Equity prices and monetary policy in the United States

Vincent Raymond Reinhart*

Introduction

The wide swings in equity prices on world markets in recent months have riveted investors' attention. With more than $11 trillion of equity wealth in the hands of the US public, such investor interest is understandable. A more difficult question is whether equity prices should receive as much prominence in the deliberations of central bankers as they do in the financial press. To the extent that equity prices are sensitive to real interest rates and contain the market's implicit assessment of corporate profits going forward, they could be read as signaling the current and future state of the economy. They could also directly affect spending by their contribution to wealth and influence on relative returns. However, that equity price *could* be important in either signaling or directly influencing the ultimate objects of a central bank's intentions – economic activity and inflation – does not necessarily imply that monetary policy *should* be sensitive to them.

To examine the case for responding systematically to stock prices, I consider three questions:

- First, how are equity prices related, even if quite imprecisely, to macroeconomic fundamentals?
- Second, do equity prices systematically influence macroeconomic outcomes?
- Third, does attention paid to the equity market on the part of monetary policymakers feed back on the dynamics of economic activity, inflation and equity prices?

The first question is related to the determinants of equity prices, a subject examined in Section 1. I consider a variety of simple valuation equations that link stock prices to interest rates and economic conditions. All those relationships convey the same general impression: equity prices are volatile relative to fundamentals and are currently on the high side of that predicted by history.

As to the second question, based on another set of estimations, this time using quarterly data on real GDP and some of its components, I show in Section 2 that equity prices importantly influence spending. Moreover, that wealth effect is more evident in the past twelve years than it was in the prior twelve years. Proportionally, much of that effect on GDP is recorded in its investment component, although consumption is estimated to be sensitive to stock market wealth as well. Offsetting the effect on aggregate demand somewhat, real imports are also sensitive to equity prices.

The two sections that follow address the third question. From a monetary policy perspective, a central bank even with a purely macroeconomic objective – say, containing inflation pressures – must be sensitive to equity prices. But, in that regard, a forward-looking central banker has a responsibility to monitor any financial variable thought to influence economic activity and pressures on inflation, including the foreign exchange value of the dollar and nominal and real interest rates all along the term structure. Elevating equity prices beyond the function they serve in helping to predict the ultimate objects of central bank concern could pose problems. For example, a simple theoretical model of the economy suggests that responding to the *level* of equity prices raises the net effect of news on equity prices (Section 3). Should the central bank respond to the *change* in equity prices, it may well raise the volatility of share prices in response to monetary policy misalignments and, depending on parameter values, actually destabilize the economy (Section 4). Concluding comments are provided in the final section.

---

* Division of Monetary Affairs; Board of Governors of the Federal Reserve System; Washington. The author would like to thank Doug Elmendorf, Mike Leahy, Dave Lindsey, Dave Reifschneider, Carmen Reinhart and Tom Simpson for their comments and Kris Dickson for his excellent research assistance. The views expressed are his own and do not necessarily reflect those of the Board of Governors of the Federal Reserve System or any other member of its staff.

1. Equity price fundamentals

All modern asset pricing relationships begin from the marginal condition that households substitute consumption over time and allocate their assets at a point in time so that risk-adjusted expected rates of return are equated to the risk-free real interest rate.[1] If P is the price of goods and services, Q the price of an equity share D, the dividends provided per period, and r the risk-free real rate, then:

$$r_t = \frac{D_t}{Q_t} + E\frac{Q_{t+1}/P_{t+1} - Q_t/P_t}{Q_t/P_t} - \rho_t$$

where E denotes the expectation conditioned on all available information. In this relationship, ρ is the equity premium, which depends on how returns covary with the marginal utility of consumption and is not presumed to be constant. All rates of return refer to the period over which households can change their consumption. Similarly, dividends are paid out over that interval. In continuous time models, consumption can vary instant by instant, so that the appropriate real rate is the instantaneous one – effectively an overnight rate.

An analyst could make specific assumptions about the movement through time of dividends and the real short rate to derive an association between the level of D/Q and a market rate. With the help of an auxiliary relationship describing dividend payout policy, or how dividends are related to earnings, Π, a description of the earning-price ratio could be developed. But any such relationship is conditional on those assumptions and holds other variables constant in the background. They are not structural in the way that the intertemporal substitution condition is, implying that they can vary over time. Moreover, different assumptions could even change the market rate that is the appropriate benchmark.

To see this property, I can use the arbitrage condition to solve for the level of equity prices in the absence of uncertainty.[2] The simplest of all pricing models assumes that the real rate, inflation, and the equity premium are all constant and that dividends grow at a constant rate in nominal terms, G. This nominal dividend growth can be divided into its real and inflation-compensation component, as in:

$$G = g + \pi$$

As a result of these assumptions, the pricing formula simplifies to:

$$Q_t = \sum_{i=0}^{\infty} \frac{D_t(1+G)^i}{(1+r+\rho+\pi)^{i+1}}$$

where the exponent in the numerator and denominator differ by one because dividends are assumed to be paid at the end of the period. As long as dividends grow more slowly than the net rate of discount, this summation is bounded and the D/Q ratio can be written succinctly as:

$$D/Q = r + \rho + \pi - G$$

which is often referred to as the Gordon equation, after Myron Gordon (1962).

This simple equation might be served in a variety of flavors. For instance, because dividends grow with the prices of goods and services, this could as well be written in terms of real rates,

---

1 These are discussed, for example, in Shiller (1981) and Campbell and Shiller (1987). An extensive review of this work and a discussion of its relevance to the current situation is provided by Cochrane (1997).

2 Exactly why there would be an equity premium in a certain world is a puzzle in itself, but assume that ρ remains. This eliminates all manner of complications associated with nonlinearities and covariance terms but offers another reason why the final pricing equation might be inadequate.

$$D/Q = r + \rho - g$$

Or, define the nominal short rate as R, which sums the real rate and expected inflation. As a result,

$$D/Q = R + \rho - G$$

Or, split the equity premium into a part related to consumption covariation, ρ^c, and another part related to the bankruptcy risk of firms, ρ^b. The sum of the risk free nominal and the bankruptcy-risk term might be proxied by a private nominal rate, R^b, as in:

$$D/Q = R^b + \rho^c - G$$

Lastly, assume that dividends are paid out as a constant fraction, k, of earnings, Π. This implies that dividends and earnings grow at the same rate. This payout rate can transform the constant-growth model to:

$$\Pi/Q = \frac{r + \rho - g}{k}$$

Thus, with not much work, it is possible to derive several variants of a "fair pricing" model. In principle, they all should produce the same predictions. But in practice, it is not likely that analysts will be internally consistent about their assumptions for the right-hand-side terms. More complicated models allow movement through time of dividends, the real short rate, inflation, and the payout rate. But because they are all arbitrary to some degree, they need not produce even roughly comparable estimates of the "fair value" of equity prices. One way to distinguish these alternative explanations of equity prices would be empirical fitness. To that end, I estimated various versions of the Gordon equation using monthly data from 1980.

In principle, the yield on equities should depend on the rate on a competing asset and variables that help to forecast earnings growth and future dividend payouts.[3] The latter category would include inflation expectations (presumably at a long horizon) and the unemployment rate.[4] As for the rate on competing assets, I considered six alternatives, varying by maturity and riskiness. They are the: (1) federal funds rate, (2) three-month Treasury bill rate, (3) ten-year Treasury note yield, (4) three-month commercial paper rate, (5) yield on Moody's AAA-rated seasoned corporate issues, and (6) yield on recently offered A-rated utility bonds.

The Gordon equation relates the level of the return on equities to an interest rate and perhaps other variables. However, standard test statistics of regression equations are only appropriate for stationary variables. Thus, some work may be required to render the underlying time series stationary, if as some researchers, contend, nominal, and even real, interest rates have a unit root (Rose (1988)). In a univariate case, a series with a single unit root may be rendered stationary by first differencing to make it an appropriate regressor or regressand. In a multivariate case, some linear combination of nonstationary variables may be stationary, in which case those variables are said to be cointegrated, in the manner described by Engle and Granger (1987). The appropriate way to combine variables can be imposed from

---

3 In recent years, US firms have clearly shifted away from paying dividends, with the ratio of dividends to earnings falling to under 40%. While the theoretical model emphasized what investors receive, dividends, I will concentrate on the earnings-price ratio because of this evident change in firm behavior. But it should be noted that any puzzle of equity price overvaluation would be more intense when the model is written in terms of dividends rather than earnings.

4 Survey measures of longer-term inflation expectations are only available sporadically in the early 1980s. I interpolated values for the University of Michigan's survey of households' five-to-ten-year-ahead inflation expectations using the predictions of a regression of the long-term expectation against monthly readings on one-year-ahead inflation expectations and lagged actual inflation (which are available without gaps).

theoretical priors, estimated by a first stage regression, or calculated through maximum likelihood techniques.

To uncover the specific time-series properties of the variables of interest, I first conducted a battery of tests, which are reported in an appendix, for the presence of one or two unit roots in monthly data for a collection of interest rates and macro variables. It turns out that the levels of nominal interest rates, inflation expectations, and the unemployment rate are all nonstationary. Further, measures of the real rate, or the nominal rate less the appropriate maturity inflation expectations, are also nonstationary.[5] As a result, it is appropriate to allow for the possibility that a coefficient on inflation expectations is not unity and that the relationship explaining nominal interest rates includes other variables. Moreover, it is important to estimate with a technique that generates robust standard errors.

An error-correction model is one simple technique that exploits the dynamic movements of the explanatory variables to estimate a single cointegrating relationship.[6] In estimating an equation that imposes a long-run relationship on the data, I can introduce lagged and led values of changes in the dependent variable and lagged values of the difference between the level of the variable and that predicted by fundamentals, or the error-correction term. Both lags and leads are included because investors are presumably forward looking in their determination of asset values. What is not evident in the technique is how many leads and lags to include. In principle, various combinations of lagged error-correction terms and the led and lagged dependent variable can yield an equivalent representation.

Table 1

Estimates of equations predicting the earnings-price ratio for the S&P 500

Parameter estimates and summary statistics (using monthly data over the period 1980–96)

	Federal funds rate	**Three-month Treasury bill rate**	**Ten-year Treasury yield**	**Three-month CP rate**	**Moody's AAA-rated yield**	**A-rated utility yield**
Speed of adjustment (λ)	-0.082 (0.024)	-0.086 (0.024)	-0.098 (0.025)	-0.084 (0.025)	-0.099 (0.026)	-0.106 (0.026)
Constant	1.962 (1.919)	1.521 (1.791)	0.253 (1.494)	1.326 (1.828)	-0.742 (1.450)	0.256 (1.377)
Interest rate j	0.642 (0.133)	0.768 (0.150)	0.973 (0.163)	0.690 (0.140)	1.062 (0.177)	0.940 (0.145)
Inflation expectations	0.167 (0.347)	0.207 (0.322)	0.469 (0.248)	0.198 (0.333)	0.496 (0.242)	0.336 (0.243)
Unemployment Rate	-0.116 (0.264)	-0.137 (0.252)	-0.610 (0.259)	-0.089 (0.256)	-0.784 (0.274)	-0.702 (0.248)
Lagged dependent variable	0.129 (0.069)	0.117 (0.069)	0.088 (0.071)	0.124 (0.070)	0.096 (0.071)	0.080 (0.071)
Led dependent Variable	0.125 (0.069)	0.117 (0.070)	0.096 (0.069)	0.124 (0.070)	0.102 (0.070)	0.089 (0.070)
R^2	0.159	0.164	0.180	0.159	0.175	0.184
Standard error	0.336	0.335	0.332	0.336	0.333	0.331

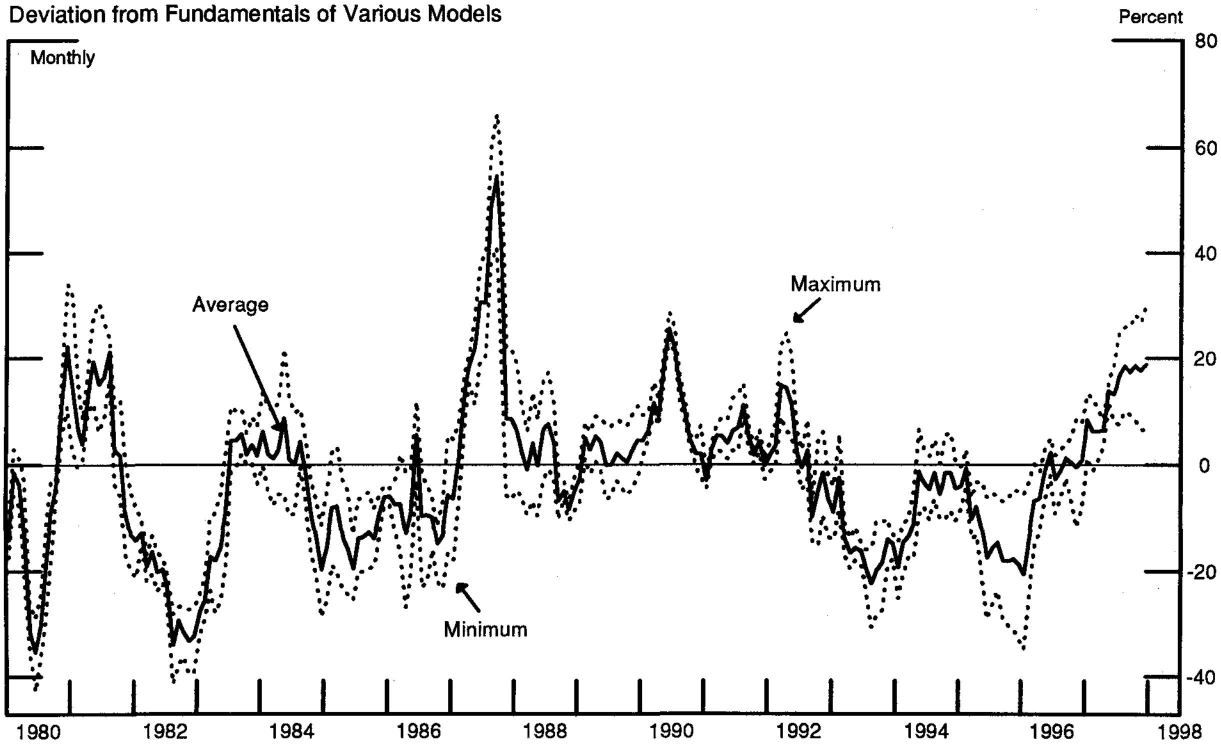
Note: Standard errors in parentheses.

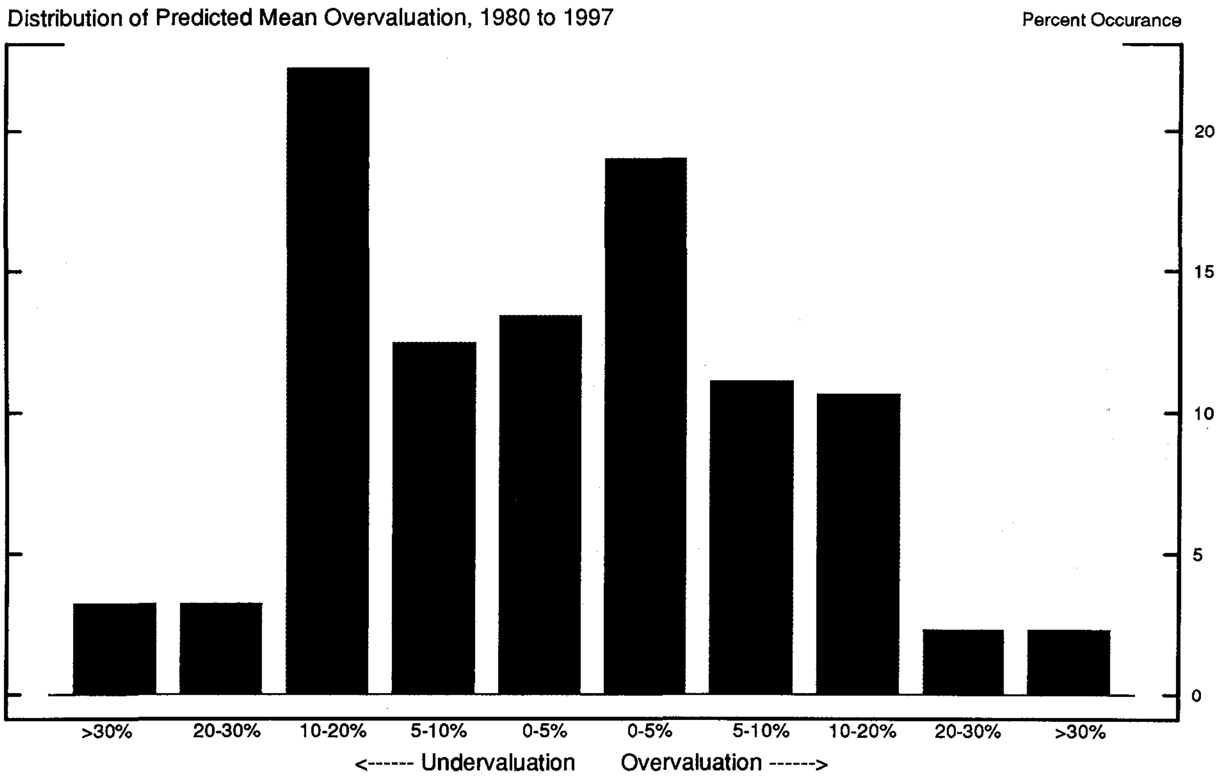
5 At a broader level, it may be difficult to imagine an economy where both nominal and real interest rates are nonstationary, particularly, as Cochrane (1991) points out, when those variables move in a narrow range over very long samples.

6 A discussion of various techniques is provided in Campbell and Perron (1991).

Figure 1

Predicted overvaluation of S&P 500





To keep matters simple and to avoid estimating many parameters, I examined a specification of the form:

$$\Delta \frac{\Pi_t}{Q_t} = \frac{\lambda^j}{k} \sum_{i=1}^{k} \left(\frac{\Pi_{t-i}}{Q_{t-i}} - a_1^j - a_2^j R_{t-i}^j - a_3^j \pi_{t-i}^{10} - a_4^j u_{t-1} \right) + b^j \Delta \frac{\Pi_{t-1}}{Q_{t-1}} + c^j \Delta \frac{\Pi_{t+1}}{Q_{t+1}} + \eta_t^j$$

one for each of the alternative right-hand-side variables. Taking the simple average of the lagged error-correction term follows the advice of Berkowitz and Giorgianni (1996) and permits an easy exploration of alternative lag lengths (the parameter *k)* while keeping the number of parameters estimated constant. Notice that this is an appropriate object of estimation because the terms in the summation should be stationary if a cointegrating vector exists and the other variables, both on the left and right-hand side of the equation, are stationary because they appear in difference form. If the speed of error correction, the coefficient λ, is significantly negative and either or both a_2 and a_3 are nonzero, then a cointegrating vector exists.

After some experimentation with lag length, these six equations were estimated individually with two lags of the error-correction term using monthly data from 1980 to 1996. Those regression results, summarized in Table 1, indicate that the earnings-price ratio moves positively, and mostly one-for-one, with nominal interest rates. Among those interest rates, private longer-term yields seem to have slightly more predictive power. There is an important business-cycle element in pricing, in that the coefficient on the unemployment rate is usually significantly negative. However, somewhat inexplicably, expected inflation plays no role in these estimates. In all cases, the speed of error-correction is estimated to be significantly negative, implying that earning-price yield tends to revert to a moving mean determined by fundamentals. That is, because the level of the nominal rates on the right-hand side helps to explain the change in the earnings-price ratio over time, the earnings-price ratio is cointegrated with these nominal rates (individually).

I evaluated those fundamentals for the six alternative specifications from 1980 onward, using only the level portion of the estimation equation and not the dynamic terms. The percent deviation of the predicted earnings yield based on macro variables each month from the actual earnings yield gives an estimate of the under- or overvaluation of the S&P 500, the range for which is provided in the upper panel of Figure 1. The dotted lines give the maximum and minimum predicted deviation from fundamental valuations, judged each month across the six models, while the solid line gives the mean of those six estimates. As is evident, equity values are considered by these models to be currently overvalued – to the tune of 6 to 28%. But even that excess is dwarfed by the significant bubble in prices, at least as viewed by these models, in summer 1987.

The bottom panel sorts the mean deviation from fundamentals by size. The resulting distribution is distinctly bimodal, producing spikes at significant undervaluations (10 to 20%) and at correct valuations (0 to 5%). Adding to the widespread uneasiness about equity prices reported in the financial press is the swing in fundamentals over the past two years: The models believed equities to be about 20% undervalued at the end of 1995, but the subsequent appreciation of share prices more than eroded that mispricing to produce the current estimated overvaluations.

2. Evidence on the effect of equity values on spending

Asset valuation is only directly relevant to monetary policymakers if it can be determined that those asset values influence aggregate demand. This presents another opportunity to estimate an error-correction model, this time to establish the long-run relationship among financial market quotes and macroeconomic outcomes. Over the years, economists have purported that two sets of market quotes have some predictive power for aggregate demand: the real value of equity prices (as in Sprinkel (1964)) and the slope of the term structure (as in Estrella and Hardouvelis (1991)). Because of this predictive power, both of these variables are in the index of leading indicators. My strategy is to offer both as potential explanatory variables for real GDP and its main components, consumption and business fixed investment, and let the data determine relative merits.

Some analysts have given a structural interpretation to the inclusion of the yield curve in an explanation of aggregate demand. According to Benjamin Friedman (1978), for instance, the long-term nominal interest rate importantly captures inflation expectations, so that the slope of the term structure proxies for the (negative of) the real short-term interest rate. I will not offer that structural interpretation. Rather, I seek to determine the incremental influence of relative equity prices given the presence of an indicator that captures the regularities of the business cycle. As a result, though, the estimates will not be directly comparable to those of other researchers examining the role of wealth in influencing consumption or saving using structural relationships.[7]

Because dynamics are likely to be difficult to disentangle, I estimate a model of the form:

$$\Delta y_t^j = \frac{\lambda^j}{k}\sum_{i=1}^{k}\left[y_{t-i}^j - a_1^j - a_2^j(R_{t-i}^{10} - R_{t-i}^{3m}) - a_3^j(q_{t-i} - p_{t-i}^j)\right] + b^j \Delta y_{t-1}^j + c^j \Delta y_{t+1}^j$$

where y^j represents the logarithms of, respectively: (1) real GDP, (2) real consumption, (3) real business fixed investment, and (4) real imports of goods and services.

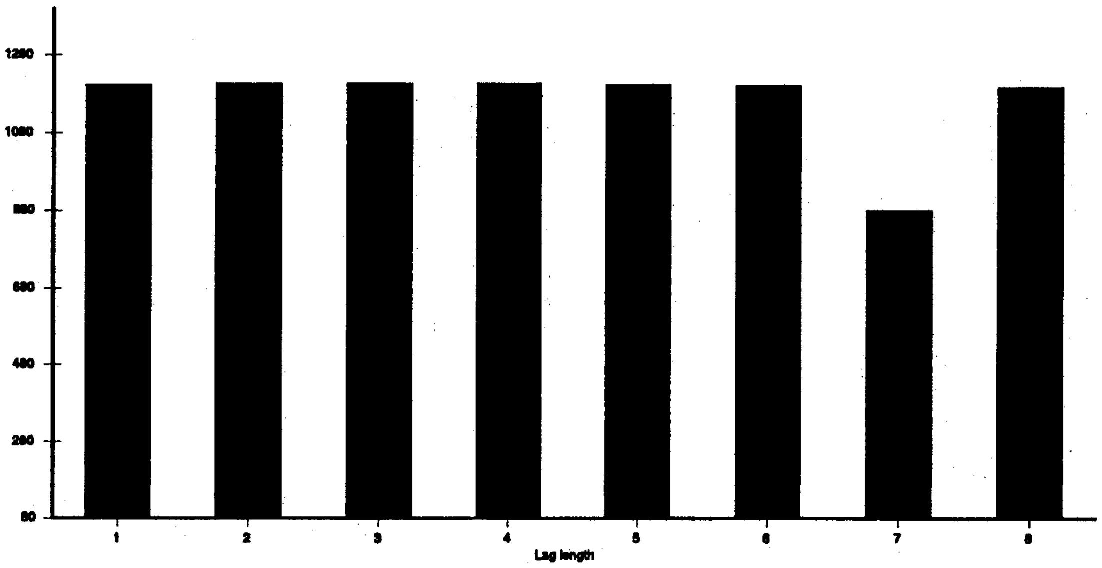
Again, dynamic terms are included to improve the precision of the estimates of the long-run relationship, not to generate an equation with which to forecast near-term behavior. While the yield curve slope is identical across equations, the S&P 500 (q) is deflated by the price index specific to that component of GDP (p^j).[8] As the components of GDP are likely to be highly correlated with each other and the total, I will estimate the four relationships simultaneously over quarterly data from 1973 to 1996 for various lag lengths of the error-correction summation. I chose this subset of the data for which income statistics are available on the hypothesis that observations drawn from the fixed-exchange-rate sample are not relevant for current experience.

Figure 2

Estimates of the model explaining real GDP and its components

Using quarterly data over the period 1973–96

Value of the Likelihood Function



---

7 Deaton (1992) provides a comprehensive review of the consumption literature. A description of consumption in a large structural model applying conventional theory, with an emphasis on shifts in behavior over time, is given in Mauskopf (1990).

8 I found, but do not report, similar results to what follows using a broader measure of wealth from the flow-of-funds accounts.

As is evident in the upper panel of Figure 2, a lag of four quarters maximizes the log likelihood function, perhaps suggesting a residual seasonality in the data.[9] On the possibility that the structure of the model is not homogeneous through time, I re-estimated over two samples, from 1973 to 1984 and from 1985 to 1996, which represents an equal division of the data. As is evident from Table 2, the data are clearly drawn from (at least) two distributions. Pre-1985, financial market variables do not appear to exert a systematic effect on spending. Post-1985, both relative returns and the value of equity prices influence GDP and its components.

Table 2

Parameter estimates and summary statistics

	1973–84				1985–96			
	GDP	**C**	**I**	**M**	**GDP**	**C**	**I**	**M**
Speed of adjustment (λ)	-0.038 (0.020)	-0.045 (0.012)	-0.027 (0.029)	-0.044 (0.041)	-0.083 (0.024)	-0.095 (0.024)	-0.069 (0.025)	-0.067 (0.040)
Constant	8.743 (0.189)	8.503 (0.122)	6.416 (0.460)	5.848 (0.269)	8.328 (0.055)	7.938 (0.053)	5.611 (0.408)	5.324 (0.303)
R^{10} - R^{3m}	0.190 (0.103)	0.158 (0.042)	0.591 (0.669)	0.420 (0.393)	0.027 (0.013)	0.039 (0.013)	0.164 (0.081)	0.109 (0.083)
Relative equity prices	-0.479 (0.238)	-0.612 (0.134)	-0.776 (0.831)	-0.634 (0.563)	0.325 (0.035)	0.321 (0.033)	0.714 (0.237)	1.030 (0.281)
Lagged dependent variable	-0.094 (0.098)	-0.439 (0.098)	0.078 (0.093)	0.099 (0.131)	-0.205 (0.109)	-0.422 (0.098)	-0.105 (0.107)	-0.315 (0.112)
Led dependent Variable	-0.262 (0.104)	-0.182 (0.098)	-0.025 (0.101)	-0.126 (0.136)	-0.205 (0.109)	-0.389 (0.099)	-0.303 (0.105)	-0.302 (0.115)
R^2	0.301	0.499	0.484	0.257	0.090	0.193	0.205	0.127
Standard error	0.010	0.006	0.023	0.037	0.005	0.005	0.016	0.018

Note: Standard errors in parentheses.

For whatever reason, over the past twelve years, the real value of equities (appropriately deflated) appears to exert a significant and sizable positive effect on spending. The elasticity of aggregate spending to stock market prices, at about $\frac{1}{3}$, is a weighted average of an elasticity of about $\frac{1}{3}$ for consumption, over $\frac{2}{3}$ for investment, and 1 for imports, where the weights are their contributions to GDP. Thus, a rise in equity prices spurs spending on goods from abroad more than at home, limiting the net impact of that wealth gain on real GDP. As to domestic spending, because the effect of equity prices appears to be greatest for investment, rising equity prices have no doubt importantly contributed to the expansion of capital in recent years. Similarly, investment has a more cyclical response to the slope of the term structure, with a semi-elasticity of about $\frac{1}{6}$ for each percentage point change in the spread of the ten-year yield over the three-month bill rate. In all four cases, the speed of error correction is significantly negative, indicating that I have identified cointegrating vectors.

The net result of this estimation exercise is to suggest that spending, both total GDP and its major components, are related to equity prices, but that these relationship are sensitive to the period chosen. Because of their influence on aggregate demand, central bankers have some grounds for consulting equity prices in the formulation of policy.

9 As is evident in the figure, the likelihood function for this estimation (and the others that follow) tends to be quite flat. Unfortunately, the parameter estimates – and policy implications – differ across the lag lengths chosen, even though they have fairly similar explanatory power. One reason researchers may differ in their enthusiasm for various indicators may be that they are sampling in different regions of this flat likelihood surface.

3. Monetary policy and equity prices

Monetary policymakers might be concerned about equity prices straying above fundamentals because of potential adverse effects as prices rise or as they fall back to earth.[10] As to the rise, if prices are moving above fundamentals, relative prices are misaligned, dictating some misallocation of resources. Households might be consuming out of their paper wealth, firms buying capital based on inflated market relative to book values, households and businesses taking on debt because leverage ratios look good, and new firms starting up because capital markets are so receptive.

Monetary policymakers might also be concerned about increases in stock prices because of a fear that there was time dependence to overvaluation – on the logic that the longer prices stray above fundamentals, the further they stray and the harder they will fall. Equity prices might matter on the way down because of concerns about systemic risk, knock-on effects on spending and confidence, and the risk of subsequent undershooting. However, mechanisms are well developed for dealing with systemic risk, including lending via the discount window and a willingness to add ample reserves at times of stress.

A simple model

A simple two-equation dynamic model can capture the linkage between monetary policy and equity prices and provide an example of a near-rational bubble. It also suggests caution in thinking that policy action can automatically deflate an asset bubble. The model is a variant of that first provided by Blanchard (1981) but which has since been employed by Blanchard and Dornbusch (1984), Branson, Fraga and Johnson (1985), and Dornbusch (1986), among others, to examine a variety of policy issues.

To be specific, suppose that aggregate demand, y, depends on the real short-term interest rate, r, and relative equity prices, q, as in:

$$y = a_1 - a_2 r + a_3 q$$

I define the real rate as the difference between the nominal rate, i, which is set by the central bank, and instantaneous inflation, π.[11] Equity prices may enter in determining aggregate demand because of wealth effects on consumption or because Tobin's q influences investment spending.

As to the rest of the economy, inflation follows inertially from previous excesses of spending over potential output, k, so that:

$$\dot{\pi} = b(y - k)$$

where the dot over a variable signifies the time derivative. This is an accelerationist-style Phillips curve implying that the current level of inflation is a backward-looking average of past inflation.[12]

Monetary policy smooths the nominal interest rate according to the output gap and inflation, following the insight of John Taylor (1993) that Federal Reserve behavior of the past decade could be related to the recent behavior of measured inflation and an estimate of the excess of output over its potential. While Taylor specified a relationship explaining the level of the federal funds rate, the proximate instrument of monetary policy in the United States, an equation describing the change in that rate would also fit the data, as well as the stylized fact that policy rates tend to evolve smoothly through time. The exact relationship is given by:

---

[10] A discussion of the role of a central bank confronted with an asset bubble is provided by Miller (1996).

[11] Lower-case variables represent logarithms and I will suppress time subscripts wherever possible.

[12] A forward-looking inflation process of the sort modelled by Calvo (1983) would alter the results because it introduces fundamental problems of indeterminacy, some of which are discussed in Reinhart (1992).

$$\dot{i} = \alpha(y - k) + \beta\dot{\pi}$$

Further assume that, in this first-difference form of the Taylor rule, the net responsiveness to the change in the inflation rate is unity ($\beta = 1$), with the result that the change in the real rate is a function of the output gap. The consequence of such a policy rule combined with the backward-looking specification of inflation determination is that the central bank is merely satisfied with making the inflation rate follow a random walk, and the real rate follows:

$$\dot{r} = \alpha(y - k)$$

Some of the issues involved with the central bank following a rule conditioned only on real variables, that is, lacking a nominal anchor, are examined in Reinhart (1991). But for the purposes at hand, this rule serves to establish the important linkages between equity prices and monetary policy.

Equity prices satisfy the intertemporal arbitrage condition discussed in the previous section, written in continuous time as:

$$r + \rho = \frac{\delta}{q} + \frac{\dot{q}}{q}$$

where δ denotes the fixed stream of dividends and ρ is the premium required of equity investments; both the dividend rate and the equity premium are assumed to be constant, although it is of no consequence, except in complicating the notation, to make them functions of income.

Some steady-state comparisons

The solution to this model is straightforward. In the long run, output must equal its potential for policy to be at rest,

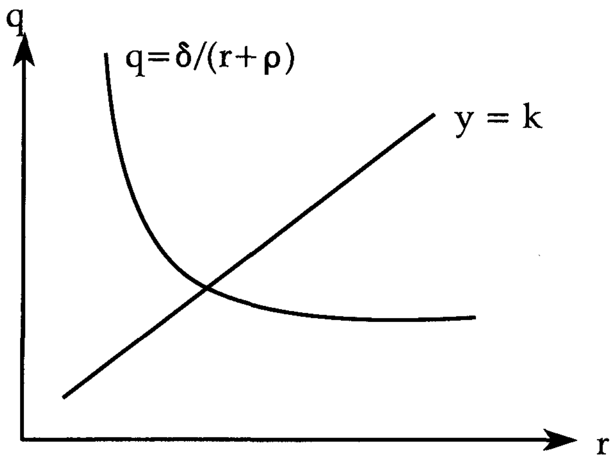
$$k = a_1 - a_2 r + a_3 q$$

and relative asset prices must satisfy the familiar rectangular hyperbola,

$$q = \frac{\delta}{r + \rho}$$

The determination of the real rate and equity prices, as in Figure 3, is set at the intersection of the two schedules.

Figure 3



Even at this basic level, before introducing dynamics, the model offers insight as to two structural changes that could bolster equity prices. As a first possibility, note that the level of potential output fixes the position of the spending-balance relationship. If the economy can produce at a higher level of resource utilization without generating inflationary pressures, real interest rates must be lower in the long run. But a lower rate of discount supports higher equity values, which would be seen as the movement up the equity-price-real-rate hyperbola. Notice, however, that the rise in equity prices should, in principle, be explained by lower real rates. Thus, the general failure of statistical models to predict the runup in share values over the past few years, along with the apparent continued elevated levels of real interest rates, suggests that more is at work than an increase in the economy's potential.

As a second possibility, note that the equity-price determination equation included ρ, the equity premium. That term is necessary to account for the fact that the mean excess return on equities over a risk-free rate in the United States is typically estimated at around 5 to 6% over long periods (as first documented by Mehra and Prescott (1985)). This equity premium is a puzzle in most theoretical models, in that it would be significantly eroded if households exhibited just a little willingness to shift their consumption intertemporally. Instead, the relatively high historical return on equities given the smoothness of consumption would seem to imply that consumers inordinately value stable consumption. In the simple model, a reduction in the equity premium shifts the long-run equity price locus outward, along the fixed policy rule, and is consistent with both a higher real interest rate and higher equity prices. From this perspective, the recent string of high returns could be seen as the price realignment required to pare the expected equity premium.

Many reasons might be offered as to why the equity premium has declined, including increased concerns about the value of social security benefits, the spread of defined-contribution pension plans, declines in the transactions costs and enhanced publicity of mutual funds, the aging of baby boomers, or even a decline in the expected volatility in nominal and real returns as the Federal Reserve makes further progress toward price stability. Whatever the reason, an exogenous decline in the equity premium would raise both equity prices and the real rate. Moreover, statistical models of the type estimated in the previous section would fail to explain that configuration of market returns because the regime over which those models were estimated no longer held sway. However, it is somewhat risky to emphasize an explanation that required jettisoning a regularity describing behavior of at least the past century. Further, this is less an explanation than a rationalization, because it pushes the fundamental explanation of high equity prices, why ρ declined, outside the scope of the model.

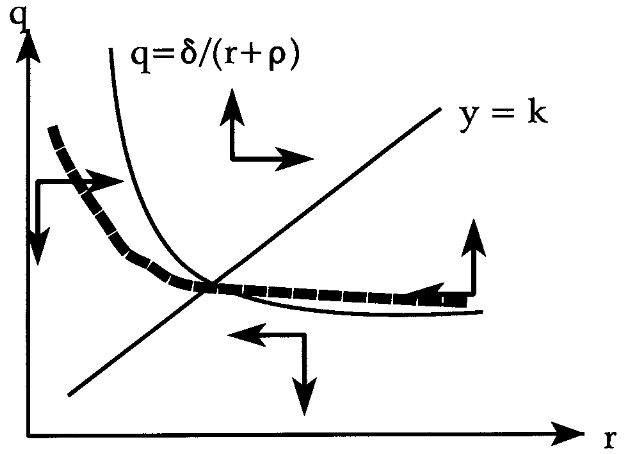
Dynamics

The movement from steady state to steady state can be described by two equations of motion (the rate-smoothing and equity-price-arbitrage relationships) which pinpoint r and q at each moment. As shown in Figure 4, there is a unique set of equity prices and real interest rates that provides for a stable transit to the steady state. Those points slope downward along the dashed line. However, any point in that quadrant can set off a dynamic path that satisfies all the equations of the model. It is only those points along the downward sloped saddlepath that satisfies the model and returns the system to its steady state from a point different from the long-run equilibrium.

Those points along the saddlepath match intuition: if monetary policy were unexpectedly loose, that is, if r fell below its long-run level, equity prices would jump up on impact. The spur to spending associated with a lower real rate and higher equity prices would send output above its potential, leading monetary policy to tighten gradually to return the economy to its potential. The relationship lurking in the background, the Phillips curve, implies that inflation will be permanently higher in an amount depending on the cumulative upward deviation of output from its potential. It is in this sense that high share price might be seen as emblematic of policy laxity. This view has led some, going back at least to Sprinkel (1964), to advocate that the central bank accord asset prices some priority among the indicators that it consults.

Regardless of the broader merit of that argument, four points should be considered before translating generally high equity values into a specific indictment of Federal Reserve policy. First, the

Figure 4



support provided by low interest rates to equity values should be shared by all long-lived assets. As yet, there is no evidence of widespread asset-price inflation, in that land, home, and commodity prices appear well contained. Second, the key mechanism by which policy bolsters the stock market is by pushing the real rate below its equilibrium level. While both the real short rate and its equilibrium are, to varying degrees, unobservable, reasonable proxies of current real rates are not particularly low. Third, within this tiny model, the Phillips curve rules, and temporarily high equity prices should be associated with a quickening of inflation. No such pressures are evident as yet. And fourth, at no point in the dynamic adjustment triggered by inappropriately easy monetary policy could equity prices be said to be overvalued. Rather, it is low real rates that buoy their value, a factor that should be captured in statistical models of equity values.

A near-rational bubble

In this model, an asset bubble would entail increases in equity prices beyond fundamentals that still allowed all relative prices to satisfy investors' arbitrage condition, spending balance, and the policy rule.[13] For instance, suppose that equity prices were just a bit higher than the long-run equilibrium level but the real rate was at its natural level, as at point A in Figure 5. Such a point could be thought of as a situation where monetary policy was correctly aligned for the steady state but equity markets misaligned, or monetary policy was currently too loose for the current level of equity prices. That point would be an equilibrium because expectations of future changes in equity prices would make both investors and policymakers content with all asset prices. The problem is that this starting point sets off explosive dynamics where equity prices are continually rising, as denoted by the thick solid arc. Along that transition, equity prices do not yield excess returns, rather, the low dividend-price ratio is just offset by capital gains.[14]

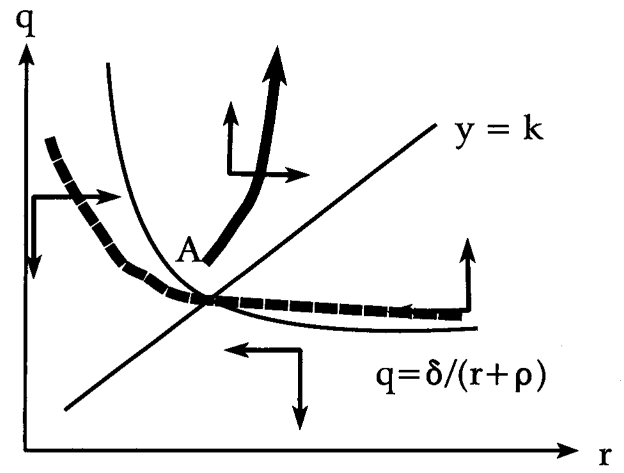
Monetary policymakers shadow the increase in equity prices by raising short rates, as required by the Taylor rule when aggregate demand rises as the result of higher-wealth-induced increases in aggregate demand. However, the gradualism embodied in the Taylor rule is not sufficient to offset the full extent of the effects of the rise in wealth: Because aggregate demand remains always above potential output, inflation is rising continually during this episode. Thus, the model yields the result that policymakers tighten in response to an asset bubble, but some of the effects of the rise in equity prices spill

---

[13] Work on asset-price bubbles was pioneered by Flood and Garber (1980). An attempt to determine if equity markets could be characterized as having a rational bubble can be found in Craine (1993).

[14] This is a near-rational bubble because investors should rationally expect that at some point it will pop. To make this a rational bubble, the model would have to include, and price, a random hazard that such an event would occur, as in Blanchard and Watson (1982).

Figure 5



over to inflation. Note also that tightening does not pop the bubble. Indeed, along the transition, capital gains are driven by the current short rate. So, *if the central bank raises the short rate, the asset bubble inflates faster to give investors the requisite higher return.*

Were there a rational bubble inflation in the current situation, we would expect that empirical models based on the long-run determination of equity prices would underpredict. This follows because the term dropped in moving from the instantaneous arbitrage condition to the long run, the anticipated change in equity prices, should systematically bias the predictions of empirical models. However, because a bubble does create wealth, we would expect it to generate excess demands for goods and inflationary potential. It is also the case that the evidence for rational bubbles is slim to nonexistent: As yet, no one has found a rational bubble in US history.

4. The systematic response of monetary policy to equity prices

The model also can be used to entertain questions about the appropriate degree to which monetary policymakers should respond to equity prices. Even with the simple Taylor rule, the central bank is responding to equity prices to the extent that those prices are important in influencing spending. That is, substituting the determination of aggregate demand into the policy rule yields:

$$\dot{r} = \alpha(a_1 - a_2 r + a_3 q - k)$$

Notice that in this formulation, equity prices are important for what they imply about future spending and inflation, not for their own sake. Indeed, they have the same status as any of the other critical determinants of spending, production, and inflation, such as the foreign exchange value of the dollar, federal spending and taxes, and foreign economic activity, which are subsumed in the constant terms of this model. But, as already mentioned, equity prices straying from their long-run level directly corresponds to a monetary policy misalignment. This might suggest keying policy choice to share values, if the central bank knew fundamental valuations.

Elevating attention to equities beyond their direct consequences to spending would entail adding another term to this rule. Policymakers might be confident about fundamentals, in which case the central bank could respond incrementally to the *level* of equity prices or, if unsure of the long-run value of the stock market, they might move their policy lever based on *changes* in equity prices.

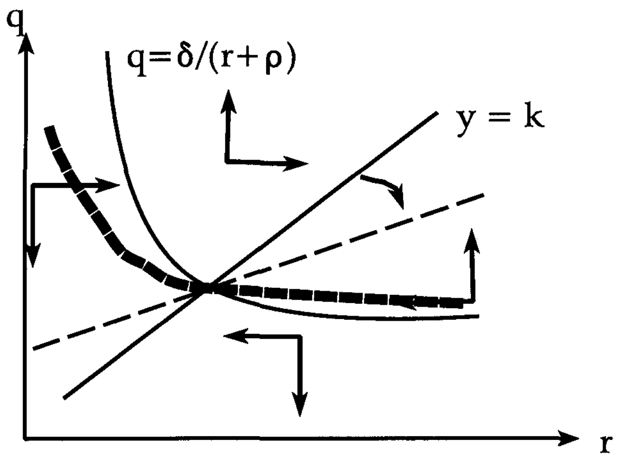
Feedback to the level of equity prices

If policymakers cared about the level of equity prices beyond any consequences for spending, they could modify their rule to:

$$\dot{r} = \alpha(a_1 - a_2 r + a_3 q - k) + \gamma(q - \overline{q})$$

where the line above a variable denotes its steady-state value. This additional concern about equity prices has the effect of flattening the long-run locus at which policy is at rest, as in Figure 6. Essentially, the central bank is no longer satisfied with responding solely to output varying from its potential; it also moves when out of the steady state because share values differ from their long-run levels. This flattens the saddlepath. While changes in equity prices around a steady state are damped, transitions from one to another are more abrupt. Thus, the consequence for volatility is not obvious. If prices move mostly because of the release of information regarding fundamentals, then there would be larger discrete changes. If prices move mostly to generate the capital gains required to equate returns, then volatility would be damped.[15] The profession's general inability to explain equity prices, which was also evident in the regression exercises earlier, would seem to imply that movements in the former, not the latter, camp are importantly responsible for volatility.

Figure 6



Responding to changes in equity prices

Concern about the change in equity prices could be expressed in a policy rule written as:

$$\dot{r} = \alpha(a_1 - a_2 r + a_3 q - k) + \lambda\frac{\dot{q}}{q}$$

This might be justified by the central bank leaning against the wind of surges or collapses in share values. It might particularly find favor because the rule does not presume that the central bank knows the long-run level of equity prices, but rather responds to an observable, for example, recent changes in

[15] A similar ambiguity in the effect of capital controls on asset-price volatility is shown in Reinhart (1998).

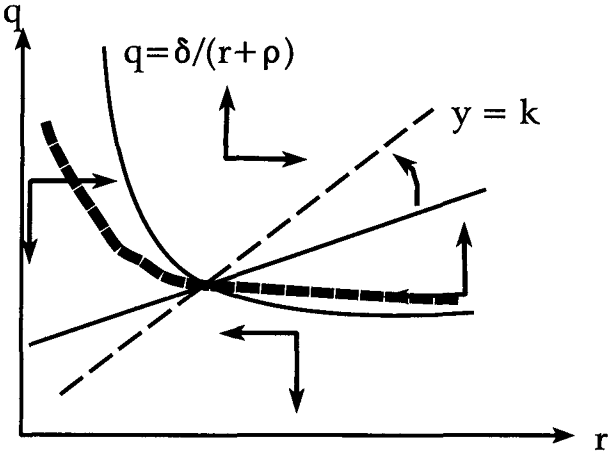
equity prices. However, levels of variables do matter because the change in equity prices can be explained by the arbitrage condition.

Indeed, the effect of this emendation of the rule is to change the extent of the central bank's feedback on both the level of equity prices and its policy instrument. While there is no change in either the slope or the position of the equity arbitrage condition, the slope of the condition at which policy rests (evaluated at the steady state) becomes:

$$\frac{\Delta(q - \bar{q})}{\Delta(r - \bar{r})} = \frac{\lambda - \alpha a_2}{\alpha a_3 + \frac{\lambda\delta}{\bar{q}^2}}$$

Notice that a positive term, the feedback to equity price changes, enters the numerator. As suggested by Figure 7, increasing the responsiveness to changes in equity prices rotates the policy locus leftward. For small values of λ, this steepens the saddlepath; as a result, policy deviations produce larger swings in equity values. For sufficiently large values of λ, the dynamics become explosive so that any policy deviation from the long-run value of the real rate eventually generates an unbounded change in equity values. Essentially, by responding to past changes in stock prices, the central bank has become a feedback trader, amplifying swings in prices. Should that feedback be sufficiently intense, that behavior becomes destabilizing.

Figure 7



The message from this model for an analyst seeking to raise the weight of asset prices in monetary policy is discouraging, in that

- responsiveness to the level of equity prices increases the impact of news on valuations, while
- responsiveness to the change in equity prices sets up a feedback loop that raises the net swing in equity prices to policy misalignments and may, depending on parameters, destabilize.

If a central bank steers clear of these problems by not giving equity prices an explicit role in its policy setting, it will still have to monitor the stock market, even beyond any concerns about systemic risk. Equity prices will enter into policy formulation to the extent that they are important determinants of aggregate demand and a contemporaneous signal of the stance of policy.

Conclusion

Because of the lags in the effects of monetary policy on spending and, even further delayed, on price formation, waiting to tighten until inflation is evident is waiting too long. As a result, policy must be preemptive to help to preserve an economic expansion. However, conducting monetary policy in a preemptive fashion requires being willing to set policy on the basis of forecasts of real economic activity and inflation. One element that is important in such an assessment is the current level and the expected future direction of equity prices. Thus, elevated equity prices might tip the balance in favor of policy restraint if a forward-looking central bank was concerned that this higher wealth would fuel excessive aggregate demand or otherwise signalled that policy was misaligned. In that formulation, equity prices are important for what they imply about future spending and inflation, not for their own sake. Indeed, they have the same status as any of the other critical determinants of spending, production, and inflation, such as the foreign exchange value of the currency, the federal budget balance, and foreign economic activity.

Some analysts have suggested that equity prices, at times, should have a more important role than solely what they imply for the economic forecast, particularly when there are signs that the market is overvalued. Obviously, this requires that the central bank have a firmer view of fundamentals than the market and a willingness both to stray from its fundamental goal of achieving price stability and to accept responsibility for the actions it might take to move the market back to fundamentals. In principle, equity prices might receive elevated consideration if the central bank were worried that the inflating of an asset bubble implied a significant misallocation of resources or that the bursting of the bubble would pose systemic risks or other macroeconomic spillovers that could not be addressed by other instruments of monetary policy, including the discount window, or, perhaps, by supervisory action. The message from a simple theoretical model of the economy is that such proposals should be treated warily. While equity prices do indeed signal the stance of monetary policy, responding to them in a mechanistic manner may actually raise their volatility and, in the extreme, destabilize.

Of course, the central bank may be concerned with distortions induced by overvalued share prices. The misallocation of resources associated with elevated equity prices could take the form of excessive consumption because households spend from their higher wealth or excessive capital spending because firms find it easy to raise funds. While such stimulus to consumption raises the risk that aggregate spending would outstrip potential output, there is an offset. Imports appear also to be sensitive to equity prices, and more so proportionally than total consumption. As for capital spending, there is evidence that elevated share values contributes to the strength of that component of aggregate demand. If a boom in spending also carries with it the risk of a subsequent bust, the associated spending has fueled impressive gains in capacity, which may help to account for the recent good performance of inflation.

Appendix: The time-series properties of the variables

Typically, researchers look for a specific form of nonstationary behavior; for instance, does a series or composite of series have a unit root? The standard tests include the Dickey-Fuller (D.F.) and augmented Dickey-Fuller (A.D.F.) statistics. A complication arises because the form and distribution of any of these statistics depend on the exact form that the null hypothesis of a unit root takes. For example, the null hypothesis of a unit root may or may not have a drift term or, as emphasized by Perron (1989), structural breaks of a variety of forms. This appendix presents a collection of test statistics for the raw variables. Tests using data underlying the monthly models were estimated using observations from January 1980 to December 1996. Additionally, statistics for combinations of those variables relevant for the model

Table A-1

Is there one unit root?

Estimated using monthly data from January 1980 to December 1996

	Assuming no drift		Drift		Assuming break	
	D.F.	A.D.F.	D.F.	A.D.F.	D.F.	A.D.F.
A. Macroeconomic variables	(1)	(2)	(3)	(4)	(5)	(6)
1. Unemployment rate	-0.76	-1.62	-1.79	-2.45	-1.74	-2.38
2. Federal funds rate	-1.87	-1.98	-2.64	-2.99	-2.72	-3.09
Treasury yields						
3. Three-month	-1.85	-1.95	-2.58	-2.93	-2.64	-2.99
4. One-year	-1.59	-1.64	-2.45	-2.68	-2.50	-2.72
5. Three-year	-1.25	-1.39	-2.47	-2.86	-2.48	-2.87
6. Ten-year	-0.94	-1.23	-2.52	-3.07	-2.49	-3.06
7. S&P 500 earnings-price yield	-1.85	-1.96	-1.81	-2.45	-1.67	-2.36
Private yields						
8. Commercial paper (six-month)	-1.91	-1.90	-2.75	-2.91	-2.84	-3.01
9. AAA-rated Utility	-0.55	-0.94	-2.46	-3.10	-2.39	-3.07
10. Moody's A-rated	-0.81	-1.01	-2.33	-2.80	-2.30	-2.78
Inflation expectations						
11. One year ahead	-3.46	-3.25	-3.36	-2.70	-3.63	-2.82
12. Ten years ahead	-2.86	-2.36	-3.59	-2.33	-4.09	-2.55
B. Real interest rates						
13. Federal funds rate	-2.21	-2.12	-3.22	-3.34	-3.20	-3.32
Treasury yields						
14. Three-month	-2.39	-2.31	-3.23	-3.25	-3.22	-3.25
15. One-year	-2.26	-2.09	-3.21	-3.09	-3.20	-3.09
16. Three-year	-2.01	-2.14	-2.89	-3.07	-2.88	-3.06
17. Ten-year	-2.21	-2.09	-3.06	-2.95	-3.05	-2.95
18. S&P 500 earnings-price yield	-2.33	-1.93	-3.04	-2.47	-3.08	-2.54
Private yields						
19. Commercial paper (six-month)	-2.40	-2.21	-3.32	-3.21	-3.29	-3.19
20. AAA-rated Utility	-2.16	-1.99	-3.06	-2.92	-3.09	-2.94
21. Moody's A-rated	-1.89	-1.84	-2.99	-2.97	-2.99	-2.96
C. Critical values						
1%	-4.08		-4.08		-4.32	
5%	-3.47		-3.47		-3.76	
10%	-3.17		-3.17		-3.46	

Table A-2

Are there two unit roots?

Estimated using monthly data from January 1980 to December 1996

	Assuming no drift		Drift		Assuming break	
	D.F.	**A.D.F.**	**D.F.**	**A.D.F.**	**D.F.**	**A.D.F.**
A. Macroeconomic variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
1. Unemployment rate	-12.42	-4.38	-12.56	-4.45	-12.91	-4.66
2. Federal funds rate	-9.57	-9.09	-9.56	-9.08	-9.57	-9.09
Treasury yields						
3. Three-month	-9.93	-8.06	-9.93	-8.06	-9.94	-8.08
4. One-year	-9.96	-8.15	-9.96	-8.15	-9.97	-8.16
5. Three-year	-9.84	-7.55	-9.84	-7.55	-9.84	-7.56
6. Ten-year	-9.95	-7.07	-9.96	-7.08	-9.96	-7.11
7. S&P 500 earnings-price yield	-11.35	-5.75	-11.39	-5.78	-11.44	-5.82
Private yields						
8. Commercial paper (six-month)	-10.70	-8.77	-10.70	-8.77	-10.70	-8.77
9. AAA-rated Utility	-8.91	-6.34	-8.93	-6.36	-8.95	-6.41
10. Moody's A-rated	-9.85	-6.79	-9.85	-6.79	-9.86	-6.83
Inflation expectations						
11. One-year ahead	-19.02	-8.53	-19.12	-8.69	-19.12	-8.69
12. Ten-years ahead	-17.49	-10.56	-17.52	-10.65	-17.52	-10.64
B. Real interest rates						
13. Federal funds rate	-11.13	-9.26	-11.13	-9.28	-11.13	-9.29
Treasury yields						
14. Three-month	-12.43	-8.40	-12.44	-8.42	-12.45	-8.45
15. One-year	-13.29	-8.40	-13.30	-8.43	-13.31	-8.44
16. Three-year	-12.15	-7.67	-12.18	-7.71	-12.18	-7.72
17. Ten-year	-13.88	-7.32	-13.93	-7.39	-13.93	-7.40
18. S&P 500 earnings-price yield	-16.48	-7.41	-16.48	-7.41	-16.52	-7.47
Private yields						
19. Commercial paper (six-month)	-12.64	-8.87	-12.64	-8.89	-12.64	-8.89
20. AAA-rated Utility	-14.38	-7.61	-14.47	-7.75	-14.48	-7.77
21. Moody's A-rated	-13.70	-7.62	-13.75	-7.70	-13.76	-7.73
C. Critical values						
1%	-4.08		-4.08		-4.32	
5%	-3.47		-3.47		-3.76	
10%	-3.17		-3.17		-3.46	

– real interest rates – were calculated. Table A-1 tests for the presence of one unit root while Table A-2 checks for two unit roots. The first two columns of each table record statistics based on the assumption that there is no drift, the middle two columns posit a significant drift, while the last two permit drift and a single permanent shift in the intercept term commencing in October 1987. The Dickey-Fuller and augmented Dickey-Fuller test statistics must be negative and larger in absolute value than the corresponding critical values, which can be found in Guilkey and Schmidt (1989) and Perron (1989).

As is clear from the entries in the first table, the raw variables have at least one unit root. Further, the simple transformations involved in calculating real rates and equity-index ratios are insufficient to render those variables stationary. In other words, it will take more work to yield cointegrating relationships, and the estimation technique will have to reflect these properties. As is evident in Table A-2, though, each variable appears to have no more than a single unit root.

Table A-3 applies this same battery of tests to the quarterly data on the logarithms of spending, real equity prices (deflated by the appropriate chain-weighted price index for each category of spending), and the slope of the term structure, sampled quarterly from 1973 to 1996. For the Perron-style test of a unit root in the presence of a segmented trend, I arbitrarily assumed a single break in the fourth quarter of 1984. Again, as is evident in panel A of the table, none of the levels of these variables are stationary, but, as in panel B, differences are. Thus, these variables appear individually to have single unit roots. It is the aim of the main text to investigate how they combine to form cointegrating relationships.

Table A-3

Are there one or two unit roots?

Estimated using quarterly data from 1973:1 to 1996:4

	Assuming no drift		**Drift**		**Assuming break**	
	D.F.	**A.D.F.**	**D.F.**	**A.D.F.**	**D.F.**	**A.D.F.**
A. Is there one unit root?	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Quantities (chain-weighted)						
1. GDP	-0.26	-0.24	-1.86	-3.26	-2.28	-3.66
2. Consumption	-0.19	0.04	-1.50	-3.03	-2.24	-3.46
3. Investment	0.20	-0.65	-1.48	-3.30	-1.46	-3.22
4. Imports	0.85	0.21	-2.16	-2.80	-2.41	-3.02
5. Slope of the Treasury term structure (10-year less 3-month)	-2.71	-3.13	-2.86	-3.39	-2.86	-3.40
Real S&P 500 deflated by price index						
6. GDP	0.58	0.08	-2.46	-2.62	-2.23	-2.56
7. Consumption	0.47	-0.03	-2.47	-2.66	-2.26	-2.61
8. Investment	0.94	0.31	-2.36	-2.48	-2.07	-2.39
9. Imports	0.51	-0.43	-2.86	-2.92	-2.42	-2.85
B. Are there two unit roots?						
Quantities (chain-weighted)						
1. GDP	-6.98	-4.21	-7.00	-4.24	-7.01	-4.28
2. Consumption	-7.72	-3.86	-7.79	-3.90	-7.84	-3.94
3. Investment	-5.47	-3.80	-5.45	-3.77	-5.46	-3.77
4. Imports	-7.31	-4.21	-7.32	-4.21	-7.32	-4.22
5. Slope of the Treasury term structure (10-year less 3-month)	-8.70	-5.38	-8.67	-5.33	-8.75	-5.49
Real S&P 500 deflated by price index						
6. GDP	-7.20	-4.21	-7.49	-4.60	-7.57	-4.67
7. Consumption	-7.23	-4.26	-7.49	-4.61	-7.56	-4.68
8. Investment	-6.91	-4.08	-7.24	-4.51	-7.31	-4.57
9. Imports	-6.12	-3.83	-6.44	-4.21	-6.47	-4.24
C. Critical Values						
1%	-4.08		-4.08		-4.32	
5%	-3.47		-3.47		-3.76	
10%	-3.17		-3.17		-3.46	

References

Berkowitz, Jeremy and Lorenzo Giorgianni (1996): "Long-horizon exchange rate predictability?" Board of Governors of the Federal Reserve System, *Working Paper*, September.

Blanchard, Olivier J. (1981): "Output, the stock market, and interest rates." *American Economic Review* No. 71, pp. 132-43, March.

Blanchard, Olivier J. and Rudiger Dornbusch (1984): "U.S. deficits, the dollar, and Europe". Banca Nazionale del Lavoro, *Quarterly Review*, No. 148, pp. 89-113.

Blanchard, Olivier J. and Mark Watson (1982): "Bubbles, rational expectations and financial markets", in Paul Wachtel (Ed.), *Crises in the Economic and Financial Structure*, Lexington Books, Lexington, MA.

Branson, William, Armenio Fraga and Robert A. Johnson (1985): "Expected fiscal policy and the recession of 1982". Federal Reserve Board of Governors, unpublished paper.

Calvo, Guillermo A. (1983): "Staggered contracts in a utility-maximizing framework". *Journal of Monetary Economics*, No. 12, pp. 383-98, November.

Campbell, John Y. and Robert J. Shiller (1987): "Cointegration and tests of present value models". *Journal of Political Economy*, No. 95, pp. 1062-88, October.

Campbell, John Y. and Pierre Perron (1991): "Pitfalls and opportunities: what macroeconomists should know about unit roots". *NBER Macroeconomics Annual*, No. 6, pp. 144-200.

Cochrane, John H. (1991): "A critique of the application of unit root test". *Journal of Economic Dynamics and Control*, No. 15, pp. 275-84.

Cochrane, John H. (1997): "Where is the market going? Uncertain facts and novel theories". Federal Reserve Bank of Chicago, *Economic Perspectives*, No. 21, pp. 3-37, November/December.

Craine, Roger (1993): "Rations bubbles: a test". *Journal of Economic Dynamics and Control*, No. 17, pp. 829-46.

Dornbusch, Rudiger (1986): "Flexible exchange rates and excess capital mobility". *Brookings Papers Papers on Economic Activity*, No. 17, 209-26.

Engle, Robert W. and Clive W. J. Granger (1987): "Co-integration and error correction: representation, estimation, and testing". *Econometrica*, No. 55, pp. 251-76, March.

Estrella, Arturo and Gikas Hardouvelis (1991): "The term structure as predictor of real economic activity". *Journal of Finance*, No. 46, pp. 555-76.

Flood, Robert and Peter Garber (1980): "Market fundamentals versus price level bubbles: the first tests". *Journal of Political Economy*, No. 88, pp. 747-70.

Friedman, Benjamin (1978): "Crowding out or crowding in? Economic consequences of financing government deficits". *Brookings Papers on Economic Activity*, pp. 593-641.

Gordon, Myron J. (1962): *The Investment, Financing, and Valuation of the Corporation*, Richard D. Irwin, Inc. (Ed.) Homewood, IL.

Guilkey, David K. and Peter Schmidt (1989): "Extended tabulations for Dickey-Fuller tests". *Economic Letters*, No. 31, pp. 355-7.

Mauskopf, Eileen (1990): "The transmission channels of monetary policy: how have they changed". Federal Reserve *Bulletin*, No. 76, pp. 985-1008, December.

Mehra, Rajnish and Edward Prescott (1985): "The equity premium: a puzzle". *Journal of Monetary Economics*, No. 15, pp. 145-62, March.

Miller, Geoffrey P. (1996): "The role of a central bank in a bubble economy". *Cardozo Law Review*, No. 18, pp. 1053-81.

Perron, Pierre (1989): "The great crash, the oil price shock, and the unit root hypothesis". *Econometrica*, No. 57, pp. 1361-401, November.

Reinhart, Vincent R. (1991): "Conducting monetary policy without a nominal anchor." *Journal of Macroeconomics*, No. 13, pp. 573-96, Fall.

Reinhart, Vincent R. (1992): "The design of an interest rate rule with staggered contracting and costly transacting". *Journal of Macroeconomics*, No. 14, pp. 663-88, Fall.

Reinhart, Vincent R. (1998): "How the machinery of international finance runs with sand in its wheels". *Review of International Economics*, forthcoming.

Rose, Andrew K. (1988): "Is the real interest rate stable?" *Journal of Finance*, No. 63, pp. 1095-112, December.

Shiller, Robert J. (1981): "Do stock prices move too much to be justified by subsequent changes in dividends?" *American Economic Review*, No. 71, pp. 421-36, June.

Shiller, Robert J. (1989): *Market Volatility*, MIT Press, Cambridge, MA.

Sims, Christopher A. (1982): "Policy analysis with econometric models". *Brookings Papers on Economic Activity*, pp. 107-64.

Sprinkel, Beryl W. (1964): *Money and Stock Prices*, Richard D. Irwin, Inc. (Ed.) Homewood, IL.

Taylor, John B. (1993): "Discretion versus policy rules in practice". *Carnegie-Rochester Conference Series on Public Policy*, No. 39, pp. 195-214.