Should the Fed Take Deliberate Steps to Deflate Asset Price Bubbles?

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On several occasions over the last few years, various economists and policymakers have expressed the opinion that the stock market was overvalued. They often compared the situation with the 1920s and warned that the U.S. economy was headed for a similar collapse. Some analysts also suggested that the Fed raise interest rates to slow the rate of "asset inflation," on the grounds that it would be better to burst a speculative bubble in its early stages than to let it develop and suffer the inevitable crash. This paper takes up the other side of the debate and argues that deliberate attempts to puncture asset price bubbles may well turn out to be destabilizing. Identification of asset price bubbles requires more knowledge about asset price fundamentals than central banks possess, and the inability to identify speculative bubbles makes it difficult to take timely and well-measured countervailing actions.

"There is a fundamental problem with market intervention to prick a bubble. It presumes that you know more than the market."

—Alan Greenspan, quoted in the *New York Times*, November 15, 1998.

By historical standards, stock prices are very high. Prices have more than doubled over the last few years, and measures of conventional valuation have reached record levels. For example, dividend yields on shares in large firms have fallen below 2 percent, and despite last summer's fall in the market they remain below the levels prevailing before the Crash of 1987 or the Great Crash of 1929.

Because of the rapid increase in prices and unprecedented measures of conventional valuation, some economists have expressed concern that the stock market is overvalued. For example, in December 1996, Federal Reserve Chairman Alan Greenspan warned that the market was being driven by "irrational exuberance." Various other economists and financial journalists have also compared the situation with the 1920s and have warned that the market may be headed for a similar collapse.[1] In addition, some cite the experience of the 1920s as an example of the damage that can result when the central bank stands by and allows a speculative bubble to develop unabated. In order to avoid the same mistake, they suggest it might be better for the Fed to act preemptively and take deliberate steps to deflate a bubble, rather than to let it grow and suffer through a cycle of boom and bust.[2]

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1. For example, see the April 18, 1998 cover story in *The Economist*.

2. Roughly speaking, a concern about bubbles and asset price stabilization can be motivated by appealing to models with a credit propagation channel, such as in Bernanke and Gertler (1989) or Kiyotaki and Moore (1997), as well as some mechanism that gives rise to equilibrium indeterminacy. The essential idea goes as follows. Capital assets serve not only as factors of production but also as collateral for external credit. That is, capital goods are valuable to business firms not only for the output which they help produce but also for obtaining credit from banks, finance companies, and so on. When a stock price bubble emerges, a firm's capital increases in value. This loosens external credit constraints and allows an expansion of investment. But because the firm's assets are overvalued, loans are collateralized at prices that cannot be sustained.

This proposal begs two questions. First, how do we know that the market is overvalued? Economists and financial analysts make judgments like this by comparing market prices with "fundamental valuation," which is determined by the expected present discounted value of future dividends. In practice, a stock's fundamental value is determined by some model of dividends and discount factors. Analysts infer that a stock is over- or undervalued when there are gross differences between its model valuation and market price. Of course, valuation models are only approximate, and they necessarily omit certain factors that are relevant for tracking market fundamentals. Among other things, this means that there is bound to be some variation in fundamental valuation that approximating models cannot explain and that model valuations will differ from market prices even if market prices are uniquely determined by fundamentals.

This is the source of an identification problem originally pointed out by Hamilton and Whiteman (1985). In a rather general setting, they demonstrated that speculative bubbles are *observationally equivalent* to movements in unobserved fundamentals governing dividends and discount factors. Thus, in the absence of *complete* information about fundamentals (which central bank analysts cannot possess), the existence of a bubble cannot be empirically verified. Furthermore, because small but persistent movements in hidden fundamentals can give rise to enormous model approximation errors, one cannot infer that a bubble exists even when prices are *grossly* out of line with model valuations. Thus, we really can't know whether the market is overvalued.

The second question concerns how the Fed should proceed given that it cannot confirm that a bubble exists. The paper argues that inability to identify bubbles makes it difficult to take timely and well-measured actions to puncture them. Because policies conditioned on noisy or unobserved state variables can be destabilizing rather than stabilizing, deliberate attempts to puncture speculative bubbles may turn out to be counterproductive.

The paper presents a case study which illustrates this possibility. The case involves monetary policy in the late 1920s, when (contrary to some recent revisionist accounts) the Federal Reserve took aggressive steps to curb speculation on the stock market. Starting in 1928, monetary policy was sharply contractionary at home, and because of the gold standard foreign central banks were also obliged to tighten. These actions succeeded in slowing economic activity and in stopping the rapid increase in share prices. But it is not at all clear whether the monetary actions of 1928–1930 were stabilizing or destabilizing.

I. Do We Know that the Market Is Overvalued?

In this section, I consider the problem of empirically verifying the existence of a speculative bubble. I present an example which illustrates that unless central bank analysts have access to *all* the information that private investors use to price securities, they will be unable to distinguish asset price bubbles from unobserved movements in fundamentals. The argument presented here is a simplified version of the one presented by Hamilton and Whiteman (1985), but the main point generalizes to more complicated environments. I also demonstrate that apparent bubbles can be quite large even if unobserved movements in fundamentals are rather small. Even gross pricing errors are not prima facie evidence of bubbles.

Fundamentals and Bubbles

The example is based on Campbell and Shiller's (1988) approximate present value model, which links variation in stock prices to changes in expected dividends and discount factors. I chose this model because it provides the simplest framework within which to discuss the policy question.

To begin, define the gross return on an equity (or portfolio of equities) as

(1) $$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} ,$$

where P_t is the equity price and D_t is the dividend payment. Because prices and dividends grow exponentially, it is convenient to study their natural logarithms. Letting lower case variables represent natural logs of their upper case counterparts, equation (1) can be written as

(2) $$p_t = p_{t+1} + \log[1 + \exp(d_{t+1} - p_{t+1})] - r_{t+1} .$$

Although the exact relation between prices, dividends, and returns is non-linear, following Campbell and Shiller one can derive an approximate linear relation by taking a first-order Taylor expansion around the mean of the log dividend-price ratio. The approximate formula is

(3) $$p_t = k + \rho p_{t+1} + (1 - \rho) d_{t+1} - r_{t+1} ,$$

where ρ and k are constants of linearization,

$$\rho = \{1 + \exp[E(d_t - p_t)]\}^{-1} ,$$

When the bubble bursts, asset prices fall and loans that were formerly well-collateralized may no longer be. This tightens external credit constraints, and lending for new investment projects declines. Hence, an asset bubble may give rise to a cycle of boom and bust in investment. In principle, the cycle of boom and bust could be avoided if policymakers could somehow offset the impulse giving rise to the bubble, or if they were to adopt a policy rule that eliminated the indeterminacy.

$$k = -\log(\rho) - (1-\rho)\log(1/\rho - 1) .$$

Over the period 1926 to 1994 (i.e., omitting the recent run-up in prices), the mean annual dividend yield, D_t/P_t, on the U.S. stock market was 4 percent, which means that ρ is around 0.96 and k is around 0.08.

Many discussions about stock market valuation focus not on prices per se but on the ratio of prices to dividends. To develop formulas for the price-dividend ratio, subtract current dividends from both sides of (3) and re-arrange terms:

(4) $$(p_t - d_t) = k + \rho(p_{t+1} - d_{t+1}) + \Delta d_{t+1} - r_{t+1} .$$

Now take the expected value of both sides, conditional on available information. Because $(p_t - d_t)$ is observable, its realization and projection are equal. The variables on the right hand side are still unknown, however, and are replaced by their expected values:

(5) $$(p_t - d_t) = E_t[k + \rho(p_{t+1} - d_{t+1}) + \Delta d_{t+1} - r_{t+1}] .$$

Here the notation E_t represents an investor's expectation conditioned on information available at date t.

Equation (5) is a linear expectational difference equation which is stable into the future. Iterating forward for K periods, the current price-dividend ratio can be expressed as

(6) $$(p_t - d_t) = E_t\sum_{j=0}^{K}\rho^j(k + \Delta d_{t+j+1} - r_{t+j+1}) + \rho^K E_t(p_{t+K} - d_{t+K}) .$$

In order for fundamentals to determine prices uniquely, it must be the case that the second term on the right hand side shrinks to zero as K grows large:

(7) $$\lim_{K\to\infty} \rho^K E_t(p_{t+K} - d_{t+K}) = 0 .$$

Assuming this condition holds, the log price-dividend ratio can be expressed in terms of the present value of expected dividend growth and returns,

(8) $$F_t = k(1-\rho)^{-1} + E_t\sum_{j=0}^{\infty}\rho^j(\Delta d_{t+j+1} - r_{t+j+1}) .$$

Here the notation F_t indicates that this is the "fundamental" value for the price-dividend ratio.

Later on, it will be convenient to separate expected stock returns into two components, a risk-free rate, $r_{f,t}$, and a risk premium, $r_{p,t}$. The risk-free rate and risk premium both depend on the stochastic discount factor used to value uncertain future returns (e.g., see Hansen and Richard 1987). The risk-free rate is inversely related to the conditional expectation of the stochastic discount factor, M_t:

$$(1 + r_{f,t+1})^{-1} = E_t M_{t+1} ,$$

and the risk premium is related to its conditional covariance with excess returns:

$$r_{p,t+1} = \frac{-cov_t(M_{t+1}, r_{t+1} - r_{f,t+1})}{E_t M_{t+1}} .$$

Substituting the identity $E_t r_{t+j+1} = E_t(r_{f,t+j+1} + r_{p,t+j+1})$ into equation (8) and suppressing the constant term yields the following expression for the fundamental price-dividend ratio:

(9) $$F_t = E_t\sum_{j=0}^{\infty}\rho^j\Delta d_{t+j+1} - E_t\sum_{j=0}^{\infty}\rho^j r_{f,t+j+1} - E_t\sum_{j=0}^{\infty}\rho^j r_{p,t+j+1} .$$

Other things equal, the fundamental price-dividend ratio is increasing in expected dividend growth and decreasing in future risk premia or risk-free rates.

If the convergence condition (7) does not hold, there are an infinite number of solutions to (5), each of which satisfies

(10) $$(p_t - d_t) = B_t + F_t ,$$

where $B_t = \lim_{j\to\infty}\rho^j E_t(p_{t+K} - d_{t+K})$ represents a "bubble" in the current ratio. This term represents the effects of self-fulfilling forecasts on securities markets.[3]

For example, an investor might be willing to buy a security for a price greater than its fundamental value if he believed that one period hence someone else would offer an even higher price for it. In turn, the second buyer might be tempted by the expectation that a third buyer would appear later on, willing to pay an even higher price. In other words, prices might be high if investors expect them to rise in the future, and they might expect them to rise in the future simply because they believe other investors also expect them to rise in the future. Mackay (1932) surveyed a number of historical episodes that seem to fit this description.

In any case, condition (7) rules out self-fulfilling beliefs of asset appreciation, because it says that the discounted price must eventually fall in line with dividends. Otherwise, self-fulfilling beliefs could give rise to variation in asset prices that are unrelated to fundamentals.

Bubbles and Model Pricing Errors

Now consider the problem of identifying a bubble. To think clearly about this problem, one must be explicit about the information available to private investors and to central bank analysts. I assume that private investors exploit information

3. Mathematically, a bubble can occur if the price-dividend ratio were expected to grow at a rate faster than 1/ρ. For heuristic arguments concerning the existence of bubbles in general equilibrium, see Campbell, Lo, and MacKinlay (1997), ch. 7. For a formal treatment, see Santos and Woodford (1997).

on a wide variety of variables that are useful for predicting dividend growth and returns. They certainly know the history of dividends and returns themselves, and probably rely on many other indicators as well. Their (large) information set is represented by current and past values of a vector $\mathbf{x}_t = [\Delta d_t, r_{ft}, r_{pt}, \mathbf{y}_t']'$, where the vector $\mathbf{y}_t$ includes whatever additional information they possess.

The companion form for $\mathbf{x}_t$,

$$\mathbf{z}_t = \mathbf{A}\mathbf{z}_{t-1} + \mathbf{u}_t \ , \tag{11}$$

is especially useful for calculating present values. Here $\mathbf{z}_t$ is a vector in which current and past values of $\mathbf{x}_t$ are stacked one on top of another.[4] For simplicity, I have also dropped the constants, and from this point on all the variables should be interpreted as deviations from mean values.

According to (11), the k-year ahead forecast for $\mathbf{z}_t$ is just $\mathbf{A}^k\mathbf{z}_t$. To pick out the forecast of dividend growth or returns, define row vectors $\mathbf{S}_d$, $\mathbf{S}_{rf}$, and $\mathbf{S}_{rp}$ to be conformable with $\mathbf{z}_t$, to have values of 1 in the places corresponding to Δd_t, r_{ft} and r_{pt},respectively, and to have values of 0 everywhere else. Then,

$$E_t\Delta d_{t+k} = \mathbf{S}_d\mathbf{A}^k\mathbf{z}_t \ , \tag{12}$$

$$E_t r_{f,t+k} = \mathbf{S}_{rf}\mathbf{A}^k\mathbf{z}_t \ . \tag{13}$$

and

$$E_t r_{p,t+k} = \mathbf{S}_{rp}\mathbf{A}^k\mathbf{z}_t \ . \tag{14}$$

Substituting these expressions back into the present value formula (equation 9), the fundamental solution is

$$F_t = (\mathbf{S}_d - \mathbf{S}_{rf} - \mathbf{S}_{rp})\mathbf{A}(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{z}_t \ . \tag{15}$$

I assume that condition (7) holds, so that market and fundamental valuations coincide:

$$(p_t - d_t) = F_t \ . \tag{16}$$

This assumption is made to simplify the analysis and to construct an especially transparent example of the identification problem.

Now, suppose that central bank analysts also believe that fundamental values are determined according to (9) but are unsure whether (7) holds. How would they go about trying to verify the existence of a bubble?

If they had access to the same information as private investors, the central bank staff would also form forecasts according to equations (12) through (14) and plug them into the fundamental valuation formula (15). Then, if there were a difference between their valuation model and market prices, they would infer the presence of a bubble. In our example, they would find that market and fundamental valuations coincide and correctly conclude that there are no bubbles.

This works if central bank analysts have access to all the information used by the private sector. But what if they do not? After all, although central banks gather and process a great deal of information about the economy, their primary focus is on inflation, not on picking stocks or managing portfolios. Financial market conditions are relevant for predicting inflation, and central bankers do analyze and monitor a great deal of information relevant to securities markets. But somehow I suspect that private financial analysts devote greater resources and attention to the problem of pricing securities. Thus, it seems more plausible to assume that central bank analysts have access to only a *subset* of the information available to private analysts.

To formalize this assumption, partition the vector $\mathbf{y}_t$ into $[\mathbf{y}_{1t}', \mathbf{y}_{2t}']'$, and assume that everyone observes $\mathbf{y}_{1t}'$ but that only private investors observe $\mathbf{y}_{2t}'$. Hence, the central bank also knows the history of returns and dividend growth, as well as some (perhaps much) of the additional information upon which private investors rely. Finally, I assume that market prices are determined by the behavior of private investors, and that central bank analysts are outside observers.[5]

If $\mathbf{z}_t$ and $\mathbf{A}$ are partitioned conformably with $\mathbf{y}_t$, the market and fundamental value is

$$(p_t - d_t) = (\mathbf{S}_d - \mathbf{S}_{rf} - \mathbf{S}_{rp})\begin{pmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{pmatrix} \times \begin{pmatrix} \mathbf{I}_{11} - \rho\mathbf{A}_{11} & -\rho\mathbf{A}_{12} \\ -\rho\mathbf{A}_{21} & \mathbf{I}_{22} - \rho\mathbf{A}_{22} \end{pmatrix}^{-1} \begin{pmatrix} \mathbf{z}_{1t} \\ \mathbf{z}_{2t} \end{pmatrix}. \tag{17}$$

By the partitioned inverse formula, this can be written as

$$(p_t - d_t) = (\mathbf{S}_d - \mathbf{S}_{rf} - \mathbf{S}_{rp})\begin{pmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{pmatrix} \times \begin{pmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} \\ \mathbf{B}_{21} & \mathbf{B}_{22} \end{pmatrix}\begin{pmatrix} \mathbf{z}_{1t} \\ \mathbf{z}_{2t} \end{pmatrix}, \tag{18}$$

where

$$\mathbf{B}_{11} = [(\mathbf{I}_{11} - \rho\mathbf{A}_{11}) - \rho\mathbf{A}_{12}(\mathbf{I}_{22} - \rho\mathbf{A}_{22})^{-1}\mathbf{A}_{21}\rho]^{-1} \ , \tag{19}$$

$$\mathbf{B}_{12} = \rho(\mathbf{I}_{11} - \rho\mathbf{A}_{11})^{-1}\mathbf{A}_{12}[(\mathbf{I}_{22} - \rho\mathbf{A}_{22}) - \rho\mathbf{A}_{21}(\mathbf{I}_{11} - \rho\mathbf{A}_{11})^{-1}\mathbf{A}_{12}\rho]^{-1} \ ,$$

4. See Harvey (1981) for instructions on how to construct the companion form for general time-series processes.

5. If you like, central bank staff invest in mutual finds which are managed by private analysts.

$$\mathbf{B}_{21} = \rho(\mathbf{I}_{22} - \rho\mathbf{A}_{22})^{-1}\mathbf{A}_{21}[(\mathbf{I}_{11} - \rho\mathbf{A}_{11}) - \rho\mathbf{A}_{12}(\mathbf{I}_{22} - \rho\mathbf{A}_{22})^{-1}\mathbf{A}_{21}\rho]^{-1} ,$$

$$\mathbf{B}_{22} = [(\mathbf{I}_{22} - \rho\mathbf{A}_{22}) - \rho\mathbf{A}_{21}(\mathbf{I}_{11} - \rho\mathbf{A}_{11})^{-1}\mathbf{A}_{12}\rho]^{-1} .$$

The central bank observes data generated according to (18) and tries to determine whether prices are in line with fundamentals. They do so by comparing market prices with the predictions of their own valuation model. Because they have less information than the private sector about dividend growth and discount factors, their approximate valuation model predicts that the price-dividend ratio evolves according to

$$(20) \qquad F_t^m = (\mathbf{S}_d - \mathbf{S}_{rf} - \mathbf{S}_{rp})\begin{pmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{pmatrix} \times \begin{pmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} \\ \mathbf{B}_{21} & \mathbf{B}_{22} \end{pmatrix}\begin{pmatrix} \mathbf{z}_{1t} \\ 0 \end{pmatrix},$$

where the superscript m indicates that this is a model valuation. The central bank staff compares F_t^m with $(p_t - d_t)$ and finds that there is an unexplained component equal to

$$(21) \quad (p_t - d_t) - F_t^m = (\mathbf{S}_d - \mathbf{S}_{rf} - \mathbf{S}_{rp})\begin{pmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{pmatrix} \times \begin{pmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} \\ \mathbf{B}_{21} & \mathbf{B}_{22} \end{pmatrix}\begin{pmatrix} 0 \\ \mathbf{z}_{2t} \end{pmatrix}.$$

Because the central bank has less information than private analysts, its approximating model omits variables that are relevant for asset pricing. Therefore, there is bound to be variation in price-dividend ratios which the approximating model cannot explain.

The key issue concerns how the central bank interprets the model approximation error. If the staff were to equate “unexplained variation” with “bubbles,” it would conclude (mistakenly, in this case) that there is a bubble. On the other hand, if the staff assumed there were no bubbles, it would interpret “unexplained variation” in terms of movements in the hidden state variables, $\mathbf{z}_{2t}$. “Bubbles” and “hidden fundamentals” are just two labels for “unexplained variation.”

In order to tell the difference between the two interpretations, the central bank staff would need access to *all* the information relevant for asset pricing. Because this condition cannot be met in practice, especially regarding discount factors, it is impossible to verify the existence of asset price bubbles empirically. When valuation models diverge from market prices, it may be tempting to conjecture the existence of a bubble, but this divergence is equally consistent with approximation errors in modeling fundamentals.

At this point, one might object that hidden fundamentals seem more plausible when there are small or short-lived approximation errors, but that there are times when market prices are so far from model valuations that it is difficult even to *imagine* a set of possible fundamentals that would support them. In such cases, can’t we infer the presence of a bubble? Perhaps surprisingly, the answer is no, because in present value models seemingly small errors in forecasting dividend growth or returns can have a big influence on prices. Model approximation errors can indeed be large and persistent if investors have private information about persistent or long-lasting changes in fundamentals.

To illustrate this point, consider a special case of the model described above. Suppose the central bank believes that expected stock returns and dividend growth are both constant. This is certainly an oversimplification, but it provides a useful rough approximation. The latter assumption is empirically plausible, and the former corresponds to the “random walk” theory of stock prices. In terms of the notation defined above, this means that

$$(22) \qquad \mathbf{x}_t = [\Delta d_t, r_{ft}, r_{pt}]'$$

and

$$\mathbf{A}_{11} = \mathbf{0} .$$

In addition, suppose that market analysts have private information that dividend growth will be somewhat higher than average for the indefinite future and that expected risk-free rates and risk premia will be somewhat lower. A simple way to model this is to set

$$(23) \qquad \mathbf{z}_{2t} = [z_{dt}, z_{ft}, z_{pt}]' ,$$

$$(24) \qquad \mathbf{A}_{12} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

$$(25) \qquad \mathbf{A}_{22} = \begin{pmatrix} \phi_d & 0 & 0 \\ 0 & \phi_f & 0 \\ 0 & 0 & \phi_p \end{pmatrix}.$$

Finally, suppose that $\mathbf{x}_t$ does not help predict the private signal $\mathbf{z}_{2t}$,[6] so that

$$(26) \qquad \mathbf{A}_{21} = \mathbf{0} .$$

According to these assumptions, the apparent bubble (or model approximation error) is

6. Again, this can be generalized; my goal here is to construct an especially simple example.

$$(27)\quad (p_t - d_t) - F_t^m = \frac{z_{dt}}{1-\rho\phi_d} - \frac{z_{ft}}{1-\rho\phi_f} - \frac{z_{pt}}{1-\rho\phi_p}\ .$$

Recall that ρ is around 0.96 in annual data. The parameters ϕ_d, ϕ_f, and ϕ_p are close to 1 if hidden fundamentals are persistent, and in that case the denominators are close to zero. Thus, hidden fundamentals can generate extremely large pricing errors if they are persistent.

For example, over the last few years some people have begun speaking of a "new era" for the U.S. economy, in which productivity growth would be higher than in the recent past because of new computer and information technologies, corporate restructuring, and so on. If investors believed that there were a trend break in dividends ($z_{dt} > 0$),[7] and the higher growth were expected to last indefinitely ($\phi_d = 1.0$), there would be a model approximation error equal to 25 times the expected increase in growth. If the economy were expected to grow at an annual rate of 3 percent rather than 2 percent ($z_{dt} = 0.01$), there would be an unexplained 28.4 percent[8] increase in the price-dividend ratio.

Similarly, suppose investors had private information that the equity risk premium would be lower than average over the next few decades, e.g., for the reasons stated in Blanchard (1993). Since 1926, the risk premium has averaged around 8 percent per year. However, since 1966 the average has been much lower, around 5 percent per year. Furthermore, prior to 1926 the average risk premium was also much lower, averaging 3 percent for the years 1802 to 1870 and 5 percent for the years 1871 to 1925 (e.g., see Siegel 1992 and 1994). If the equity risk premium were expected to be 5 percent a year instead of 8 percent and if this were expected to persist into the indefinite future, the model price-dividend ratio would be off by a factor of 2.1, and if the risk premium were expected to revert to its 19th century value, the model price-dividend ratio would be off by a factor of 2.7.

If the two sources of error were combined, the model price dividend ratio would be off by a factor of 2.7 to 3.4. Thus, failure to account for modest but persistent movements in hidden fundamentals may result in model valuations that are substantially less than the market ratio. It may be tempting to interpret such large deviations as evidence that the market is overvalued, but in fact they are also consistent with plausible unobserved movements in fundamentals.[9]

The bottom line is that approximate valuation models inevitably diverge from market prices, simply because they are "approximate." Pricing errors may reflect the presence of bubbles or movements in omitted state variables, but it is impossible to tell the difference between the two. More importantly, we can't infer the presence of a bubble even when model valuations seem grossly out of line with market prices.

II. WHAT SHOULD WE DO ABOUT IT?

Earlier in the year, some people argued (and perhaps some still may argue) that the market was obviously overvalued, and they encouraged the Fed to raise interest rates in order to prick the bubble before it grew larger. For example, in April 1998, the cover story in *The Economist* stated that "America is experiencing a serious asset-price bubble," and it warned that the bubble could harm the economy if it were to burst suddenly, reducing the value of collateral assets and bringing on a recession. The article went on to argue that "the longer that asset prices continue to be pumped up by easy money, the more inflated the bubble will become and the more painful the economic after-effects when it bursts." It concluded with the recommendation that "the Fed needs to raise interest rates."

Proponents of such a policy sometimes point to the Great Crash of 1929 as an example of the dangers associated with failure to take deliberate action to puncture a bubble. One conventional view is that monetary policy was too lax in the years prior to the Great Crash and that easy money contributed to a bubble in stock prices by accommodating a speculative demand for credit. For example, Barry Eichengreen (1992) quotes Adolf Miller, a member of the Federal Reserve Board during the 1920s, as saying that the policy of 1927–1929 was "one of the most costly errors committed by the Federal Reserve System or any other banking system in the last 75 years." *The Economist* (1998) echoed this opinion:

> *"In the late 1920s, the Fed was also reluctant to raise interest rates in response to soaring share prices, leaving rampant bank lending to push prices higher still. When the Fed did belatedly act, the bubble burst with a vengeance."*

7. Recall that the price-dividend ratio has been expressed in terms of deviations from the mean.

8. The approximation error in the log-dividend price ratio is 0.25, and the dividend-price ratio is off by a factor of exp(0.25) = 1.284, or by 28.4 percent.

9. A fall in expected risk-free rates would have a similar effect on price-dividend ratios. In addition, the recent cut in capital gains taxes may also help to explain the discrepancy between market and model price-dividend ratios. The cut in capital gains taxes makes dividends even less attractive relative to share repurchases, and presumably reduces the optimal payout ratio. Holding earnings constant, this would shift the mean price-dividend ratio upward.

In this section, I consider the merits of this line of argument. First, I demonstrate that because bubbles are hard to identify, a policy of deliberate action to burst bubbles may be destabilizing rather than stabilizing. Second, I review the historical record of the years leading up to the Great Crash and argue that the conventional characterization of Federal Reserve behavior is misleading. The Fed did not stand on the sidelines and allow asset prices to soar unabated. On the contrary, in the critical years of 1928 to 1930, Federal Reserve policy represented a striking example of a deliberate, preemptive strike against an (apparent) speculative bubble. Whether those actions were stabilizing or destabilizing is not at all obvious.

Are Preemptive Strikes Stabilizing or Destabilizing?

From Milton Friedman (1953), we know that policy is likely to be destabilizing unless properly timed and of the right magnitude. The inability to identify bubbles bears on both dimensions of monetary policy.

Following Friedman, decompose the log price-dividend ratio into three components:

$$(28)\qquad (p_t - d_t) \equiv F_{1t} + F_{2t} + B_t \,,$$

where F_{1t} is the fundamental value apart from the effects of monetary policy, F_{2t} represents fundamental variation due to policy actions, and B_t is a bubble. In addition, suppose one goal of policy is to minimize

$$(29)\qquad var[(p_t - d_t) - F_{1t}] = \sigma^2_{F_2} + \sigma^2_B + 2\rho_{F_2B}\sigma_{F_2}\sigma_B \,,$$

where $\sigma^2_{F_2}$ and σ^2_B are the variances of the policy and bubble components, respectively, and ρ_{F_2B} is their correlation.

From this expression, it is clear that difficulty in identifying bubbles seriously constrains attempts to burst bubbles. For example, if there were no bubbles, $\sigma_B = \rho_{F_2B} = 0$, and any attempt to prick a bubble would be destabilizing. More generally, if there are bubbles, policy is stabilizing if

$$(30)\qquad -1 \le \rho_{F_2B} \le -(1/2)(\sigma_{F_2}/\sigma_B) \,,$$

and destabilizing if

$$(31)\qquad -(1/2)(\sigma_{F_2}/\sigma_B) < \rho_{F_2B} \le 1 \,.$$

The identification problems bears on the correlation coefficient, ρ_{F_2B}. Since the existence of a bubble cannot be empirically verified, ρ_{F_2B} is likely to be close to zero. In this case, σ_{F_2} must also be close to zero to remain in the stabilizing region.

As Milton Friedman taught us many years ago, vigorous policies conditioned on noisy or unobservable state variables are likely to be destabilizing rather than stabilizing. Because bubbles are difficult to identify, the central bank must be cautious about engaging in preemptive strikes in order to remain in the stabilizing region.

Monetary Policy in the Years 1927–1930 [10]

Many people take for granted that there was a speculative bubble in share prices in the late 1920s. But what is the supporting evidence? To some extent, this opinion may simply represent wisdom after the fact. There is a temptation to conclude that share prices were unsustainable because they were unsustained, a temptation to infer that monetary policy must have been too lax from the fact that equity prices continued to rise through 1928 and 1929. But such reasoning is circular. As Friedman and Schwartz point out, the logic "what goes up must come down" does not imply that "what has come down" must have been "too high up."

A closer examination of the events of those years suggests that the conventional wisdom is mistaken on at least four points. First, stock prices were not obviously overvalued at the end of 1927. Second, starting in 1928, the Federal Reserve System shifted toward increasingly tight monetary policy, motivated in large part by a concern about speculation in the stock market. Third, tight monetary policy probably did contribute to a fall in share prices in 1929. And fourth, the depth of the contraction in economic activity probably had less to do with the magnitude of the crash and more to do with the fact that the Fed continued a tight money policy after the crash. Hence, rather than illustrating the dangers of standing on the sidelines, the events of 1928–1930 actually provide a case study of the risks associated with a deliberate attempt to puncture a speculative bubble.

To review the evidence, it is convenient to begin by describing economic conditions in 1927. In that year, there was a mild recession in the United States, and industrial production fell by around 10 percent. In addition, Britain was threatened by a balance of payments crisis whose proximate cause was a demand by France to convert a large quantity of sterling reserves into gold. Thus, both domestic and international conditions inclined the Federal Reserve System to shift toward easing. The resulting fall in interest rates helped damp the decline in domestic economic activity and facilitated an outflow of gold toward Britain and France.

Should the Fed have refrained from easing in 1927 because of concerns that the stock market might be overvalued? Measures of conventional valuation suggest the answer is no, for there was no obvious sign of an emerging bubble at that time. For example, Figure 1 focuses on the price-dividend ratio in the critical years. These data refer to the

10. This section relies heavily upon the seminal work of Friedman and Schwartz (1963) and Eichengreen (1992).

value-weighted New York Stock Exchange (NYSE) portfolio and were obtained from the Center for Research in Security Prices.[11] At the end of 1927, the price-dividend ratio was around 23, which is actually a bit below its long-run average of 25. Although share prices had risen rapidly in the 1920s, so too had dividends and corporate earnings. Given that the price-dividend ratio was slightly below average, the Fed would have had little reason to refrain from easing in a recession year or to decline to assist another core member of the gold standard in maintaining balance of payments equilibrium. Given the financial information available at the time, it is hard to agree with Adolf Miller that the actions of 1927 represented a grave error.

In any case, equity prices began to accelerate in January 1928, and they rose by 39 percent for the year. Dividend payments also grew rapidly that year, and the price-dividend ratio increased by 27 percent.

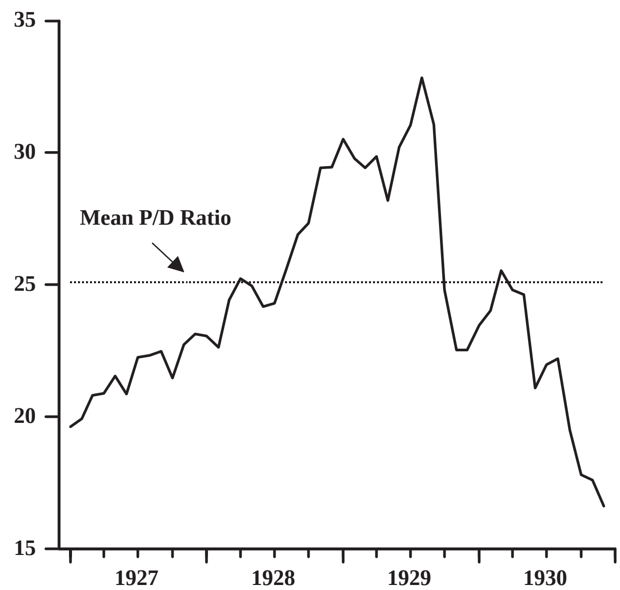
Motivated by a concern about speculation in the stock market,[12] the Fed responded aggressively. It raised the discount rate in three steps, from 3.5 percent in January to 5 percent in July. Because nominal prices were falling that year, the latter translated into a real discount rate of 6 percent, which is quite high in a year following a recession. At the same time, the Fed also engaged in extensive open market operations to drain reserves from the banking system. Indeed, James Hamilton (1987) reports that it sold more than three-quarters of its total stock of government securities. As he states, "in terms of the magnitudes consciously controlled by the Federal Reserve, it would have been difficult to design a more contractionary policy.''

Furthermore, monetary policy was tight not only in the United States but also throughout much of the world. By that time, roughly three dozen countries had returned to the gold standard, and many gold standard partners were forced to fall in line with the Fed's actions in order to avoid balance of payments problems. After the war, the United States had a current account surplus and was a net lender to the rest of the world. The position elsewhere was reversed, and many countries relied on capital inflows from the United States to maintain balance of payments equilibrium.

When the Fed tightened monetary policy in 1928, debtor countries were threatened with incipient balance of payments crises: unless their central banks also tightened policy, lending from the United States would be disrupted and their balance of payments would move toward a deficit. In that case, they would either have to devalue or abandon the gold standard altogether. The former was an unattractive option for countries with dollar-denominated debts, and the latter was virtually out of the question at the time, especially for countries where restoration of the gold standard had been painful and difficult.

FIGURE 1

Price-Dividend Ratio, 1927–1930



The alternative was to conform with the Fed. By shifting toward more contractionary monetary policies, other gold standard countries could ensure that domestic interest rates would rise in parallel with those in the United States and would be able to maintain balance of payments equilibrium. This explains, for example, why the Bank of England shifted toward tighter monetary policy in 1928, three years after Britain had entered a slump. It also explains why countries still trying to rebuild from the devastation of World War I would adopt contractionary policies.

The implication is that monetary policy was far more restrictive than a purely domestic perspective might suggest. In 1928 there was a synchronized, global contraction of monetary policy, which occurred primarily because the Fed was concerned about the rapid rise in stock prices.

These actions had predictable effects on economic activity. Debtor countries felt the effects first, and demand for U.S. exports soon began to fall. By the second quarter of 1929, it was apparent that general economic activity in the United States was slowing as well. The Federal Reserve was well aware of this slowdown: for example, Barry Eichengreen cites an internal Federal Reserve Board memorandum dated

11. One should bear in mind that the NYSE data were constructed after the fact and were not available to policymakers in the 1920s. From their point of view, this series was a hidden state variable. Other stock price measures were available, but they were of lower quality and covered a more narrow segment of the market.

12. E.g., see Eichengreen (1992), chapter 8.

April 1, 1929, which mentioned the decline in exports, a slowdown in construction and housing starts, and a postponement of railroad projects. Economic activity peaked in August, and in September the economy fell into a recession.

What were the effects on the stock market? At the beginning of 1929, it seemed that the contractionary actions of the prior year were working. The price-dividend ratio on the NYSE index reached a local peak in January and then fell gradually through the first half of the year (see Figure 1). Thus, it appeared that stock prices had stabilized. Furthermore, shares were still not obviously overvalued. The local peak was reached at 30.5, which is roughly 20 percent above the long-term average. Dividends had grown rapidly through 1928, and investors projecting similar growth rates forward may have been willing to settle for dividend yields somewhat below the long-run average.

During the first half of 1929, monetary policy was on hold. Some economists argue that inaction in this period was responsible for the events that followed. But three observations are relevant here. First, as mentioned above, price-dividend ratios had stabilized and were falling gradually. To a contemporary observer, it would have appeared that the actions of 1928 were having the intended effects. Second, it was becoming increasingly apparent that general economic activity was slowing, and many other countries had already entered recessions. And third, while monetary policy was not becoming tighter, it was still quite tight. Short-term real interest rates were still around 6 percent, and there was no growth in the monetary base.

Price-dividend ratios continued to fall until July 1929, but then prices began to take off. In August, the Fed raised the discount rate another percentage point to 6 percent. The stock market peaked in the first week of September. It is worth noting that at its peak the price-dividend ratio was 32.8, which is well below values reached in the 1960s or 1990s. Share prices declined in a more or less orderly fashion until the end of October, when the market crashed. From its peak, the price-dividend ratio fell roughly 30 percent, to a level roughly similar to that prevailing at the beginning of 1928, when the Fed began to tighten.

In the immediate aftermath of the Crash, the Federal Reserve Bank of New York took prompt and decisive action to ease credit conditions. When investors attempted to liquidate their equity holdings, many lenders (especially foreign lenders and banks outside of New York) also called their loans to securities brokers. With the encouragement of officials at the New York Fed, many of these brokers' loans were taken over by New York banks, who were allowed to borrow freely at the discount window for this purpose. The New York Fed also bought government securities on its own account (over the objection of the Federal Reserve Board) in order to inject reserves into the banking system. In this way, they were able to contain an incipient liquidity crisis and prevent the Crash from spreading to money markets.

But this respite from tight money proved to be temporary. After the liquidity crisis had been contained, monetary policy once again resumed a contractionary stance. Throughout 1930, officials at the New York Fed repeatedly proposed that the System buy government securities on the open market, but they were systematically rebuffed.[13] The reasons other members of the Federal Reserve gave for opposing monetary expansion are instructive. Several felt that much of the investment undertaken in the previous expansion was fundamentally unsound and that the economy could not recover until it was scrapped. Others felt that a monetary expansion would only ignite another round of speculative activity, perhaps even in the stock market. In any event, monetary policy remained contractionary; the monetary aggregates fell by 2 to 4 percent, and long-term real interest rates increased.

By maintaining a contractionary stance throughout 1930, after a recession had already begun, the Fed contributed to a further decline in economic activity and share prices. By the end of the year, the price-dividend ratio had fallen to 16.6, or roughly 34 percent below the long-run average. By then, there was a consensus that speculative activity had been eliminated!

Were the Fed's actions stabilizing or destabilizing? If one grants that there was a speculative bubble at the beginning of 1928, when the Fed began to tighten, then stocks still must have been overvalued in the aftermath of the crash. After all, price-dividend ratios were about the same in the dark days of November 1929 as at the beginning of 1928, and fundamentals must surely have taken a turn for the worse. If equities were still overvalued, it follows that a further dose of contractionary monetary policy was needed to purge speculative elements from the market. Perhaps this is what motivated the famous advice of Treasury Secretary Andrew Mellon to President Herbert Hoover:

> "*Liquidate labor, liquidate stocks, liquidate the farmers, liquidate real estate. It will purge the rottenness out of the system.*"[14]

To argue that the actions of 1928–1930 were stabilizing, one must implicitly adopt the liquidationist position.

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13. The Fed did reduce the discount rate several times in 1930, but the fall in the discount rate lagged the decline in money market interest rates. Thus, even though the discount rate was falling, banks had no incentive to borrow at the discount window, and indeed had an incentive to repay prior loans.

14. Mellon went on to say that this would help people "live a more moral life."

On the other hand, if one interprets the Great Crash as a bursting bubble, so that shares were more or less properly valued in the aftermath, then it follows that they were probably also not far from their fundamental values at the start of 1928, when the Fed began to tighten. Again, prices and price-dividend ratios were about the same after the Crash, and fundamentals had surely become less favorable. According to this interpretation, the Fed's initial actions may have been destabilizing, and the actions of 1930 certainly were.

III. Conclusion

This paper makes two theoretical points that are relevant for discussions about monetary policy and stock market valuations. First, as demonstrated by Hamilton and Whiteman (1985), speculative bubbles are observationally equivalent to changes in fundamentals (information about dividends or discount rates) that are observed by market participants but not by central bank analysts. Unless the central bank has access to all the information relevant for asset pricing, it has no way of knowing the extent to which stock prices reflect speculative activity. Second, because it is impossible to verify the existence of a bubble, deliberate attempts by policymakers to prick asset bubbles may turn out to be destabilizing. In order to stabilize asset prices around fundamental valuations, policies must be well-timed and of the right magnitude, and this is likely to be very difficult if bubbles are unobservable.

The paper also presents a case study of the difficulties and risks associated with deliberate attempts to prick speculative bubbles. This case involves the behavior of the Federal Reserve in the years 1928 to 1930. That episode is sometimes cited as evidence of the dangers of allowing asset prices to soar to unsustainable heights and the damage that can result when a bubble bursts. But upon closer scrutiny, it is clear that the Fed deliberately tightened monetary policy in 1928 in order to curb stock market speculation. That policy succeeded in putting a halt to the rapid rise in share prices, but it also may have contributed one of the main impulses for the Great Depression. The lesson of the Great Crash is not about the dangers of allowing a speculative bubble to develop unabated, but about the difficulty of identifying speculative bubbles and about the risks associated with aggressive actions conditioned on noisy state variables.

The lessons of 1928–1930 can also be appreciated by the contrast with the events of 1987. In the months leading up to the crash of 1987, the Fed did not tighten policy in an effort to deflate a bubble. Thus, while the economy was slipping into a recession prior to the 1929 Crash, growth remained stronger in 1987 and the economy was better positioned to withstand the effects of a crash. On both occasions, the Fed took timely and effective action in the immediate aftermath of the crash to contain incipient liquidity crises. But in 1929 policy quickly resumed a contractionary stance. After the 1987 crash, the Fed took a modest step toward easing, as a precautionary step aimed at containing the damage. In the subsequent months, it soon became apparent that the economy would not be adversely affected, and policy moved quickly back to a more normal stance. Thus, while the strategy of 1929 represents an example of a deliberate attempt to deflate a bubble, the strategy of 1987 represents an example of a contingency plan for containing the damage associated with a market crash.

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