Public Policy
Discussion Papers
Federal Reserve Bank of Boston

No. 04-2

Eyes on the Prize:
How *Did* the Fed Respond to the Stock Market?

Jeff Fuhrer and Geoff Tootell

Abstract:
The appropriate role for equity prices in monetary policy deliberations has been hotly debated for some time. Recent work suggests that equity prices have affected monetary policy decisions above and beyond their indirect effect on the traditional goal variables of the FOMC. However, the correlation between stock price movements and these other goal variables has made the identification of the equity price effect problematic. Previous studies have used a forecast that embodies a different information set from the one used by the FOMC, which could bias the estimated coefficient on equity prices. The authors show that, in fact, the methods used in the earlier literature fail to adequately disentangle the observational equivalence problem. The authors then show that after controlling for the information that actually enters the FOMC's decision-making process, equity prices have had no independent effect on monetary policy.

Keywords: monetary policy, policy rules, asset prices
JEL Classification: E52, E61

Jeff Fuhrer is Senior Vice President and Director of Research, and Geoff Tootell is Vice President and Economist at the Federal Reserve Bank of Boston. Their e-mail addresses are <jeff.fuhrer@bos.frb.org> and <geoffrey.tootell@bos.frb.org >, respectively.

This paper, which may be revised, is available on the web site of the Federal Reserve Bank of Boston at http://www.bos.frb.org/economic/ppdp/index.htm.

This version: June 4, 2004

At least since Chairman Greenspan's controversial remark about "irrational exuberance" in the fall of 1996, the appropriate role for equity prices in monetary policy deliberations has been hotly debated. This paper will address one aspect of that debate: What *has* been the response of the Federal Open Market Committee (FOMC) to movements in broad equity price indexes?

This may seem a mundane question, but in fact the identification of the Fed's response is not as straightforward as it might seem. In particular, we attempt to identify the extent to which the federal funds rate responds to movements in equity price indexes, once one takes into account the role of these indexes in forecasting "goal" variables for monetary policy. In order to plausibly make this identification, we need to be careful about what forecast we assume the FOMC employs, about what information is available at the time of the forecast, and about how efficiently the forecasts use information that may be contained in the equity price indexes.

As we show below, simple Taylor-rule[1] regressions that use *ex post* data and attempt to identify the influence of equity prices on monetary policy may be misleading. For these regressions, we follow the literature in specifying rules that proxy forecasts of target variables with current or future actual values of the targets. But in estimates of such rules, a finding that equity prices enter significantly need not indicate that the FOMC is directly targeting equity prices. If one uses a forecast or forecast proxy that embodies a different information set from the one used in the FOMC's forecast, then the equity price may enter significantly to the extent that it is correlated with the omitted or extraneous information in the forecast. In this case, one would falsely draw an inference that the FOMC responded to equity prices. The use of *ex post* datasets presents a similar problem, as *ex post* data incorporate more information than was available to the FOMC

[1] The Taylor rule was summarized by Janet Yellen, then a Federal Reserve Governor, in remarks at the January Federal Open Market Committee meeting as "a reaction function in which the real (federal) funds rate changes by roughly equal amounts in response to deviations of inflation from a target of 2 percent and to deviations of actual from potential output." The original reference is Taylor (1993). A good, nontechnical, and short summary can be found on the web site of the Federal Reserve Bank of Cleveland at http://www.clevelandfed.org/Research/Com2003/0703.pdf.

at the time of its decisions. In this case, too, simple Taylor-rule regressions could lead to incorrect inference about the role of equity prices in setting the federal funds rate.

Of course, this approach implies that there *is* a less controversial role for equity prices in the conduct of monetary policy. To the extent that equity prices provide information about the current and future course of monetary policy goal variables—inflation, employment, and output—the monetary authority *should* respond to equity prices. But in this case, the response should always be filtered through the forecast of these goal variables.

A more controversial role for equity prices in the monetary policy process concerns whether the FOMC should or should not take a direct interest in the stock market, independent from its influence on the FOMC's traditionally accepted goal variables. This issue is discussed in the literature pioneered by Bernanke and Gertler (1999) and Cecchetti *et al.* (2000). While this issue is important and unresolved, this paper does not take a stand on whether it would be appropriate for the Federal Reserve to respond directly to asset prices. Instead, we attempt to determine what the FOMC did.

It is our view that a good deal of recent discussion about the FOMC's response to equity prices arises from informal analyses of publicly available information about FOMC deliberations, primarily in popular press accounts. Prior to the widespread decline of stock indexes in early to mid 2000, many newspaper stories focused on comments by FOMC members that the newspapers construed as indicating either (a) that the FOMC wanted the stock market to regain its senses and move towards a more appropriate valuation; or (b) that the FOMC was attempting to prop up the stock market. This latter (inferred) behavior came to be referred to in some articles as the "Greenspan put," suggesting that the FOMC would not allow the stock market to fall below a certain level. More recently, the Fed has come under criticism for the mirror image of the previous critiques, that is, either for not popping the bubble earlier, or for allowing the bubble to pop and deflate as rapidly as it did.

Sample quotations from these articles include the following:

> "Today, some analysts and investors believe Greenspan and his Fed colleagues are so concerned about the highflying market that they want to raise interest rates to deflate the bubble. Other analysts conclude the opposite..." (*Washington Post*, August 17, 1999).
>
> "In a February survey conducted by the National Association of Business Economists, 48% of analysts polled said they believed the Fed 'has effectively given the stock market an implicit guarantee…that if the stock market were to crash, it would ease to cushion the blow.'" (*Wall Street Journal*, May 5, 2000)
>
> "Fed officials universally have gone to considerable lengths to tell investors that they are not in the business of supporting the prices of assets, including stocks and bonds." (*Washington Post*, March 20, 2001).
>
> "Since the spring, when the overall stock market began its decline to a five-year low, some analysts have concluded that Fed policy makers will cut rates if the stock market keeps plunging." (*New York Times*, September 27, 2002).

But the inferences drawn about the Fed's response to equity prices likely suffer from an identification or "observational equivalence" problem.[2] As Figure 1 suggests, there have been times in recent history when the federal funds rate has risen or fallen at approximately the same time as significant changes in broad equity price indexes. But of course, to the extent that equity prices are rising because the economy is unusually strong (or expected to be strong), an inflation-minded central bank would be expected to increase the federal funds rate. Alternatively, to the extent that there is feedback between equity price movements and household or business spending, the central bank might wisely take these linkages into account and adjust the federal funds rate accordingly. In either case, the simple correlation between the funds rate and equity prices that is evidenced in Figure 1 cannot answer the question of whether the central bank has an independent concern for the level or rate of change in equity prices.

[2] This constitutes a loose use of the term. From a naïve perspective that puts little or no structure on the data, one cannot distinguish direct responses to equity prices from indirect responses to the effects of equity prices on monetary policy goal variables. In this sense, the identification problem is one of observational equivalence. By imposing more structure on the data, as we do below, one can break this observational equivalence and separately identify these two effects.

In Section I below, we control for the well-established response of the funds rate to economic conditions in an attempt to partly disentangle this observational equivalence problem. Although the methods used in this section are common in the literature, we will suggest that they still fail to adequately disentangle the observational equivalence problem. The second section uses more direct measures of the information that enters the FOMC's decisions than are traditionally found in the literature. A final section concludes.

I. Simple Empirical Evidence

This section examines some simple empirical evidence bearing on the link from equity price indexes to the federal funds rate. The regression evidence presented in this section is intended to document the correlations across key subsamples between movements in the funds rate and movements in stock prices, controlling for some other variables that have been shown to influence the setting of the federal funds rate (see, for example, Luckett and Potts, 1978; Abrams, Froyen, and Waud, 1980; McNees, 1986; and Hakes, 1990).

The regressions take the form of Taylor policy rules, augmented to allow partial-adjustment or "interest rate smoothing," or more simply the inclusion of a lagged dependent variable, as discussed in Clarida, Gali, and Gertler (1998). We begin with the simplest such regression, in which the funds rate responds to contemporaneous observations on a "gap" measure, a four-quarter moving average of an inflation measure, the growth rate of real GDP, and lags of a variety of stock price measures. We choose this specification to begin with because it represents a simple augmentation of the canonical Taylor rule, without the need to worry about the potential simultaneity between the current funds rate and current stock prices.

Table 1 presents OLS estimates of the simple rule

$$f_t = a + bf_{t-1} + cGap_t + d\Delta y_t + z\bar{\pi}_t + eS_{t-i} \qquad (1)$$

in which *f* denotes the quarterly average of the daily observations on the federal funds rate, *Gap* is either the unemployment rate or a Hodrick-Prescott detrended real GDP gap[3], Δy is the quarterly percentage change in real GDP, and $\bar{\pi}$ is the four-quarter moving average of the rate of inflation in the GDP chain-weight price index, the PCE chain-weight price index, or the consumer price index. *S* denotes the level or the percentage change in a stock price index, lagged as indicated in the table.[4] We do not include contemporaneous equity price terms in these regressions, as the possibility of simultaneity is significant (see Rigobon and Sack, 2003). The VAR literature that argues for a recursive identification scheme for the monetary policy rule (see Christiano, Eichenbaum, and Evans, 1999) relies on the reasonable assumption that prices and output do not respond within a quarter to changes in the federal funds rate. This logic is unlikely to apply for equity prices, as they have no doubt responded within minutes to perceived and announced changes in the setting of the federal funds rate. We turn our attention to the problem of simultaneity below.

We split the sample at 1987:Q3, the quarter in which Alan Greenspan began his chairmanship. Some equity price series are not available prior to 1980, and hence we do not estimate Taylor rules for the early sample for these measures. The sample begins in 1966, as prior to this time the federal funds rate often traded below the discount rate and hence was not the effective policy rate.

Table 1 suggests that, for some combinations of gap measures, sample periods, and inflation measures, lagged equity prices are indeed significantly correlated with the

[3] Hodrick and Prescott (1997) developed a model to separate trend from cyclic movements of various macroeconomic time-series data.

[4] We prefer the change specification, as the other variables in the regression should be stationary, whereas the stock price indexes are not. One could argue that the funds rate has a unit root, based on the time-series evidence, but on theoretical grounds, we would argue that the funds rate should be stationary. Taking a standard Fisher decomposition of the nominal rate, the funds rate will have a unit root only if the inflation rate or the real rate has a unit root. In most current models of monetary policy, the inflation rate will have a unit root only if the monetary authority responds insufficiently aggressively to inflation. It is unlikely that the real rate of interest contains a literal unit root.

federal funds rate, after controlling for the variation in inflation and real variables. In a good number of cases, equity prices enter with 5 percent significance or better. The evidence seems to suggest that equity prices are more often significant in the latter part of the sample.

Figure 2 puts the contribution of equity prices into perspective. The figure depicts the fit from an estimated policy rule—in this case, the Greenspan era equation using the CPI inflation measure, the unemployment rate as the gap measure, and the change in the S&P 500 stock index, lags one to four—with (the red line) and without (the black line) the stock price information incorporated. As Table 1 indicates, stock prices enter this specification with a *p*-value of 0.0024. But the variation in the funds rate that is explained by equity prices and *not* by the unemployment rate, inflation, or GDP growth, is barely visible in the chart—the two fitted value series lie nearly on top of each other.[5] These simple results suggest that, even to the extent that we find statistically significant reduced-form evidence of a link from equity prices to the funds rate, the economic significance of any such link is small.

Still, to the extent that lagged equity prices enter significantly in Table 1, they may do so because equity prices (1) truly have a direct influence on the federal funds rate, or (2) act as instruments that are useful in forecasting future observations of the gap or inflation, which the Fed may, in turn, respond to. In order to discriminate between these two explanations, we use an instrumental variables test regression.

The test regression includes lags of the equity price measures, but also allows the possibility of a more forward-looking Taylor rule, along the lines of Clarida, Gali, and Gertler (1998). We allow *i* to take the value 0, 1, or the moving average of i = 0, …, 3:

$$f_t = a + bf_{t-1} + cGap_{t+i} + d\Delta y_{t+i} + z\pi_{t+i} + \sum_k e_k S_{t-k} \qquad (2)$$

[5] The picture looks identical when the analysis is in changes rather than levels; stock prices have little effect on even the change in interest rates.

The insight to be gained from this regression is that, if stock prices appear significant in Table 1 only because they act as instruments for forward-looking variables to which the federal funds rate responds, then the coefficients e_k on lagged equity price measures should be insignificantly different from zero in this instrumental variable regression. Such a result would be consistent with the hypothesis that the Fed responds to equity prices only insofar as they provide useful information for forecasting variables that appear in the Fed's loss function. Thus, we include lags of the funds rate, the gap measure, inflation, and the equity price index as instruments.

Table 2 presents the results from standard GMM (generalized method of moments) estimates of the regression. The right-hand columns report the *p*-value for the likelihood ratio test of the hypothesis that all the e_k are jointly zero.[6] In about 30 percent of the regressions, one can reject the hypothesis that the lagged equity prices enter only as instruments for future output and inflation and not as independent regressors. Equity prices enter significantly more often when the funds rate is posited to respond to future gap and inflation variables. Note that Hansen's *J*-test[7]—a chi-square test to determine whether moment conditions over-identify the parameters to be estimated—never indicates rejection of the over-identifying restrictions, and hence it is not reported in the table.

Table 2a examines a subset of these regressions using an alternative instrument set. We focus on the policy rules with right-hand-side variables dated *t+1,* as this specification generates the most rejections in Table 2. The alternative instrument set comprises variables that plausibly have a greater claim to exogeneity than the lagged endogenous variables used in Table 2. The instruments for this table include three quarterly lags of the logged change in real federal defense spending, lags of the logged change in oil prices, and a dummy for the political party of the sitting President. We develop no rejections of the null in this table. That is, in no case can we reject the

[6] The test is *T* times the difference between the Hansen *J*-statistics for the constrained and unconstrained regressions, distributed as χ^2 with degrees of freedom equal to the number of restricted coefficients, where T refers to the sample size.

[7] See Hansen and Singleton (1982).

hypothesis that stock prices movements are irrelevant to the FOMC's setting of the federal funds rate. We also develop no rejections at the 10 percent level or lower for the *J*-test of the correlation between the instruments and the estimated regression error.

What do we conclude from these results? As a reduced-form, statistical matter, equity prices are sometimes correlated with federal funds rate movements, even after controlling for other variables that have been shown to influence the funds rate. In addition, in many cases equity prices are also found to play a role, according to a simple identification test that assumes that the funds rate responds to expected future values of output and inflation but distinguishes the effect of equity prices as predictors of future output and inflation versus independent explanatory variables. The combined evidence in Tables 1, 2, and 2a is not overwhelming, but it suggests that a more careful analysis of policy actions is required.

Because the use of instrumented future values of a few key variables may be a very poor proxy for the forecasts prepared for the FOMC, and because the data used in these tables are *ex post*, the estimated policy rules and their implications for the efficient use of equity price information must be taken with a large grain of salt (see, for example, the arguments in Orphanides 2001 and Croushore and Stark 2002). The next section turns to a more careful identification of the forecasts and information available to the FOMC in setting the target federal funds rate.

II. Equity Prices and Federal Reserve Board Staff Forecasts

The first two tables provide some evidence that the FOMC responded directly to stock price indexes, rather than simply using them as an input into its forecast of the economy. This conclusion depends critically, however, on the validity of the forecast used in the estimated policy rule. As suggested above, estimates using poor proxies for the forecast could omit (include) information that was (was not) used in the policy decision, which could in turn be correlated with stock prices. For several reasons, the regressors in the policy rules in the previous section, though widespread in the

literature, may differ substantially from the forecasts actually considered by the FOMC. First, these regressors use *ex post* data, which in some cases the FOMC did not have access to at the time the decision was made. Second, the implicit forecasting model used in Table 2—a linear projection of unemployment or inflation on a limited set of instruments—is far more restrictive than the model employed by either the Board staff or FOMC members.

Both these problems can be avoided by using the actual forecasts the FOMC had in hand when making the policy decision. Since the late 1960s, staff at the Federal Reserve Board have prepared a detailed outlook for the economy in preparation for each FOMC meeting. This "Greenbook" forecast includes real GDP and its components, as well as the unemployment rate, employment growth, and various measures of inflation.[8] This forecast is certainly "real-time," as staff could only use information available before the meeting to produce their outlook. Not coincidentally, the outlook usually extends four to eight quarters ahead since the horizon relevant for monetary policy is unclear, in theory and in practice. As a result, the policy rules estimated in this paper include variations of the one-, two-, three-, and four-quarter-ahead forecasts.[9] There are several reasons to believe that the staff forecasts are excellent proxies for the expectations of the FOMC. Considerable time is allotted at each FOMC meeting to present the Board staff's outlook to the committee. Furthermore, the Federal Reserve Board devotes significant resources to producing accurate forecasts, and there is evidence that it has succeeded. Romer and Romer (2000) show that the Greenbook outlook for inflation dominates private-sector inflation forecasts. In addition, and of equal importance to this paper, the Board's econometric model (FRB/US) makes explicit a detailed process by which changes in wealth affect the economy, a mechanism that is no doubt reflected in the

[8] The forecasts are bound in a green cover, hence their name. Though each member's forecast may differ somewhat from the Greenbook outlook, the staff forecast is a good proxy for the expectations of the group.

[9] The early Greenbooks tended to have a short forecast horizon. As a result, a four-quarter horizon is chosen to minimize the loss of observations.

staff's forecasts. For these reasons, we examine the response of Fed policy to equity prices using these Greenbook forecasts as controls.

The frequency of the analysis also changes in this section since Greenbook forecasts and ensuing policy decisions are made at every FOMC meeting (more often than quarterly).[10] As a result, we use the funds rate in the week after the FOMC meeting as the period *t* measure of the policy instrument and the funds rate in the week prior to the FOMC meeting as the period *t-1* measure. This procedure insures that all of the data in this section—forecasts, funds rate, and equity prices—were available to the policy makers at the time of their decision. The sample remains 1965 to 2002.

As mentioned earlier, the FOMC might react to equity valuations for a variety of reasons. First, changes in equity prices alter consumer wealth and the cost of capital, both of which should affect the economic outlook and, thus, policy. On the other hand, equity prices might themselves be a target variable. In this second case, the Fed might care about the stability of the asset market or simply feel an obligation to support current prices. Those who believe in counter-cyclical monetary policy would agree that the FOMC should react for the first reason. There would probably be less support for the FOMC independently supporting asset values, which might help explain the recent criticism of the Fed over this issue. In reality, the Fed might adjust policy for both reasons, raising the concern not that monetary policy reacts to movements in equity prices, but that it overreacts to these movements.

To test whether the FOMC overreacts to equity prices involves up to three steps, as outlined in Figure 3. We must first determine whether the Greenbook forecasts efficiently incorporate the information in stock prices. If the Greenbook efficiently incorporates equity price information, as in the left branch of the decision tree in Figure 3, then the appearance of significant equity price coefficients in an FOMC-frequency policy rule that controls for the response to the efficient Greenbook forecast would indicate a policy response to equity prices independent of their effects on the other goal

[10] The FOMC met roughly monthly before 1980 and has convened eight times a year since.

variables.

If, on the other hand, the forecasts do not use equity price information efficiently, as in the right branch of Figure 3, then the testing becomes somewhat more complicated. Two possibilities arise. The first case is when the policy rule test detects no response to equity prices, implying that the FOMC *could* have used equity price information to improve its forecast, but did not. If the FOMC failed to do so out of ignorance, then the forecasts should simply be improved. In this case, the FOMC would be underreacting to equity price changes, not overreacting, as hypothesized by the "Greenspan put." If the FOMC knew the forecast was overreacting to changes in stock values and still reacted normally to the forecast, then the asset values would, incorrectly, appear to have no independent role in the policy decision. The alternative case is when estimation of the policy rule uncovers a significant response to equity prices. Under these circumstances, it must be determined whether this response arises only because the FOMC is using the equity price information to correct the inefficiency in the Greenbook forecast or whether the committee is also responding to equity prices in their own right.

To distinguish between these latter two cases, we "correct" the Greenbook forecast, using the results from the efficiency tests so that the outlook efficiently incorporates equity price information. We then re-run the policy rule regression as before, but with the efficient, adjusted, Greenbook forecast substituted for the original. If equity prices remain significant in this regression, then this constitutes evidence of a response to equity prices independent of any value in forecasting monetary policy goal variables. If equity prices are no longer significant, then the presence of equity prices in the original policy rule regression simply reflected the fact that the FOMC apparently used equity prices to make the Greenbook forecast efficient. It should now be clear that simply injecting the Greenbook forecasts into the estimation in Table 1 and finding a coefficient of zero on stock price changes is not sufficient to establish that the FOMC did not overreact to changes in equity prices.

Stage 1: Tests of Efficiency

We begin by examining the efficiency of the Greenbook forecasts of inflation, real GDP growth, and the unemployment rate, since these are the variables used in the estimated Taylor rule. A standard efficiency test,

$$X_{t+i} = \alpha_1 + \alpha_2 E_t X_{t+i} + \sum_{n=1}^{4} \beta_n S_{t-n} + \varepsilon_t \quad \text{for X=GDP, Inflation, and Unemployment Rate} \tag{3}$$

is used in this paper. Ordinary least squares estimation of Equation 3 provides a simple test of whether lagged equity price changes, S_{t-n}, add any information above and beyond the Greenbook forecasts, $E_t X_{t+i}$, for X_{t+i}. If the Greenbook forecasts of these variables efficiently incorporate the stock market information, then the coefficients on the lagged stock market variable, β_n, will be insignificant. If the forecast overreacts (underreacts) to the information, the coefficients will be negative (positive) for the GDP and inflation equations and positive (negative) for the unemployment rate equation. For example, if realized GDP growth tends to be above forecasted GDP growth following strong growth in equity prices, the forecast is underreacting and the sum of β_n will be greater than zero.

Table 3 presents the sum of the coefficients and the *p*-values for all β_n=0 for the one-, two-, three-, and four-quarter-ahead forecasts of GDP growth, inflation, and the unemployment rate. Each horizon is examined separately; thus, the four-quarter-ahead forecast is the forecast of the variable for the quarter four quarters hence, not the forecast of that variable for the year as a whole. Examining quarters individually, rather than cumulatively, reveals whether the inefficiency is an artifact of a particular quarter horizon or something more systematic. For the full sample, 1965 to 2003, the Greenbook forecast usually fails to incorporate information from equity price movements efficiently. Using either one or four lags of stock prices, the estimated signs of the coefficients in the unemployment rate and GDP growth rate regressions indicate that the Greenbook forecasts underestimate the effect of stock price changes on these two variables. Thus, the forecast actually underreacts to the stock price information. On the

other hand, the Greenbook forecast of inflation does tend to overreact to changes in equity prices. Both results leave room for a role of stock prices in an estimated Taylor rule independent of the Greenbook forecasts.

But before we turn to how policy reacted to stock prices and these forecasts, the stability of the finding of inefficiency must be checked. Certainly, in the early part of the sample fewer resources were devoted to the formation of the outlook. On the other hand, the debate has heated up since Greenspan became chairman. As a result, the sample is divided into pre- and post-Greenspan periods—not quite cutting the sample in half, but coming reasonably close. The results of the efficiency tests for these two subsamples are presented in the bottom two panels of Table 3. During the earlier part of the sample, the forecasts appear to incorporate the information from equity markets inefficiently, just as in the full sample. However, there is little evidence that the forecast is doing so inefficiently in the Greenspan years. Only four lags of stock prices appear to add to the first three quarters of the GDP forecast horizon. For those three horizons, the Greenbook forecast seems to significantly underreact to long lags of equity price changes. There is little evidence that during the Greenspan era lagged stock price changes have provided any information above that contained in the Greenbook forecasts for the unemployment or inflation rates. Furthermore, the hypothesis of stable coefficients across these two subsamples is strongly rejected. Most of the results in the 1965 to 2002 period appear to originate from the early part of the sample.

Complications Arising from the Funds Rate Assumption Imbedded in the Forecast

Why does the Greenbook outlook tend to be inefficient? One possible explanation concerns the assumption about monetary policy embedded in the forecast. This assumption can also have important implications for the interpretation of the coefficients in an estimated Taylor rule that uses the Greenbook forecasts as control variables. In some periods, the staff forecast assumed no change in policy because the FOMC believed this would provide more useful input to the policy decision, while at other times the staff conditioned its outlook on its best guess for the path of the policy

rate. With a forecast conditioned on no change in policy, one can easily see the consequences of leaving the federal funds rate at its current setting. And policy conditioning in the forecast contributes to the policy decision only in the sense of providing a convenient reference point. For the inferences we are trying to draw, however, the policy conditioning could be important.

Consider first the implications of the policy assumption for the efficiency tests. Forecasts assuming no change in policy could be inefficient because they are inefficiently using information on the monetary policy reaction. A forecast conditioned on no change in policy should overpredict the actual effect of stock prices on the economy, having precluded the normal policy reaction that would partially mute the economy's response to equity price changes. When the forecast incorporates a "best guess" policy, that source of inefficiency disappears, and the forecasts, in general, become efficient. As a result, a forecast conditioned on no change in policy might help explain the finding of forecast inefficiency.

Next, consider how the monetary policy assumption in the Greenbook forecast might affect the estimated coefficients in a reaction function. The estimate of the coefficient on stock prices could be biased if the Greenbook outlook differs from the one the FOMC actually uses when setting the funds rate. The appendix provides an example of this bias in which the FOMC actually uses the efficient forecast, the one that is conditional on a "best guess" for policy, in deciding on the interest rate, while the Greenbook forecast is conditional on no change in policy. Although the proof of this bias is left to the appendix, the intuition is straightforward. If a shock to stock prices alters the efficient forecast of the target variables, then the FOMC should react according to the best guess of that impact on the target variables. But if the Greenbook forecast assumes no change in rates, then the error term in the reaction function regression will include the forecast error as a result of the inefficient forecast of monetary policy. That forecast error in monetary policy will be correlated with stock price movements as long as such movements affect the variables of interest to the FOMC. In this case, stock prices will incorrectly appear to affect the funds rate above and beyond their effect on the

forecast. Similar reasoning applies if the FOMC actually reacts to the no-change forecast, but the Greenbook provides an outlook that incorporates policy changes. No bias occurs as long as the Greenbook assumption is the forecast to which the FOMC actually reacts.[11]

How bad is this problem for our data and sample? First, note that the policy assumption in the outlook will distort the efficiency tests only if monetary policy can rather quickly and significantly stabilize the economy within the relevant forecast horizon. In reality, monetary policy is likely to have little effect on its goal variables over the modest forecast horizons examined in this paper; the forecasts assuming no change in policy and those incorporating a best guess will differ significantly only at substantial horizons. As a result, the effect of the policy assumption on the coefficient estimates in either the efficiency tests or the estimated policy rules should be relatively small. In fact, the results in the previous section lend little support to the idea that the policy assumption is the cause of forecast inefficiency. Because the inefficiency in the forecasts is found primarily at very short horizons, where monetary policy is unlikely to offset the effects of stock price movements, it seems likely that the monetary policy assumption is not distorting the efficiency test results. We also find that the forecast *under*reacts to information on stock prices, rather than overreacts as would be expected with an assumption of no change in policy. In sum, the lags of monetary policy effects coupled with the direction of the expected bias in the efficiency tests suggest that something other than the policy assumption is responsible for the rejections of forecast efficiency. Furthermore, the fact that the policy assumption has little effect on the outlook over the horizons examined in this paper also reduces any concern about how the assumption may affect the coefficient estimates in a reaction function.

Given that the policy assumption is unlikely to generate rejections of the null of efficiency, interpretation of tests of how policy responds to asset price movements is

[11] And, of course, Board staff do not exist in a vacuum. The choice of the policy conditioning assumption in the forecasts may be determined by the FOMC and thus may be consistent with what they intend to react to. If so, bias will not occur.

relatively straightforward. To examine whether policy reacted to stock prices above and beyond their effect on the economic outlook, we must re-estimate the Taylor rule in the first two tables using the Greenbook forecasts. In doing so, we will also take into account the efficiency results, as discussed above and summarized in Figure 3.

Estimated Taylor Rules using the Greenbook Forecasts

Taylor rules similar to those outlined in Equation 1 are now estimated, using the Greenbook forecasts of the target variables of inflation, output growth, and the unemployment rate. Again, the interpretation of the coefficient for the stock price variable depends on the results from the efficiency tests in the previous section. If the forecasts efficiently incorporate the information from stock prices, a positive coefficient on stock price changes in the estimated Taylor rule would provide evidence that the FOMC overreacted to movements in equity prices. If the Greenbook forecast does not efficiently incorporate the information, and the FOMC has compensated for this, the coefficient on stock prices could be different from zero without implying a policy over-reaction. For example, if the Greenbook forecasts for GDP growth underreact to the information in equity price changes, then the coefficient on equity price changes in an estimated policy rule that includes the Greenbook outlook should be positive.[12]

Table 4 provides the *p*-values for the estimated coefficient on lagged stock price changes for estimated policy rules that use the Greenbook forecasts as control variables. Since the exact functional form of the FOMC's reaction function is unknown, a variety of specifications is examined. For the full sample, across a variety of different specifications, the most recent lag of stock price changes seems to play a role in policy independent of its effect on the Greenbook outlook. The results are roughly similar to those shown in the first two tables. This time, however, the efficiency test results may offer an explanation for their significance and a test for the explanation's validity. Since

[12] This logic strictly holds only if it is *only* the GDP forecast that uses equity price information inefficiently. More generally, the coefficient on equity prices will include a weighted-average adjustment for the inefficiencies in the Greenbook forecasts of all the right-hand-side variables. Most of the inefficiencies presented in Table 3 work in the same direction as the GDP forecast.

the Greenbook forecasts tend to underreact to changes in stock values, the FOMC must react beyond what an efficient forecast would call for. And, in fact, the coefficient on the lag of the equity price variable is positive.

Whether the FOMC incorporates the information optimally will be addressed later in the paper. The coefficient instability found in the efficiency tests requires an examination of the effect of stock prices on policy over different regimes. The Taylor rule is estimated splitting the sample into the Greenspan era and years in the sample prior to Greenspan's tenure. There is marginal evidence that stock prices help to explain changes in the federal funds rate in the early part of the sample. The estimated sign and significance would be expected if the FOMC had been attempting to compensate for the inefficient use of the stock price information when the Greenbook forecast tended to underreact to equity price changes. On the other hand, there is no evidence that stock prices independently affected monetary policy in the Greenspan era, when the evidence suggests that, for the most part, the forecasts used the information on equity prices efficiently. Thus, the appearance of an overreaction of policy in the early part of the sample may simply be due to the underreaction of the Greenbook forecasts to equity price changes in that part of the sample. In the Greenspan era there is little evidence of forecast inefficiency and no evidence of a policy over- or underreaction.[13]

To examine whether the significance of the stock prices in the early part of the sample is an efficient adjustment to the Greenbook forecast, Table 4 is re-estimated using forecasts adjusted for the information content contained in stock prices. These new forecasts are simply the fitted values from the estimated equations in Table 3. To ensure that no information unavailable to the FOMC was used in the adjustment equations, the equations are estimated up to each FOMC meeting. Five years are used to get an initial estimate so the full and pre-Greenspan samples are a bit shorter than in Table 4. The results using the unadjusted forecasts over this slightly shorter sample are presented in

[13] The early sample only shows marginal signs of significance, even though stock prices are significant over the full sample because the stability of the coefficients over the two subsamples is rejected.

the first two columns of Table 5; they are almost identical to the results in Table 4. If the FOMC incorporated efficiently the information contained in the equity price changes, then the coefficient on the lagged change in stock prices would be insignificant once the forecast inefficiency was accounted for. As is shown in Table 5, the coefficient on the lagged change in stock prices using the unadjusted forecasts disappears once the adjusted forecasts are used. Over the Greenspan era, lagged stock prices are always insignificant in both the adjusted and unadjusted equations, indicating that if the forecasts did over- or underreact to changes in equity prices, the FOMC compensated for it.[14]

The basic results are very robust to different concerns the FOMC may have about equity prices. For example, the committee may care only about downward movements in stock prices; it may react asymmetrically to declines in stock values. Allowing for such an asymmetry has no effect on the results. Equity prices never seem to affect monetary policy at a statistically significant threshold, even when the prices are falling. Alternatively, the Fed might be assumed to react to asset prices when they are away from some long-run equilibrium value. The FOMC may want equity prices to fall when the price-to-earnings ratio gets too high and rise when it gets too low. The p-e ratio, either alone or with stock prices, is generally insignificant. The one exception is in the Greenspan era, when the coefficient on the p-e ratio in the estimated Taylor rule is statistically significant. But that coefficient is incorrectly signed—when the p-e ratio is high, the FOMC is more likely to loosen, not tighten. This odd result can be explained by the changing targets of the FOMC at the end of the past decade. The rising estimate of potential GDP growth and the declining estimate of the NAIRU (non-accelerating inflation rate of unemployment) would both have lowered the constant term in the

[14] The "corrected" Greenbook forecasts that enter as regressors in Table 5 are generated regressors, and hence some care must be taken in computing appropriate standard errors. Because the stock price is included in the efficiency test regression, the variance of the parameter vector in the policy rule regressions is efficient and requires no correction (see Pagan, 1984, pp. 228-229).

reaction function. Allowing the estimate of this constant term to change in the late 1990s, as the data indicate it should, eliminates any significance of the p-e ratio.

Once the control variables the FOMC actually uses to determine its policy actions are included, there is little evidence that the FOMC overreacts to stock market information. The reaction is just what would be expected, given the effect of stock prices on the variables of concern to the FOMC—future output and inflation. Any evidence of an inefficient reaction to stock price changes appears to be more a problem with the forecasts used to control for FOMC behavior than an excessive concern by the FOMC for equity values.

As a final check on the importance of equity price movements for FOMC decisions, we present the fitted values from a representative policy rule, with and without equity prices. As Figure 4 indicates, equity prices do not enter significantly in the Greenspan era, once one controls for the four-quarter ahead forecasts of unemployment, GDP growth, and inflation. But just as importantly, the difference in the fitted values for the policy rules with and without equity prices are barely detectable on the graph, echoing the result found in Figure 2 for a less structured approach. Almost all of the variation in the federal funds rate is well explained by forecasts of the goal variables that are mentioned in the Federal Reserve charter.

III. Conclusion

Since the stock market boom of the 1990s, many have wondered whether the FOMC has pursued an unannounced goal for equity values. That concern increased after the policy actions following the Russian crisis in 1998. In fact, the role equity prices have played in monetary policy has been debated since discretionary policy began in the 1960s. But disentangling the relationship between changes in equity values and monetary policy is inherently difficult, due to the simultaneous interactions among the real economy, stock prices, and monetary policy actions.

This paper offers a new approach to this thorny identification issue. Specifically, using the actual forward-looking variables the FOMC examined before each action has

allowed a more effective way to distinguish between the FOMC's reaction to the economy and its independent reaction to changes in equity prices. It is shown that, particularly recently, the Greenbook forecasts fully incorporate the effect of equity price changes on the economy. Thus, the inclusion of these forecasts in estimated Taylor rules clarifies the interpretation of the coefficient on equity prices in these reaction functions. We find little evidence in support of the proposition that the FOMC responds to stock values, except as filtered through a forecast of accepted monetary policy goal variables.

This paper does not address whether the FOMC should react in a more complicated way to changes in asset values. If, for example, these changes represent alterations in the other moments of the forecast, perhaps policy should respond "independently."

Appendix

Bias Induced by Use of Constant Interest Rate Forecast

A simple macroeconomic framework helps to make the potential source of bias in Section II explicit. For simplicity, consider a reaction function that responds only to next period's forecast of inflation:

$$r_t = a\pi^f_{t+1} + u_t \qquad \text{A.1}$$

Inflation is determined by the simple relation

$$\pi_{t+1} = \pi_t - br_{t-k} + S_t + e_{t+1} \qquad \text{A.2}$$

which can be thought of as a reduced-form combination of a conventional Phillips curve driven by an output gap, where the output gap is in turn a function of the nominal interest rate, *r*, and a stock price shock, *S*. To begin, assume that *k*=0, so that inflation responds to last period's nominal interest rate. The implied forecast for inflation in period *t+1* is simply the sum of the first three terms on the right-hand side of the equation.

Next, consider the forecast of inflation conditioned on a constant interest rate assumption:

$$\pi^c_{t+1} = \pi_t - br_{t-1} + S_t \qquad \text{A.3}$$

We begin by assuming that the monetary authority follows the policy rule (A.1), using the model-consistent forecast of inflation implied by (A.2). Now consider estimating a policy rule using the Greenbook forecast. For simplicity, assume that the Greenbook forecast is *always* conditioned on a constant interest-rate assumption. The estimated rule would be

$$r_t = a^*\pi^c_{t+1} + \varepsilon_t \qquad \text{A.4}$$

Where the error in this regression will be

$$\varepsilon_t = a\pi^f_{t+1} - a^*\pi^c_{t+1} + u_t = a(\pi^f_{t+1} - \pi^c_{t+1}) + (a - a^*)\pi^c_{t+1} \qquad \text{A.5}$$

The key term in this regression error is the difference between the model-consistent and the constant interest rate forecasts, which is

$$a[\pi_t - br_t + S_t - (\pi_t - br_{t-1} + S_t)] = -abr_{t-1} \qquad \text{A.6}$$

Now consider estimating a reaction function with the constant interest-rate inflation forecast and a stock price measure S_t:

$$r_t = a'\pi^c_{t+1} + \beta S_t + \varepsilon_t \qquad \text{A.7}$$

In the true regression equation, the estimated coefficient on S_t should be zero. The estimate will depart from zero only to the extent that S_t is correlated with the error term. This correlation may be written

$$Corr(S_t, -ab(r_t - r_{t-1}) + u_t) \qquad \text{A.8}$$

Under the assumption that u_t and S_t are *iid* (independent and identically distributed) and uncorrelated with variables dated t-1 or earlier, this correlation will in general be nonzero as S_t is correlated with r_t. But by inspection, equations (A.1) and (A.2) imply a positive correlation between S_t and r_t. So this correlation will tend to bias the coefficient on S_t away from zero in the estimated reaction function.

This problem is mitigated if k in equation (A.2) is one or greater. Consider the case in which $k=1$. Then the constant interest rate forecast coincides with the model-consistent forecast, thus $a^*=a$ in equation (A.4), and the reaction function coefficients in (A.7) are unbiased. If $k>1$, then at the one-period-ahead horizon, no assumption about the current interest rate is required, and the bias does not arise. As one moves further out in the horizon, however, the assumption about how interest rates evolve becomes important, and once again the assumption of a constant or model-consistent interest rate can bias the estimated coefficient in the reaction function.

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Table 1

Test of significance of stock price in reduced-form policy rule regressions of the form

$$f_t = a + bf_{t-1} + cGap_t + d\Delta y_t + z\bar{\pi}_t + eS_{t-i}$$

Specification					*p*-value on *e*	
Estimation Range	Inflation measure	Stock Price Index	*S* in Level, % Change	Lags of stock price measure (i)	Unemployment Rate	Output Gap
1966:Q1 - 1987:Q3	GDP	S&P500	Change	1	0.086	0.064
	GDP	S&P500	Change	1-4	0.074	0.056
	GDP	S&P500	Level	1	0.014	0.11
	GDP	S&P500	Level	1-4	0.045	0.13
	PCE	S&P500	Change	1	0.087	0.080
	PCE	S&P500	Change	1-4	0.073	0.075
	CPI	S&P500	Change	1	0.11	0.091
	CPI	S&P500	Change	1-4	0.076	0.070
1987:Q3 - 2002:Q3	GDP	S&P500	Change	1	0.011	0.0041
	GDP	S&P500	Change	1-4	0.020	0.0029
	GDP	NASDAQ	Change	1	0.034	0.041
	GDP	NASDAQ	Change	1-4	0.15	0.14
	PCE	S&P500	Change	1	0.0088	0.0058
	PCE	S&P500	Change	1-4	0.0063	0.0019
	PCE	NASDAQ	Change	1	0.044	0.048
	PCE	NASDAQ	Change	1-4	0.21	0.15
	CPI	S&P500	Change	1	0.013	0.0067
	CPI	S&P500	Change	1-4	0.0024	0.0012
	CPI	NASDAQ	Change	1	0.049	0.051
	CPI	NASDAQ	Change	1-4	0.18	0.13
1966:Q1 - 2002:Q3	GDP	S&P500	Change	1	0.053	0.016
	GDP	S&P500	Change	1-4	0.17	0.049
	PCE	S&P500	Change	1	0.043	0.019
	PCE	S&P500	Change	1-4	0.15	0.066
	CPI	S&P500	Change	1	0.050	0.023
	CPI	S&P500	Change	1-4	0.14	0.067

Table 2

Does the stock price do more than predict output and inflation? GMM estimates of model

$$f_t = a + bf_{t-1} + cGap_{t+i} + d\Delta y_{t+i} + z\overline{\pi}_{t+i} + \sum_k e_k S_{t-k}$$

Specification			*p*-value of likelihood ratio test of hypothesis e_k=0 for all *k*					
			Gap = Unemployment rate			Gap = Output gap		
Estimation Sample	Inflation measure	Stock price measure *S*	*t*-period regressors (i=0)	*t+1*-period regressors (i=1)	*t* to *t+3* period regressors	*t*-period regressors (i=0)	*t*+1-period regressors (i=1)	*t* to *t+3* period regressors
1966:Q1 – 1987:Q3	GDP	S&P 500	0.93	0.12	0.035	0.81	0.049	0.00
	GDP	DJI	0.99	0.26	0.80	0.89	0.23	0.12
	PCE	S&P 500	0.93	0.067	0.056	0.84	0.021	0.0013
	PCE	DJI	0.99	0.22	0.86	0.92	0.13	0.13
	CPI	S&P 500	0.93	0.092	0.078	0.82	0.016	0.00
	CPI	DJI	0.98	0.27	0.89	0.90	0.13	0.15
1987:Q3 – 2002:Q3	GDP	Wilshire	0.99	0.00*	0.00	0.99	0.088*	0.25
	GDP	S&P 500	0.99	0.00*	0.00	0.99	0.012*	0.043
	GDP	DJI	0.99	0.00	0.00	0.99	0.090	0.30
	GDP	NASDAQ	0.99	0.59	0.055	0.99	0.88	0.46
	PCE	Wilshire	0.99	0.00*	0.0017	0.99	0.022*	0.44
	PCE	S&P 500	0.99	0.00*	0.00	0.98	0.0038*	0.19
	PCE	DJI	0.99	0.00	0.00	0.99	0.020	0.27
	PCE	NASDAQ	0.99	0.83*	0.43	0.99	0.38*	0.46
	CPI	Wilshire	0.99	0.040*	0.14	0.99	0.25*	0.46
	CPI	S&P 500	0.99	0.038*	0.06	0.99	0.099*	0.24
	CPI	DJI	0.99	0.39	0.083	0.99	0.53	0.38
	CPI	NASDAQ	0.99	0.32*	0.056	0.99	0.26*	0.37
1966:Q1 – 2002:Q3	GDP	S&P 500	0.83	0.0097	0.0004	0.81	0.00023*	0.00033
	GDP	DJI	0.92	0.17	0.078	0.87	0.0041*	0.022
	PCE	S&P 500	0.87	0.011	0.0047	0.86	0.00015	0.0032
	PCE	DJI	0.95	0.17	0.15	0.92	0.0034	0.061
	CPI	S&P 500	0.88	0.013	0.0087	0.86	0.00*	0.0077
	CPI	DJI	0.95	0.20	0.22	0.92	0.0031*	0.12

Instruments include 4 quarterly lags of Gap, π, *S*, and *f*.
*Indicates *J*-test significant at the 5% level or better.

Table 2a

GMM(IV) Regressions: Alternate Instrument Set (exogenous)

Specification			*p*-value of likelihood ratio test of hypothesis e_k=0 for all *k*	
			Gap = Unemployment rate	Gap = Output gap
Estimation Sample	Inflation Measure	Stock price measure *S*	t+1-period regression (i=1)	t+1-period regression (i=1)
1966:Q1 – 1987:Q3	GDP	S&P 500	0.54	0.19
	GDP	DJI	0.86	0.16
	CPI	S&P 500	0.77	0.53
	CPI	DJI	0.85	0.11
1987:Q3 – 2002:Q3	GDP	Wilshire	0.82	0.99
	GDP	S&P 500	0.84	0.98
	GDP	NASDAQ	0.89	0.99
	PCE	Wilshire	0.84	0.99
	PCE	S&P 500	0.84	0.99
	PCE	NASDAQ	0.89	0.99
	CPI	Wilshire	0.86	0.99
	CPI	S&P 500	0.88	0.99
	CPI	NASDAQ	0.91	0.99
1966:Q1 – 2002:Q3	GDP	S&P 500	0.98	0.99
	GDP	DJI	0.98	0.90
	CPI	S&P 500	0.99	0.99
	CPI	DJI	0.95	0.90

Figure 1

The Fed responds to stock prices?

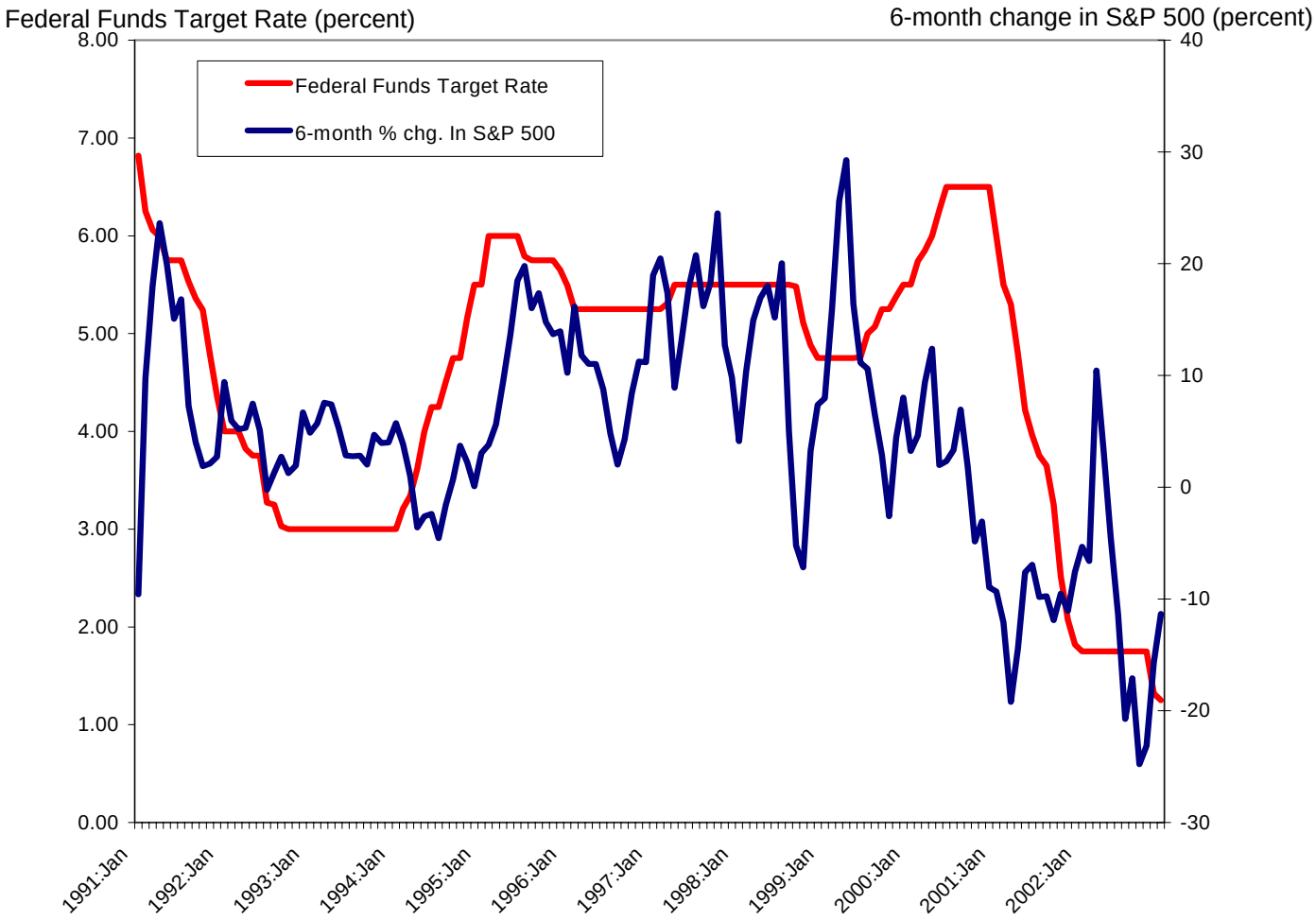


Figure 2

Improvement in Fit from Incorporating Equity Prices in Estimated Policy Rule

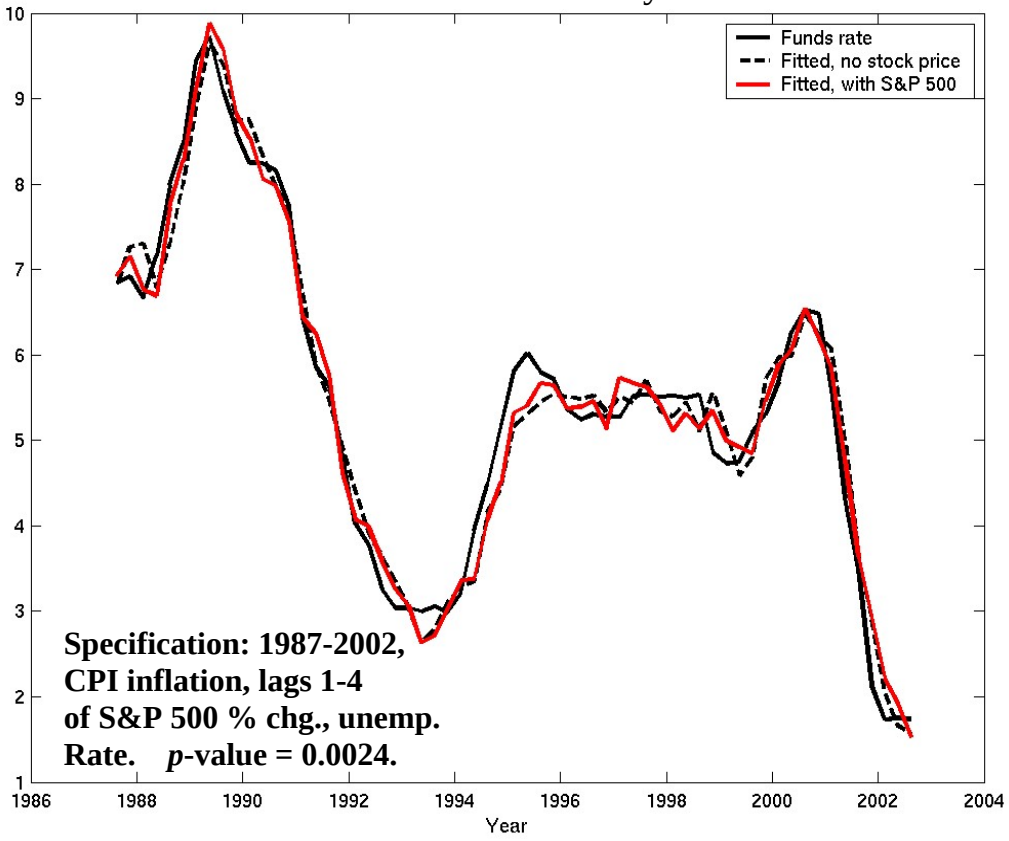


Figure 3
Testing strategy

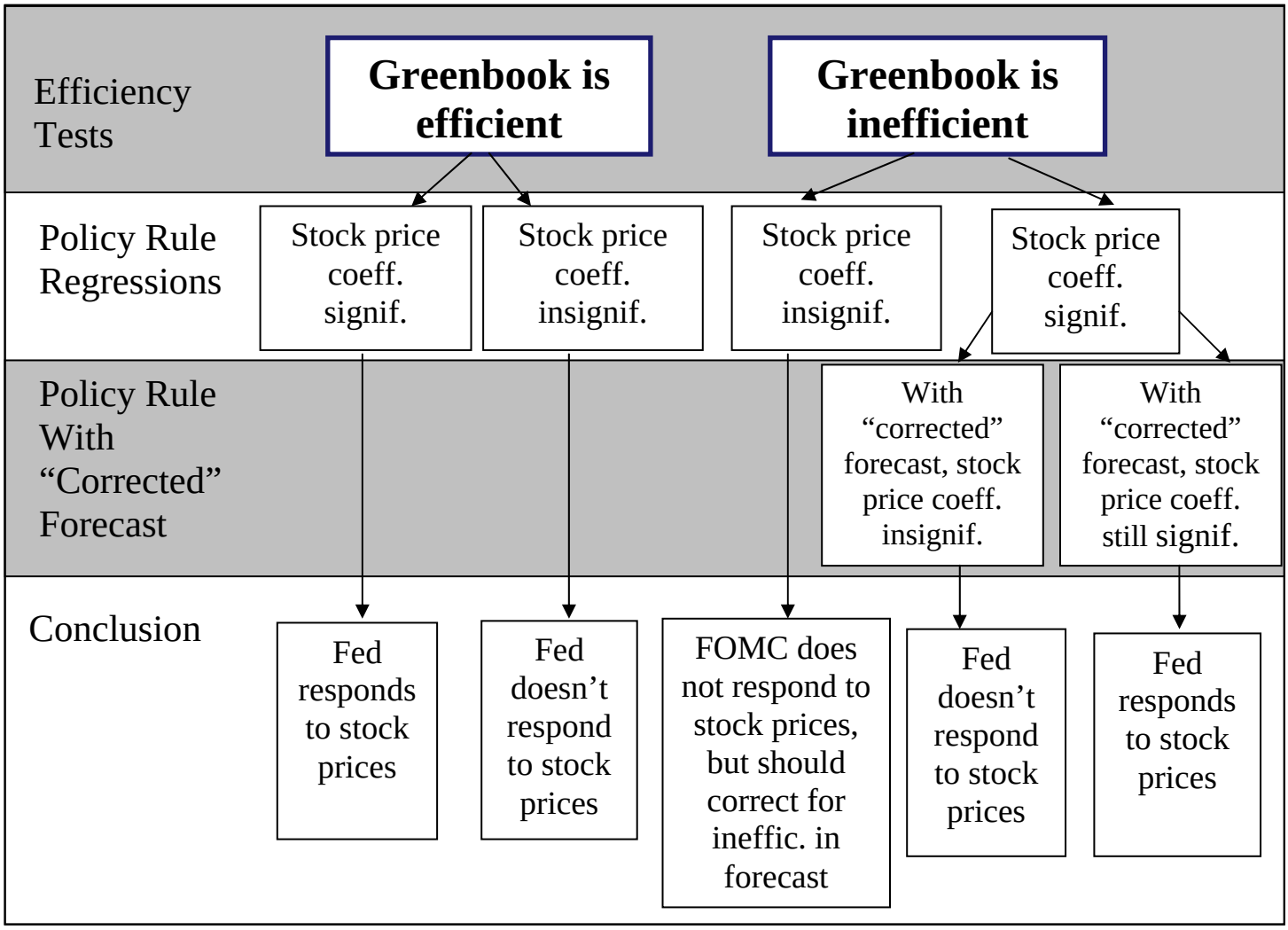


Table 3

Forecast Efficiency Test

$$x_{t+i} = \alpha_0 + \alpha_1 E_t x_{t+i} + \sum_{n=1}^{4} \beta_n \dot{S}_{t-n} + \varepsilon$$

Specification			Forecast Horizon Estimated $\sum_{n=1}^{4} \beta_n$ (*P*-value)			
Estimation Range	Variable	Lags of stock price measure (n)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Full Sample, 1966:Q1 – 2002:Q3	Unemployment Rate	1	-0.001 (0.03)	-0.004 (0.00)	-0.007 (0.00)	-0.010 (0.00)
		1-4	-0.002 (0.00)	-0.006 (0.00)	-0.011 (0.00)	-0.014 (0.00)
	Real GDP Growth	1	0.009 (0.17)	0.035 (0.00)	0.026 (0.02)	0.025 (0.06)
		1-4	0.025 (0.00)	0.057 (0.00)	0.045 (0.00)	0.035 (0.12)
	Inflation	1	-0.009 (0.01)	-0.013 (0.01)	-0.014 (0.04)	-0.012 (0.05)
		1-4	-0.017 (0.00)	-0.021 (0.00)	-0.022 (0.00)	-0.021 (0.00)
Pre-Greenspan, 1966:Q1 – 1987:Q3	Unemployment Rate	1	-0.002 (0.01)	-0.005 (0.00)	-0.009 (0.00)	-0.012 (0.00)
		1-4	-0.016 (0.00)	-0.009 (0.00)	-0.013 (0.00)	-0.032 (0.00)
	Real GDP Growth	1	0.016 (0.09)	0.041 (0.00)	0.025 (0.15)	0.026 (0.18)
		1-4	0.031 (0.00)	0.068 (0.00)	0.039 (0.00)	0.035 (0.73)
	Inflation	1	-0.013 (0.01)	-0.020 (0.01)	-0.020 (0.05)	-0.017 (0.10)
		1-4	-0.026 (0.00)	-0.034 (0.00)	-0.033 (0.00)	-0.032 (0.00)
Greenspan Era, 1987:Q3 – 2002:Q3	Unemployment Rate	1	0.000 (0.68)	0.000 (0.72)	-0.001 (0.50)	-0.002 (0.39)
		1-4	0.000 (0.62)	-0.001 (0.56)	-0.004 (0.22)	-0.007 (0.01)
	Real GDP Growth	1	-0.007 (0.40)	0.022 (0.07)	0.021 (0.05)	0.009 (0.48)
		1-4	0.017 (0.00)	0.042 (0.00)	0.040 (0.00)	0.015 (0.09)
	Inflation	1	0.001 (0.60)	0.002 (0.49)	0.001 (0.66)	0.001 (0.70)
		1-4	0.000 (0.11)	0.005 (0.06)	0.005 (0.07)	0.007 (0.13)

Table 4

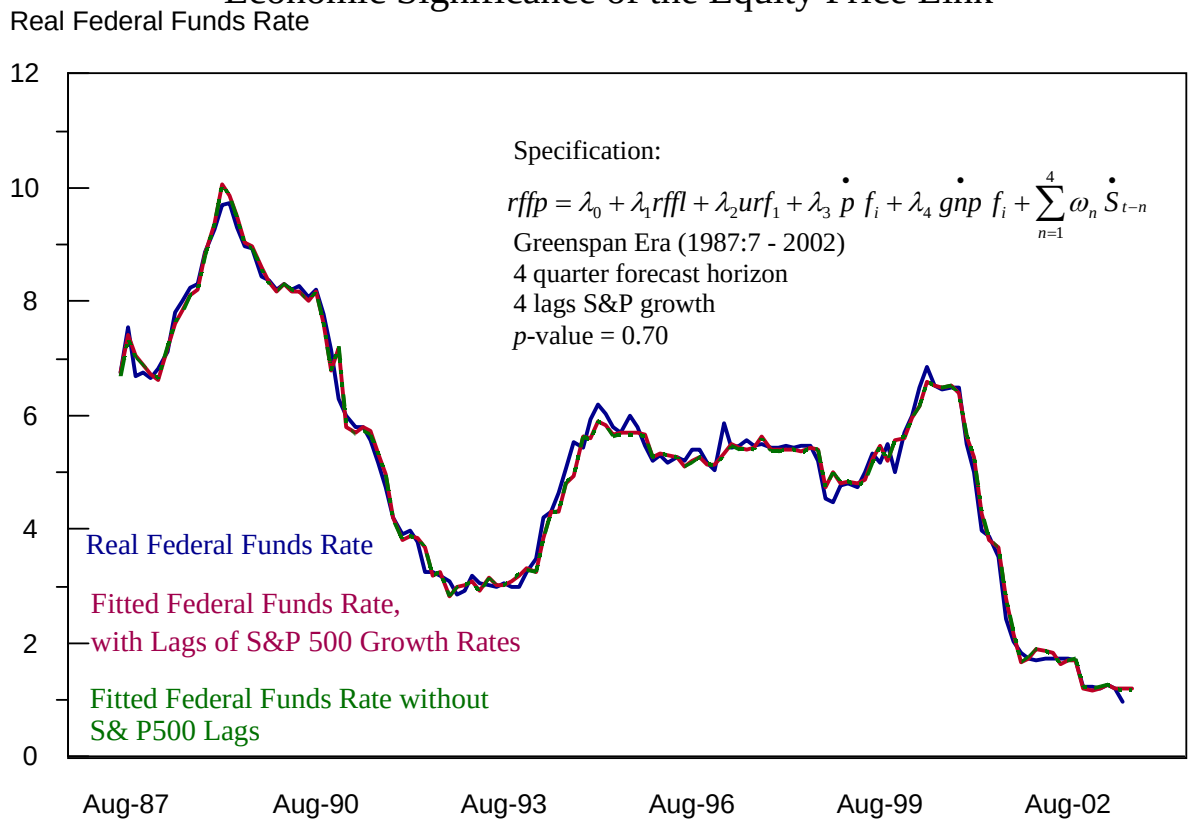
Policy Rule Estimation

$$rffp = \lambda_0 + \lambda_1 rffl + \lambda_2 urf_1 + \lambda_3 \dot{p} f_i + \lambda_4 \dot{gnp} f_i + \sum_{n=1}^{4} \omega_n \dot{S}_{t-n}$$

Specification	Forecast Horizon	1 Quarter Lag, $\dot{S}$ (p-value)	4 Quarter Lags, $\dot{S}$ (p-value)
Full Sample, 1966:Q1 – 2002:Q3	1 Quarter	0.002 (0.05)	0.001 (0.19)
	2 Quarters	0.002 (0.05)	0.001 (0.20)
	4 Quarters	0.003 (0.01)	0.001 (0.09)
Pre-Greenspan, 1966:Q1 – 1987:Q3	1 Quarter	0.002 (0.15)	0.001 (0.36)
	2 Quarters	0.002 (0.13)	0.001 (0.32)
	4 Quarters	0.003 (0.04)	0.002 (0.15)
Greenspan Era, 1987:Q3 – 2002:Q3	1 Quarter	0.000 (0.60)	-0.001 (0.41)
	2 Quarters	0.001 (0.38)	0.001 (0.71)
	4 Quarters	0.001 (0.32)	0.000 (0.70)

Figure 4

Economic Significance of the Equity Price Link



Sources: Federal Reserve Board (Federal Funds Target, Forecasts).
Wall Street Journal (S&P 500).

Table 5

Policy Rules with Adjusted Forecast

$$rffp = \hat{\lambda}_0 + \hat{\lambda}_1 rffl + \hat{\lambda}_2 urf_1 + \hat{\lambda}_3 \dot{p} f_i + \hat{\lambda}_4 \dot{gnp} f_i + \sum_{n=1}^{4} \hat{\omega}_n \dot{S}_{t-n}$$

		Rolling Sample		Adjusted	
Specification	Forecast Horizon	1 Lag, $\dot{S}$ (p-value)	4 Lags, $\dot{S}$ (p-value)	1 Lag, $\dot{S}$ (p-value)	4 Lags, $\dot{S}$ (p-value)
Full Sample, 1966:Q1 – 2002:Q3	1 Quarter	0.002 (0.03)	0.000 (0.20)	0.002 (0.03)	0.000 (0.21)
	2 Quarters	0.002 (0.03)	0.000 (0.22)	0.002 (0.08)	-0.001 (0.18)
	4 Quarters	0.002 (0.02)	0.001 (0.17)	0.002 (0.14)	-0.001 (0.27)
Pre-Greenspan, 1966:Q1 – 1987:Q3	1 Quarter	0.002 (0.13)	0.000 (0.42)	0.003 (0.10)	0.001 (0.38)
	2 Quarters	0.002 (0.12)	0.000 (0.39)	0.003 (0.14)	0.000 (0.30)
	4 Quarters	0.003 (0.08)	0.001 (0.29)	0.003 (0.15)	0.000 (0.38)
Greenspan Era, 1987:Q3 – 2002:Q3	1 Quarter	0.000 (0.60)	-0.001 (0.41)	0.000 (0.95)	-0.003 (0.15)
	2 Quarters	0.001 (0.38)	0.001 (0.71)	0.000 (0.80)	-0.001 (0.20)
	4 Quarters	0.001 (0.32)	0.000 (0.70)	0.000 (0.93)	0.000 (0.09)