π and γ_z constant. If γ_π and γ_z were already set to optimal values with $\gamma_a = 0$, then moving $\gamma_a = 0$ to a positive value is only going to degrade economic performance. And a large enough value of γ_a could do real damage by creating indeterminacy.

Figure 1 shows a schematic diagram considering condition (19) in conjunction with values of $\gamma_a \geq 0$, using calibrated values of parameters other than φ_π and φ_z from Woodford (1999). We can think of a particular policy rule as a point in Figure 1, such as $(\varphi_\pi, \varphi_z) = (2,2)$. These values would induce a determinate rational expectations equilibrium. Now let's suppose the policy authority begins to increase γ_a, leaving all else constant. As we have seen, this reduces the values of φ_π and φ_z toward zero at an equal rate. For large enough values, this would send the economy into the indeterminate region.

CONCLUSION

We have provided a simple analysis of the consequences of including the general level of equity prices in a Taylor-type policy rule. Our analysis differs from most of this literature in that we have emphasized the general equilibrium nature of models in this class and the arbitrage relationships that underpin their microfoundations. Under our preferred interpretation, we find that including equity prices in a Taylor-type policy rule will degrade economic performance and can do real damage by creating indeterminacy of rational expectations equilibrium where such indeterminacy did not otherwise exist. A more benign interpretation suggests that including equity prices in the policy authority's reaction function is essentially irrelevant to achieving optimal monetary policy within this class of rules. These findings are certainly stark, but we think that forces of the type we describe are at work even in more elaborate general equilibrium economies.

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