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Asset Prices and Central Bank Policy

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ASSET PRICES AND CENTRAL BANK POLICY

PART 1: MACROECONOMIC STABILITY AND POLICY RESPONSE

Executive Summary

How should centrals banks view movements in equity, housing and foreign exchange markets? Developments in asset markets can have a significant impact on the both inflation and real economic activity. History is replete with examples in which large swings in stock, housing and exchange rate markets coincided with prolonged booms and busts. It is important to ask whether there are any actions central banks can and should take to minimise the likelihood of macroeconomic instability arising from extreme changes in asset prices.

With these issues in mind, we address a series of specific questions. First, in formulating day-to-day policies, can policy makers improve macroeconomic performance by giving consideration to movements in asset prices? Or, as many influential economists argue, should monetary policy makers ignore asset price changes and set interest rates in response only to forecasted future inflation, and possibly to the output gap as well?

Our answer is that a central bank concerned in stabilising inflation about a specific target level is likely to achieve superior performance by adjusting its policy instruments not only in response to its forecast of future inflation and the output gap, but to asset prices as well. This conclusion is based in part on our view that reaction to asset prices in the normal course of policy making will reduce the likelihood of asset price misalignments coming about in the first place. Also, inflation forecasts depend on assumptions about asset prices that, in turn, must depend on views about the size of asset price misalignments. We are not recommending that central banks seek to burst bubbles they currently perceive to exist, nor do we suggest that they target specific levels of asset prices. Furthermore, we do not recommend responding to all changes in asset prices in the same way. The response to a rise in equity prices driven by higher productivity growth would be very different from the appropriate reaction to an asset price misalignment or bubble.

A central bank that reacts to asset price changes must attempt to estimate misalignments. It has been claimed that the pitfalls involved in doing so makes our proposal impractical.

Our response is that the difficulties associated with measuring asset price misalignments are not substantially different from those of estimating theoretical constructs such potential GDP or the equilibrium real interest rate. These difficulties have rightly not prevented central banks from using these concepts in the course of deciding on monetary policy. Similarly, although asset price misalignments are difficult to measure, this should be no reason to ignore them.

This being said, there will always be a great deal of imprecision in estimates of these misalignments, as there is in estimates of other key macroeconomic quantities that are crucial in setting interest rate instruments. As a result, it is important for central bankers to develop a framework for policy making that accounts for the various sources of uncertainty that they face in setting their instrument to meet their inflation and growth objectives.

Are there alternative, less conventional, policy responses for addressing perceived asset price misalignments? The historical record is filled with attempts by policy makers to move equity prices and exchange rates. The U.S. experience in 1929 where the Federal Reserve opposed bank lending collateralized by stock is a clear example. We examine this case, as well as attempts to rely on public statements to move asset prices or to use margin requirements to reduce their volatility, and conclude that these strategies are generally ineffective.

Should asset prices be included directly in measures of inflation? For many years, some economists have argued that a properly constructed inflation index should be based on both the prices of what is currently consumed, as conventional consumer price indices are today, and prices of future goods and services, as represented by the price of assets. Proponents of this view suggest that monetary policy should seek to stabilise such a combined index.

There are reasons to be sceptical of the arguments for such an inflation index, as no one has yet provided an analysis why focusing on such a measure of prices reduces the cost of inflation most effectively. Furthermore, most common implementations of this proposal places a very high weight on asset prices, and amounts to suggesting that central banks target asset rather than current consumption prices. We provide an alternative set of calculations based on the idea that inflation affects all nominal prices, including equity and housing. Our conclusion is that changes in stock prices are much to noisy to be useful in inflation measurement, but that prices of homes contain significant useful information about aggregate price movements.

Finally, we ask whether asset prices can be used to improve forecasts of future inflation. Many studies show a relationship between retail price inflation and movements in equity prices, housing prices and exchange rates. We survey this evidence, and add a few calculations of our own. Overall, the results suggest that asset prices have a strong effect on future inflation, although the impact surely differs across countries and may shift over time.

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The views expressed in this report are entirely our own, and should not be taken to represent those of our employers or the individuals mentioned above.

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Dr. Sushil Wadhwani was appointed a full-time independent member of the Monetary Policy Committee at the Bank of England on 1 June 1999. From 1995-9 Dr Wadhwani was Director of Research at Tudor Proprietary Trading LLC, a fund management company. He was previously Director of Equity Strategy at Goldman Sachs International (1991-5) and before that Reader/Lecturer in economics at the London School of Economics (1984-91). Dr Wadhwani has published a number of articles in academic journals and is currently a member of the Clare group of economists. His past research includes work on the determinants of unemployment and inflation, and various articles on the efficiency of financial markets.

1. Using Asset Prices to Improve Monetary Policy: Summary and Conclusions.

Should central banks take asset prices into account when they formulate monetary policy? This question comes up with a regularity that correlates strongly with the degree of turbulence and perceived misalignments in asset markets. There are good reasons for raising the issue. Developments in asset markets can have significant effects on real economic activity as witnessed by numerous historical episodes ranging from Wall Street's 1929 crash to the Tokyo housing and equity bubble in the late 1980s and the severe crises afflicting South-East Asian equity, commercial and currency markets in 1997-98. While it is difficult to disentangle cause and effect, there is little doubt that asset price booms and busts have been associated repeatedly with the emergence of serious economic imbalances. It is important to ask, therefore, whether central banks can improve their effectiveness - and lessen the likelihood of economic instability - by taking asset price shifts into account explicitly when setting monetary policy.

By no means clear that asset price changes were the root causes of the declines in output and employment that followed these (and many other similar) episodes, it is important to ask whether there is anything central banks can and should do to minimise the likelihood of macroeconomic imbalances induced by developments in asset markets.

Central bankers in fact keep a keen eye on asset price developments, and sometimes act in response to these developments. Federal Reserve Board Chairman Alan Greenspan's conclusion than US demand growth was outstripping potential increases in supply - thus raising the inflation risk that justified the Fed's subsequent rate hikes - derived in large part from the impact of rising asset prices on household wealth. Similarly, after having long taken a "benign neglect" attitude towards the declining external value of the euro, European Central Bank President Wim Duisenberg recently felt compelled to issue a public statement reassuring his fellow Europeans that neither price stability nor their personal wealth would be left at risk.

These are not isolated cases. For example, a survey conducted by the Centre for Central Banking Studies (CCSB) of the Bank of England revealed that asset price volatility influences of monetary policy in a majority of the 77 central banks questioned.[1]

Despite the concerns expressed by Chairman Greenspan and President Duisenberg, consensus views about monetary policy - including those or many prominent academics and other analysts - stipulate that central banks should set interest rates in response to actual (or forecast) inflation and possibly the output gap as well, but that they should not react directly to asset prices.[2] The reasons usually given for this conclusion is that asset prices are too volatile to be of much use in determining policy, that misalignments of asset prices are close to impossible to identify, let alone correct, and that systematically reacting to asset prices may be destabilising.

This report reviews the arguments on these issues and presents some new analysis and evidence. Contrary to the current conventional wisdom it concludes incorporating asset prices more systematically into central banks' the policy-making processes potentially could improve economic performance. Specifically, our view can be summarised in five points:

- A central bank concerned with both hitting an inflation target at a given time horizon, and achieving as smooth a path as possible for inflation, is likely to achieve superior performance by adjusting its policy instrument not only to inflation (or to its inflation forecast) and the output gap, but to asset prices as well. Typically, modifying the policy framework in this way also could reduce output volatility. We emphasise that this conclusion is based on our view that reacting to asset prices in the normal course of policy making will reduce the likelihood of asset price bubbles forming, thus reducing the risk of boom-bust investment cycles.
- Although asset price misalignments are difficult to measure, this should not be a reason to ignore them. We argue that there are situations where the emergence of

[1] Roger and Sterne (1999).
[2] See, for example, Bernanke and Gertler (1999).

such misalignments can be identified, and we suggest policy measures to avoid them. Of course there is a great deal of uncertainty associated with identifying asset price misalignments, but this uncertainty is not necessarily greater than that associated with measuring potential output, a construct that is routinely taken into account by policy makers. Our view is that central bankers should develop a framework for making policy under uncertainty that includes potential asset price misalignments as one potentially important source of economic distortions to which they should react.

- When we attempt to measure core inflation using the appropriate statistical methods, we find that a significant role should be given to some asset prices, especially housing, but not to equity prices. Such a measure of core inflation may constitute an attractive complement to conventional measures of inflation such as the consumer price index in the process of policy analysis and implementation.
- Asset prices contain information about future inflation that can be incorporated into inflation forecasts used in the monetary policy process in some countries. In addition, asset prices are important in the transmission of inflationary impulses, and sometimes they constitute a source of such impulses themselves. It is possible that attempting to forecast asset prices rather than using simple conventions could improve the quality of inflation forecasts.
- There is little evidence that changes in margin requirements and other unconventional policy tools will dampen asset price volatility. As a result, there is no evidence to suggest that attempting to substitute other policy tools in lieu of conventional monetary policy will improve central banks' ability to reach their principal policy goals.

It is important to emphasise a number of points we are not making. First, this study is aimed at improving the normal functioning of central bank policy. It is not intended to deal with asset crisis management issues. Thus, we make not explicit recommendations concerning either identifying or bursting asset bubbles should they come into being, or the appropriate response to a sharp deflation in asset prices. Second, we do not recommend the targeting of asset prices by central banks, or the inclusion of asset prices into the monetary policy objective.

1.1. Can we improve macroeconomic stability by reacting to asset prices?

The first of our conclusions, that there is a *prima facie* case for central banks to include asset price developments directly in their policy formulation process, is derived in Chapter 2. This chapter examines whether reacting to asset prices can improve macroeconomic performance - defined in terms of minimizing the variability of inflation and output - can be improved by such a change in central bank practice.

Our intuition that this ought to be the case is based on two arguments. The first is an application of the classic Poole (1970) analysis, which states that a central bank should "lean against the wind" of significant asset price movements if these disturbances originate in the asset markets themselves. Such a policy should attenuate the disturbance's influence on the real sector of the economy. In contrast, if the disturbance originates in the real sector, asset prices should be allowed to change in order to absorb part of the required adjustment.

The second argument that drives our intuition is explicitly intertemporal. It is based on the notion that when significant asset price misalignments occur, they help to create undesirable instability in inflation and/or employment that may be exacerbated when the misalignment eventually is eliminated. A pre-emptive policy approach therefore will tend to limit the build-up of such asset misalignments and macroeconomic imbalances, and would also limit the size of the required eventual correction and thereby the medium-term variability of inflation and output. Such a policy would be desirable in general, even if it would mean a temporary departure from the short-term inflation target.

We examine the robustness of these intuitive arguments by conducting extensive simulations with two more complete models incorporating sophisticated treatments of asset markets and realistic assumptions about the dynamic effects of policies and disturbances. The first model we consider, is a generalized version of the one used by Bernanke and Gertler (1999) in their recent influential study of how policy makers should react to stock price bubbles. They concluded that policy rules should only respond to stock price movements insofar as they signal changes in expected inflation, and they recommended against systematic response to bubbles. By contrast, we find that in the vast majority of cases that we study, it is strongly advisable for interest rates to respond to stock prices. The reason for the differences between our conclusions and those of Bernanke and Gertler appears to be that we investigate a wider range of possible policy responses than they do.

Another model we consider is that of Batini and Nelson (2000), who have used their framework to examine the optimal time-horizon for monetary policy feedback rules that are based on inflation forecasts. Within the confines of this model we show that a central bank that responds to exchange-rate fluctuations arising from portfolio shocks, in addition to its two-period ahead inflation forecast, tends to reduce both inflation and output volatility as compared to a monetary authority that only responds to the inflation forecast.

Although our results are based on specific models, we believe that they are quite robust in the sense that most state-of-the-art economic models would imply that policy makers' decisions could be improved by appealing to current information about asset prices. Once again, we are suggesting that policy react to asset price movements in the normal course of events to help stave off the potentially harmful effects that would arise from the development of asset price bubbles. Preventing the formation of asset bubbles improves macroeconomic performance regardless of whether a central bank's policy is based on targeting inflation.

1.2. Is it possible to measure the degree of misalignment of asset prices?

Many central bankers and academics are hostile to the notion of taking direct action to prevent misalignments because, in part, of the difficulties associated with distinguishing between movements in asset prices that are in some sense warranted by underlying fundamentals and those that are not.

It is widely debated today whether the US stock market is over fundamentally overvalued. Thus, Chapter 3 analyses the present valuation of the US equity market, concluding that even under optimistic assumptions about the increase in underlying productivity growth, the equity risk premium is currently towards the lower end of its historical range. Since econometric evidence suggests that this premium is likely to revert towards its mean in the medium term, it is probable that this will occur at least in some cases through an adjustment in equity prices. From this perspective, owning US equities implied above-average risk at the time the study was undertaken. This insight would be of use in monetary policy formation.

Note that implementing monetary policy also requires estimates of asset price misalignments in the more conventional case where policy depends only on the inflation forecast and the output gap. This is because inflation forecasts may depend in part on asset prices. In this case, estimating asset price misalignments could influence the inflation forecast.

Moreover, it is probably no more difficult to measure the degree of stock price misalignment than it is to measure the size of the output gap, or the equilibrium value of the real interest rate, concepts that many central banks already use in preparing their inflation forecast. Specifically, output gap estimates depend on estimates of underlying productivity growth and the equilibrium equity risk premium. These inputs also are necessary to estimate stock price misalignments. Furthermore, there is empirical evidence (both in the US and the UK) that forecasters have consistently overestimated the NAIRU during the 1990s.

We therefore conclude that measurement difficulties, as real as they are, should not stand in the way of attempting to incorporate estimates of asset price misalignments into the monetary policy-setting process.

1.3. Practical implementation.

An implication of our analysis in Chapter 2 is that central bankers, who set their target interest rates based solely on expectations of future inflation at some fixed time-horizon, could do better. That is, our analysis suggests that reacting to asset prices directly could result in a smoother path for both output and inflation. Thus, reacting directly to asset prices improves policy outcomes, regardless of whether a central bank employs a strict inflation-targeting framework that puts virtually no weight on short-run output variability, or a more flexible approach that gives more weight to real fluctuations. In chapter 4 we discuss how the asset price developments can be incorporated in current practice.

One way of attempting to calibrate the difference that our proposal would make, consider the situation in the US during the fourth quarter of 1999. The actual Federal Funds rate averaged around 5.3%, while a standard Taylor rule would have suggested a rather higher 6.5%. Augmenting the Taylor rule to include stock prices suggests an even higher level, above 7%. While we would not want to make too much of these precise magnitudes as there is very considerable uncertainty about some of the most basic inputs to these rules, the ranking of interest rates implies by these two rules and the actual rate is likely to be robust.

As an alternative to actually specifying a simple policy rule to determine interest rates, the government might instead specify to the central bank that inflation and, perhaps, output deviations should be minimised on average in the future. This is likely to lead central banks to assign a weight to asset prices over and above their effect on a fixed-horizon inflation forecast. We do not believe that it will make policy-setting any more difficult than it is already. As for having to communicate policy decisions to the public, it might actually be easier than a policy that ignored asset prices, especially at a time when it was suspected that asset prices were misaligned. Our proposal is consistent with the remit given to the Bank of England, and other inflation-targeting central banks.

Many analysts have expressed concern that central banks may have created potential moral hazard by creating expectations that they would take remedial policy action if asset prices fall. The informal survey discussed in Chapter 5 is consistent with this concern. However, it is at least possible that this perception has arisen because market price changes in fact are asymmetric. For example, US stock returns appear to be more skewed to the downside even at horizons of 4 to 5 years. Our proposal is that central banks react to asset price movements in a symmetric and transparent fashion. This might help reduce market perceptions of asymmetry.

One possible objection to our proposal is that it might destabilise the economy. For example, interest rate increases motivated by the view that stock prices are "too high" might lead to self-reinforcing price drops, so a "soft landing" might be hard to achieve. However, if that occurred, the central bank could respond by reversing course - indeed, if asset prices were "too low" the central bank would respond more aggressively than in the pure fixed-horizon inflation targeting case.

Finally it is worth reiterating that the report focuses on the use of conventional interest rate policy in response to asset price developments. To examine whether central banks could use alternative policy instruments for the same purpose, we looked at two suggestions that have received particular attention: margin requirements and using policy signals to influence asset price developments. We conclude that neither of these alternatives for the purpose of achieving macroeconomic objectives are substitutes for traditional monetary policy.

1.4. The danger of puncturing asset price bubbles: two historical examples.

It is important to keep in mind that this report deals with central bank reaction to asset price developments in the course of formulating monetary policy on an ongoing basis. In particular, we are not advocating a strategy of systematically puncturing asset price bubbles if and when they occur. To underscore this point we look back at two significant historical periods of asset price volatility, the United States in 1929 and Japan in the late 1980s, and argue that the role played by the respective central banks at the time is controversial. For example, many scholars have reproached the Federal Reserve for attempting to puncture the 'bubble' in the stock market in 1929, and for not doing enough to prevent the Great Depression that followed.

Similar criticisms have been leveled at the Bank of Japan in its handling of the 'bubble economy' in Japan of the late 1980s. It has been argued that an overly expansionary policy was in part responsible for the sharp inflation in real estate and equity prices between 1986 and 1989. In addition, it is claimed that the 1989 tightening helped to puncture the bubble, but helped usher in a period of financial distress coupled with a severe recession. We argue in Chapter 5 that a policy taking account of asset price developments of the type we recommend could have helped to attenuate the boom and bust cycle in the Japanese economy during and after this episode.

Both episodes point to the importance of preventing asset price bubbles rather than puncturing them, and to the necessity of having appropriate crisis management strategies in place. In addition the Japanese example suggests that regulatory measures affecting the banking and financial system can have powerful effects on asset price inflation and deflation.

1.5. Should asset prices be included directly in our measure of inflation?

Several analysts have argued that the central bank should directly target a measure of inflation that includes asset prices. Armen Alchian and Benjamin Klein[3] first advanced a case for this over twenty-five years ago. The argument has recently been championed by one of the members of the Monetary Policy Committee of the Bank of England (Professor Charles Goodhart), and there have been various attempts to implement such a policy.

The Alchian and Klein premise is that the goal of central bank policy should be to maintain the stability of the purchasing power of money. They go on to assert that a stable purchasing power should refer not only to the price of what is currently consumed, but also to future goods and services. Since many asset prices actually refer specifically to the latter, it has been argued that they should be included together with the consumer price index as the central bank's target variable.

At a first glance, the Alchian and Klein argument is compelling, but on closer scrutiny there are reasons to be skeptical. At a theoretical level, Alchian and Klein do not provide an analysis showing why focusing on their chosen measure of inflation reduces the cost of inflation most effectively. It would in fact be surprising if it did, given the large number of reasons why inflation is costly in the first place. Be that as it may, the implementation of the Alchian and Klein measure is fraught with such difficulties that it is very unlikely to a practical alternative to more conventional inflation measures. One implementation is

[3] Alchian and Klein (1973).

the construction of an index of the cost of lifetime consumption, where asset prices are used to measure the prices of the future goods and service that one will wish to purchase. Since most people's consumption is predominantly in the future, the weight on assets becomes very large – well in excess of 90%. Suggesting that the central bank target such an index would amount to recommending that they target asset prices. But asset prices change for too many reasons for such advice to be sensible.

We examine an empirical implementation of the Alchian and Klein proposal, based on the idea that inflation affects all nominal prices. That is to say, movements in all prices, including those of assets, have a common core component that represents aggregate inflation. We discuss a method for extracting this core measure, and apply it to a set of prices that include the prices of consumer goods and services (those commonly including in consumer price inflation measures), prices of equities and prices of housing. Our findings are very clear. Equity prices contain much too much noise to be useful in inflation measurement. That is to say, their relative price has too much variability over monthly or annual horizons. Housing, however, is quite another story. There is substantial evidence that changes in prices of homes contain significant information regarding aggregate price inflation. In the U.S. case, the sale prices of homes are important even after we account for the changes in the service flow prices of housing that are currently included in the U.S. Consumer Price Index.

Overall, we believe that current inflation measures could profitably benefit from an increased weight on housing, but that the current practice of ignoring equity price changes in measures of inflation is justified.

1.6. Do asset prices help forecast inflation?

Central banks that have adopted price stability as a major objective need reliable inflation forecasts both to assess the likely evolution of prices in the absence of changes in monetary policy, and to judge the consequence of such changes. In this context asset prices can provide useful information. There exist a large number of empirical studies that show significant relationships between changes in asset prices and inflation some periods later. For example, a recent study by Charles Goodhart and Boris Hofmann shows that inflation in a broad sample of OECD countries is significantly affected by changes the exchange rate, the price of housing, and equity prices.[4] To be sure, the relationships are not identical across countries, and may even change over time, but as we show when we carry out out-of-sample forecast comparisons using the Goodhart-Hofmann data, asset prices do provide useful information about future inflation in a number of countries and time periods.

This conclusion is confirmed by simulations carried out on multi-equation models often employed by central banks to prepare forecasts used as inputs in the policy decision process. For example, changes in stock prices have significant effects both on inflation and output in a model used at the United States Federal Reserve. Similarly, inflation and output are influenced strongly by the exchange rate and the price of housing in Bank of England's macroeconometric model. Simulations reveal that international differences are present also in large-scale models. Stock price changes tend to have a larger impact in the United States than in other OECD countries in view of the larger capitalization of the US market, and the larger share of household wealth represented by stocks. On the other hand, exchange-rate changes are more important in other countries where exports and imports make up a greater proportion of GNP.

The recognition that asset prices can have strong effects on future inflation implies that central banks have an incentive to forecast asset prices themselves. While we fully recognise that this is very difficult, we contend that it is not a reason not to try. In any event, monetary policy decisions in fact rely on some assumption about the evolution of key asset prices. At the Bank of England, for instance, one of the important inputs into the inflation forecast is the evolution of the external value of Sterling, and this in turn is forecast using interest differentials. Comparisons of these exchange-rate forecasts during the past four years with the subsequent outturns reveal persistent errors in the same direction, which may have led policy makers to set interest rates at too high a level.

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[4] Goodhart and Hofmann (2000).

Part 1. Macroeconomic Instability and Policy Response

2. Asset Prices and Macroeconomic Stability.

The principal novelty of this report is our claim that central banks can improve macroeconomic performance by reacting systematically to asset prices, over and above their reaction to inflation forecasts and output gaps. As we describe below, it is our view that central banks that seek to smooth output and inflation fluctuations can improve these macroeconomic outcomes by setting interest rates with an eye toward asset prices. As we discuss in more detail below, the main reason for this is that asset price bubbles create distortions in investment and consumption, leading to extreme rises and then falls in both output and inflation. Raising interest rates modestly as asset prices rise above what are estimated to be warranted levels, and lowering interest rates modestly when asset prices fall below warranted levels helps to smooth these fluctuations by reducing the possibility of an asset price bubble coming into existence in the first place.

It is important to emphasise that our policy prescription does not concern appropriate reactions to crises that might arise if asset prices should, for whatever reason, suddenly collapse. Instead, our concern is with prophylactic policies designed to prevent the undesirable affects of asset price bubbles.

In this chapter we will develop our argument in three successively more detailed models. In the first section we provide the intuitive reasoning in the context of deliberately simplified contexts, while the results of more general and detailed simulation analyses are reported in sections 2.2 and 2.3.

2.1. Reacting To Asset Prices May Improve Macroeconomic Stability.

2.1.1. An argument based on Poole.

The first illustration of the potential usefulness of reacting to asset prices is an application of the basic insight of Poole (1970).[5] We use a simplified version of the models by Smets

[5] Poole's arguments have been extended, generalized and applied to the debate about exchange rate intervention by, inter alia, Boyer (1978), Henderson (1984) ,and Genberg (1989).

(1997) and Reinhart (1998) to drive home the basic point. Imagine a conventional macroeconomic model consisting of (i) an aggregate demand equation incorporating a wealth effect due to asset price changes, (ii) an aggregate supply relationship based on a Phillips curve, (iii) an asset market equilibrium condition that determines asset prices, and (iv) a monetary policy reaction function in which the Central Bank sets the short-term interest rate in response to inflation, the output gap, and, potentially, the price of equities or other assets. Leaving aside for the moment refinements associated with intertemporal issues and expectation formation, these relationships can be combined and illustrated in a simple diagram.

In Figure 2.1, the line labeled GM represents combinations of inflation (B) and asset prices (q) for which there is equilibrium in the goods market.[6] The line is upward sloping because an increase in the asset price leads to an increase in aggregate demand due to a wealth effect, and the increase in demand leads to inflation. The inflationary effect is tempered by the policy reaction of the central bank, which raises the short-term interest rate in response to inflation (the left-hand panel). In the right-hand panel the central bank is assumed to tighten policy also in response to the increase in q, which makes the GM line steeper.

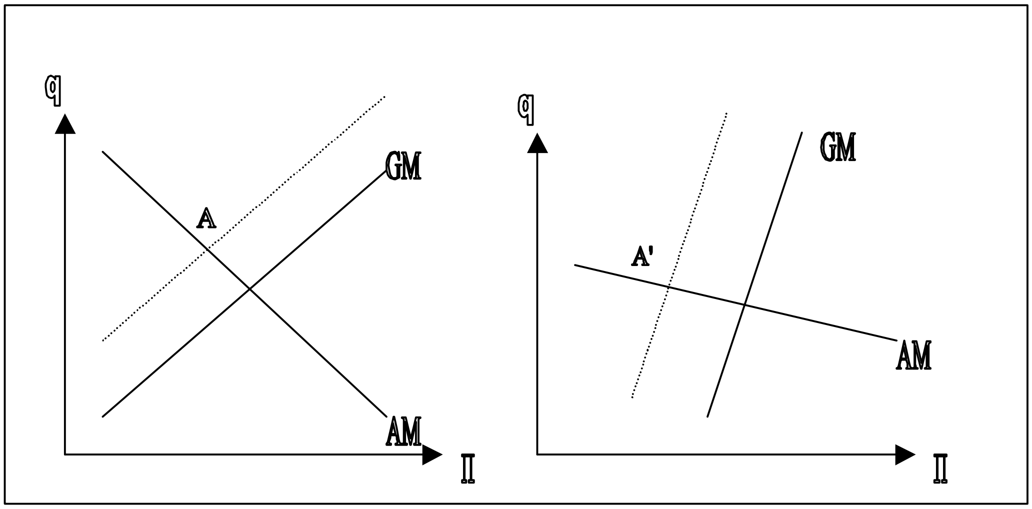
The AM line represents asset market equilibrium. It has a negative slope because an increase in inflation elicits a tightening of monetary policy, which depresses the asset price. If the central bank reacts to the fall in q by tightening less, the depressing effect on the asset price is smaller and the AM line will be flatter (the right-hand panel).

We will use this model to discuss two types of disturbances, a supply (productivity) shock on the one hand, and an asset market shock, on the other. It turns out that the desirability of monetary policy responding to the asset price will be very different in the two cases.

The dashed lines in Figure 2.1 illustrate the consequences of an positive supply shock, that increases supply now, but that is not sufficiently persistent to influence the asset price

Figure 2.1.

A temporary supply shock



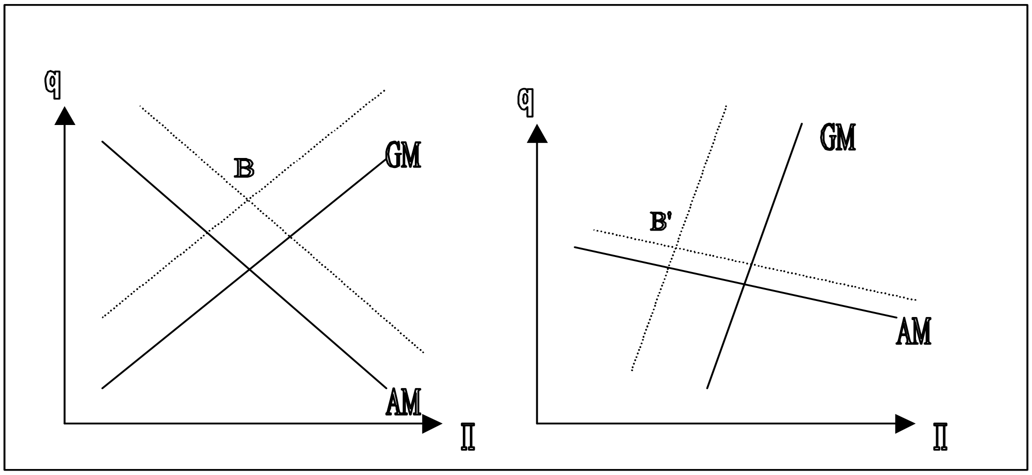
directly through expected increases in dividends in the future. In this case the disturbance will only have a direct influence on the goods market. The equilibrium moves to A in the left-hand panel, and this entails not surprisingly a reduction in inflation and an increase in the asset price as monetary policy is relaxed in response to the reduced inflationary pressures. In the right-hand panel where the central bank reacts directly to the asset price, the reduction in inflation is larger because 'asset price inflation' leads the central bank to be less expansionary than it really ought to be. This is a case where responding to the asset price is inappropriate.

In Figure 2.2, the supply shock is assumed to be persistent enough that it leads to a direct increase in the asset price as a result of expected future dividends. This implies that both the goods market and the asset market equilibrium lines shift upwards. The new equilibrium will be at B when the central bank does not react to q and at B' when it does. Two points are worth highlighting here. The first is that when the productivity shock leads to an increase both in current output and in a wealth effect due to a higher asset

[6] The "asset" could refer to equities (or real estate) in an economy where the stock market (the housing sector) is particularly important or to foreign exchange in a highly open economy where the external sector is crucial. In the latter case, q would obviously refer to the exchange rate.

Figure 2.2.

A persistent supply shock



price, there needs to be no inflationary consequences. The second point is that here again there is no case for intervening in response to the increase in the asset price.

In Figure 2.3 the productivity shock is assumed to be permanent in the sense that it has a direct effect on the asset price as in the previous case. But in contrast to that case we now assume that the **current** supply of goods is not yet increased. Hence the goods market line does not shift upwards (it might even shift to the right if the expected future income generates higher demand now), but the asset market line does. Here the productivity shock is inflationary, and in the case where the central bank tightens policy in response to the increase in q, the increase in inflation in smaller. In other words, in this situation it is useful for the central bank to react directly to the asset price.

Figure 2.3.

A shift in the risk premium

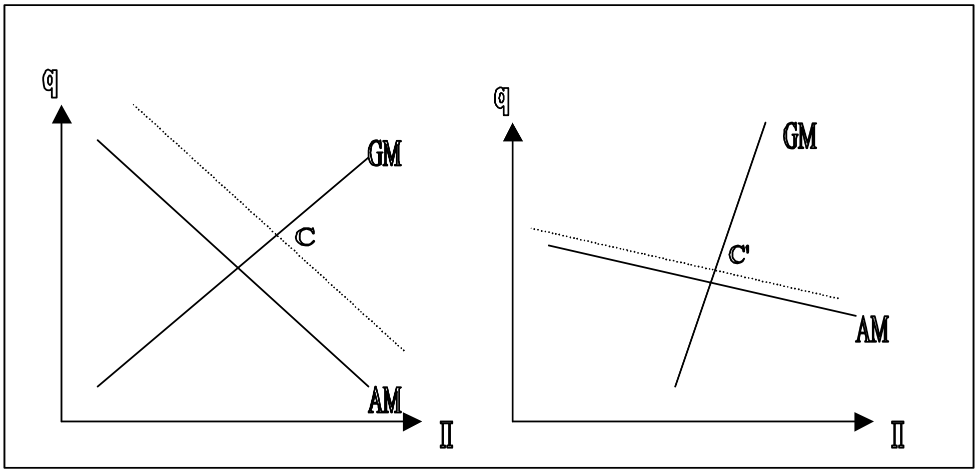


Figure 2.3 can also be used to illustrate another case where reacting to the asset price is useful. Imagine a shock in the asset market that has no direct counterpart in the goods market; a reduction in the equity risk premium might be a case in point. The consequence of this would correspond to what is depicted in Figure 2.3. The increase in q would bring about some inflationary pressures due to the wealth effect on aggregate demand, and a monetary policy that responds directly to the increase in the asset price will limit the inflationary consequences of the shock.

These examples show that asset prices carry information about the economy that can be exploited by the policy maker to improve macroeconomic stability. To be sure, the results were described in a very simple framework and must be checked in more complete and realistic models. In particular, dynamic elements need to be taken into account. In the next section we show that doing so makes the case for reacting to asset prices even stronger.

2.1.2. Misalignments in an inter-temporal setting.

Kent and Lowe (1997) present an argument for intervening to reduce the likelihood of the emergence of a growing misalignment (or bubble) of an asset price. Their argument is explicitly inter-temporal and based on two important assumptions, that asset price bubbles tend to grow exponentially until they burst, and that when a bubble bursts there will be a severe reduction in inflation due to a reverse financial accelerator effect. Intuitively their case for intervention can be stated as follows.

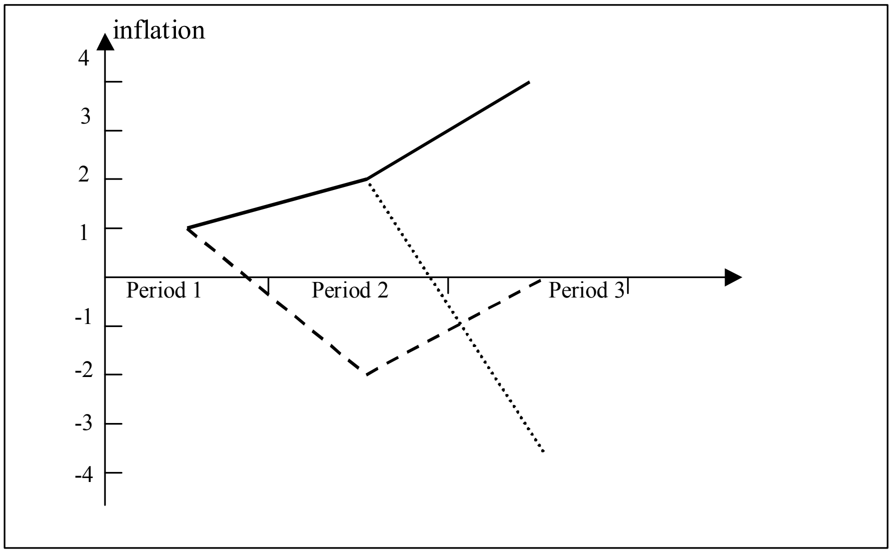
Consider a three-period horizon, and imagine that a financial bubble emerges in period 1.[7] As a result of the increase in the asset price, inflation will increase due to the usual wealth effect. If the central bank maintains a neutral interest rate policy, the bubble will either burst or double in size in period two. In the former case inflation will fall precipitously (to -2 in Figure 2.4), and in the later it will increase with the bubble (to +2). If we assume for simplicity that the probability of bursting is 50%, the expected (as of period 1) inflation rate is zero, which is assumed to be the target of the central bank. In period 3 we have three possibilities, either the bubble burst in period 2 in which case it is assumed not to reappear, or it did not in which case it will either continue to grow or burst in period 3. In the first case inflation in period 3 will be zero (the dashed line in Figure 2.4) and in the latter it will either be +4 (the solid line) or -4 (the dotted line). In either case the *ex ante* expected inflation rate will be on target.

The above scenario assumes that the central bank conducts a neutral monetary policy in period 1. This can be justified on the grounds that, as of this period, the expected inflation rate is on target during the entire policy horizon (assumed to be periods 2 and 3 since the interest rate affects inflation with a lag). If the central bank were concerned with the variance of inflation around the target, it would clearly prefer the scenario where the bubble bursts in period 2. This is the basis for the suggestion that the central bank might be well advised to react to the emerging bubble in period 1.

[7] The example as well as Figure 2.4 are taken directly from the Kent-Lowe paper, but the description leaves out the finer subtleties of the analysis.

Figure 2.4.

The effect of an asset price bubble on inflation



To show this, suppose that by raising the interest rate in this period, the central bank can increase the probability of the bubble bursting in period 2. By doing so, the likelihood of the favourable (return to fundamentals) scenario is increased, which is desirable as we just saw. Of course, this outcome comes at the price of an inflation rate in period 2 that is below target.[8] Kent and Lowe show that it is possible to construct examples where raising the interest rate in response to the emerging asset price bubble is indeed the preferred outcome, because the large reduction in the variance of inflation outweighs the small deviation from the target level.

It is important to note that in the example just constructed the central bank deliberately pursues a policy, which makes the expected rate of inflation deviate from the target rate. This is appropriate because this policy reduces the expected variability of the future inflation path. In the next two sections we investigate this conclusion further by conducting simulation experiments in more detailed macroeconomic models.

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[8] It is below target for two reasons; the greater likelihood of a bursting bubble which brings about a big decline in inflation and the effect of the increased interest rate itself.

2.2. Explorations of the Bernanke-Gertler Model

2.2.1. Introduction

The question of how central bankers should response to asset-price volatility in the context of an overall strategy for monetary policy is the focus of a recent influential paper by Bernanke and Gertler (1999). Their analysis unequivocally recommends a monetary policy rule that reacts aggressively to inflation and does not respond directly to movements in stock prices. This conclusion comes primarily from the finding that, in their model, policy may be destabilising if it reacts to equity values. This result is very striking, as most people's intuition, and the conclusion of the previous section, is that whether or not policy should react to a bubble in stock prices must depend on a number of circumstances. We are led to ask how sensitive the results of Bernanke and Gertler are to the particular assumptions they make in their analysis. Our conclusion is that the choice of policy rule in the face of asset-market disturbances may not be as clear-cut as the Bernanke-Gertler paper suggests. In fact, we will show that their model implies that central banks should react systematically to asset price bubbles in many cases.

2.2.2. Summary of the Bernanke-Gertler Paper and Findings

2.2.2.1. Overview

While Bernanke and Gertler acknowledge that monetary policy is not a sufficient tool to contain the potential damage of booms and busts in asset prices, they point out that asset-price crashes have done sustained damage historically only in the cases when monetary policy remained unresponsive. It is, therefore, natural for central banks to view price stability and financial stability as highly complementary and mutually consistent objectives. They go on to propose that the best policy framework for achieving both objectives is flexible inflation targeting and that policy should not respond to movements in asset prices except insofar as they signal changes in expected inflation.

Fluctuations in asset prices should not be an independent source of concern to policymakers in an environment characterized by capital markets that are perfectly efficient and free of regulatory distortions. Things change, however, if asset-price volatility is being driven by non-fundamental factors (such as bubbles or fads) and if these changes in asset prices have potentially significant effects on the rest of the economy. When there are potentially destabilising misalignments, there is a clear case for policy makers to take them into account.

Bernanke and Gertler identify two channels through which asset prices could affect the real economy. The first of these is through the wealth effect on consumption spending. They do not consider this a quantitatively important channel and parameterize their model so that this effect is modest. The main channel they examine is the one from asset prices to balance sheets of firms, and on to real activity. In the presence of credit market frictions, the condition of firms' balance sheets affect their ability to borrow. In addition to the direct effects of deteriorating balance sheets on spending and aggregate demand, there are also likely to be magnification effects through the financial accelerator, with declining sales and employment implying continued weakening of cash flows and hence further declines in spending. There are also likely to be feedback effects on asset prices through the 'debt-deflation' mechanism, as falling levels of spending together with forced asset sales lead to further decreases in asset values. The strength of these channels will depend to a significant degree on the initial financial conditions in the economy.

The authors conclude that, faced with non-fundamental movements in asset prices in an economy with credit market frictions, inflation targeting is the best policy strategy for central bankers. They point to the fact that inflation targeting provides a unified framework for making monetary policy in normal times and for preventing the effects of financial crises. It also has the advantage of inducing policymakers to adjust interest rates automatically in a stabilising direction in the face of asset price instability. This strategy implies that central banks should ignore movements in stock prices that don't appear to generate inflationary or deflationary pressures.

2.2.2.2. The Model

Simulations in the Bernanke-Gertler paper are based on a standard dynamic new-Keynesian model, modified to allow for financial accelerator effects and exogenous bubbles in asset prices[9]. Briefly, the economy comprises three sectors: households who consume and save; a government that manages fiscal and monetary policy; and a business sector composed of firms that hire labour, invest in new capacity, and produce goods and services.

Firms finance the acquisition of capital both through the use of internal funds and through external borrowing. The existence of credit market frictions means that there is a premium on external finance that affects the overall cost of capital and thus the real investment decisions of firms. This external finance premium depends inversely on the financial condition of potential borrowers. An improvement in a borrowing firm's position translates into a fall in the premium, which serves to magnify investment and output fluctuations. So, for example, an increase in a firm's share price, raising the net worth of the owners, will make the firm more creditworthy, reduce the external finance premium, thereby increasing borrowing and investment.

This financial accelerator mechanism provides an additional channel through which monetary policy can affect spending. With a fall in real interest rates, for example, asset prices will rise, reducing the cost of external borrowing and providing an extra stimulus for investment.

Price stickiness in the model is reflected in staggered nominal price setting, where not all prices are adjusted every period. Optimization and forward-looking behaviour are assumed throughout, except in the case of the Phillips curve, where expectations are modeled as being formed by a combination of forward and backward looking behaviour. In their simulations, Bernanke and Gertler presume that these expectations are roughly 60% forward looking and 40% backward looking.

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[9] The model is closely based on that in Bernanke, B, Gertler, M and S. Gilchrist (1998).

The crucial innovation of the analysis is to allow for the possibility that observed stock prices differ persistently from fundamental values, and that this difference grows exponentially. That is, they incorporate bubbles into the model. The consequence of this is that the bubble affects the quality of a firm's balance sheet, and so the cost of capital falls systematically when stock prices exceed fundamental values. The result is an increase in investment, resulting in both higher current aggregate demand and higher future potential output.

2.2.2.3. The Bernanke-Gertler Simulations

Bernanke and Gertler use this model to compare the ability of different policy rules to stabilise output and inflation in the face of asset-market disturbances.[10] Specifically, they report results for four policy rules that vary depending on the response to inflation and stock prices. The four combinations are: (1) accommodative with no response to stock prices, (2) aggressive with no response to stock prices, (3) accommodative *with a* response to stock prices, and (4) aggressive *with* a response to stock prices.

To see the impact of a bubble, Bernanke and Gertler subject their economy to an asset price bubble that begins as a one per cent exogenous increase in stock prices above fundamentals.[11] In the simulations, the bubble is "killed off" after five periods. It is assumed that agents in the model know the *ex ante* stochastic process for the bubble but not the time that it will burst.

We begin our discussion of the simulations with a comparison of policy rules (3) and (4) – those that include a response to the bubble. Figure 2.5 is a reproduction of Bernanke and Gertler's Figure 2.[12] The striking result is that the accommodative policy that reacts

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[10] We are grateful to Ben Bernanke and Mark Gertler for generously providing us with their model. We thank Pau Rabanal for his patience in answering our questions about the simulations, and Roisin O'Sullivan, who actually did all of the work.

[11] Experiments show that the actual size of the bubble is irrelevant for the comparisons we report.

[12] We note that, while Bernanke and Gertler's figures are labeled "output gap," they in fact have plotted the response of output. We follow their lead, as it is our view that welfare comparisons in this model should be done by examining output fluctuations, rather than variation in the gap. The reason for this is that, in the presence of the bubble, the Bernanke-Gertler model implies that too much investment, and so potential

Figure 2.5: Comparing Policies that Do React to Stock Prices.

Solid line - Policy (4), Aggressive reaction to inflation.

Dashed line - Policy (3), Accommodative reaction to inflation.

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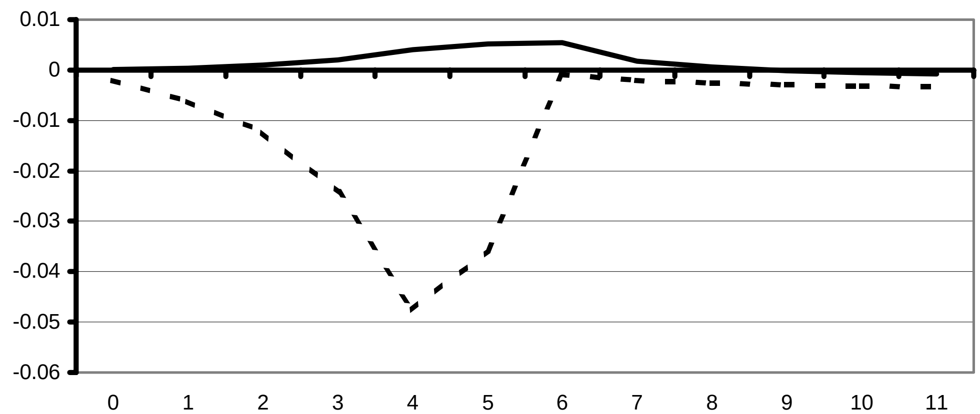
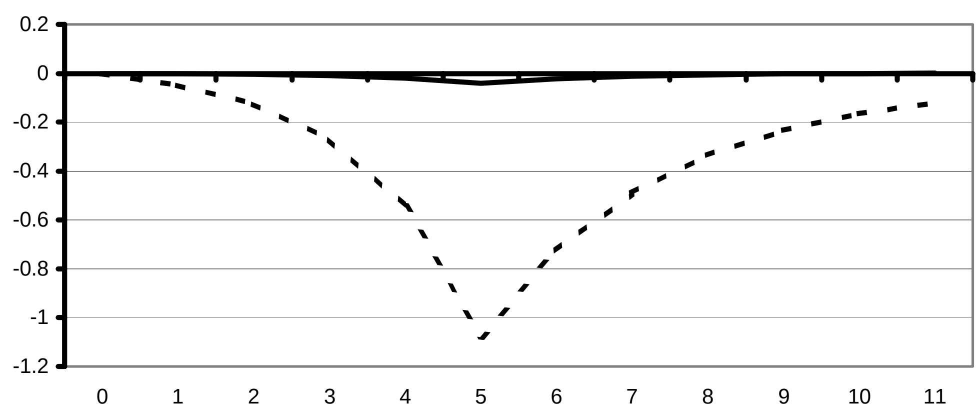
Panel A: Output

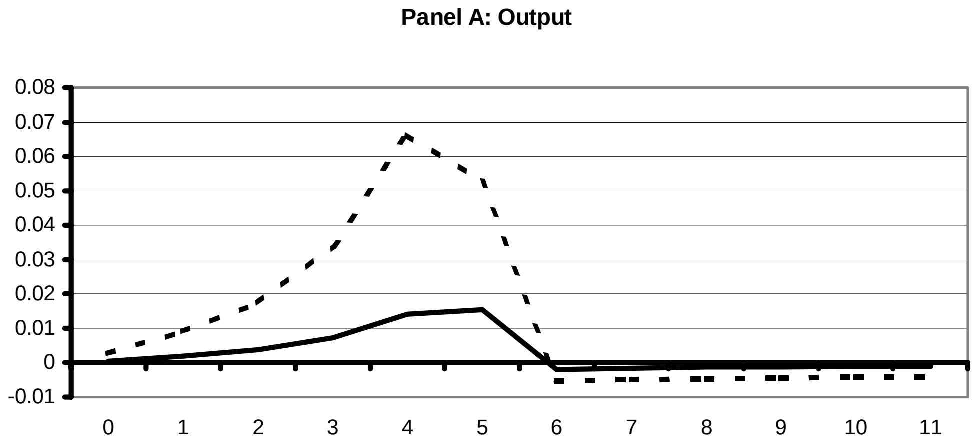


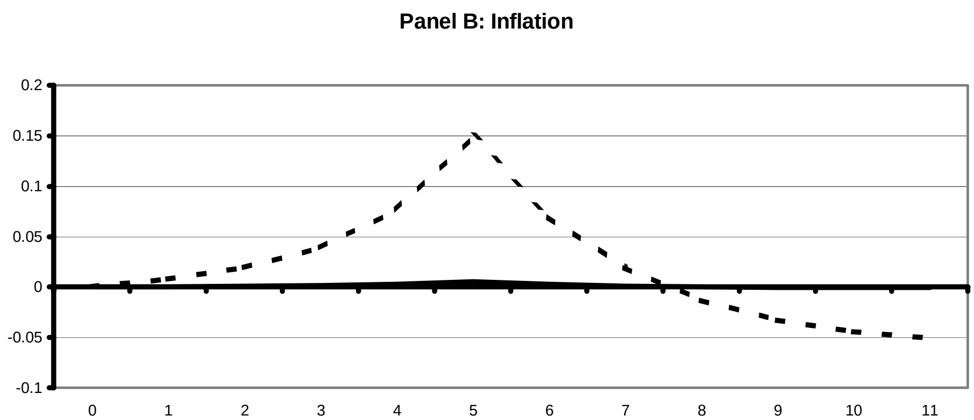
Panel B: Inflation



output is distorted as well. The proper baseline, therefore, is not the absence of a gap, but the absence of any change in output at all.

Figure 2.6: Comparing Policies that Do Not React to Stock Prices.
Solid line - Policy (2), Aggressive reaction to inflation.
Dashed line - Policy (1), Accommodative reaction to inflation.





to stock prices, policy (3), causes both output and inflation to fall precipitously; while policy (4) which reacts to stock prices as well but is much more aggressive in reacting to inflation, leads to a modest increases in output and a very slight decrease in inflation. These patterns are very different from those of policies with no stock price reaction, cases (1) and (2). As we show in Figure 2.6 (Bernanke and Gertler's Figure 1), in the absence of a reaction to stock prices, the aggressive policy again stabilises both output and inflation.

A second way of comparing these policies is to look at the variance of output and inflation. Table 2.1 reports the results constructed directly from the Figures.[13] The one thing that is clear from the table is that the accommodative policy is a disaster. The

Table 2.1: Variability of Output and Inflation under Different Policy Rules

	Bubble Shock	
Policy Rule	**Variability of Output**	**Variability of Inflation**
Accommodative, no reaction to stock prices	6.26	33.09
Aggressive, no reaction to stock prices	0.38	0.03
Accommodative, reaction to stock prices	2.41	995.68
Aggressive, no reaction to stock prices	0.05	1.41

Note: This is the corresponding table to Bernanke and Gertler's Table 1, where variances are calculated on a consistent basis with the graphs drawn (i.e. for one bubble lasting five periods).

variation in both output and inflation is orders of magnitude higher than it is in the aggressive policy, regardless of whether one responds to asset prices. But whether or not it is advisable to respond to asset prices looks less clear-cut. That is, including asset prices raises inflation variability but lowers output variability, and so the choice depends on policymakers' preferences.

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[13] These numbers are intended to mirror the information in Bernanke and Gertler's Table 1. They differ in that we are using the information from the same simulations used to construct the graphs. That is, the bubble process we use is consistent between this table and the figures (and throughout our analysis). Bernanke and Gertler's table is based on substantially different bubble processes, and so gives different results.

2.2.3. Robustness experiments.

In examining Bernanke and Gertler's simulations, we are left wondering about the robustness of their results to a number of adjustments to their model. These fall into the following categories:

1. We ask how difficult it would be to eliminate the perverse effect (whereby output falls in response to a stock price increase), and study the consequences of adding the output gap to the policy rule.
2. By introducing an objective function for the policymaker, we can compute rules that are optimal. We presume that policy makers minimise a weighted sum of output and inflation variability, and proceed to examine a fairly general policy rule that includes reactions to changes in future inflation, the output gap and stock prices and ask if we can outperform Bernanke and Gertler's rule. In addition, we look at the consequences of policy rules that respond to the bubble rather than stock prices.
3. Real life monetary policymakers appear to prefer smooth paths for interest rates. What if we allow for interest rate smoothing in the policy rules? What if the variance of interest rate changes enters the objective function?
4. Bernanke and Gertler study a case in which agents place a weight of approximately 40 percent on past inflation and 60 percent on future inflation in their aggregate supply function. It is well known that changing the extent to which agents are forward or backward looking can have a large impact on outcomes. How much does it matter here?
5. What if the degree of leverage in the economy is reduced when it is known that the authorities will react to a bubble?

As we explain briefly below and document in detail in Appendix 2.1, the consequence of each of these adjustments is to reinforce the basic message of this chapter, namely that macroeconomic stability is well served if monetary policy reacts in part to asset price misalignments.

2.2.3.1. Including the Output Gap in the Policy Rule

First, we make a simple adjustment to the policy rules of described above by adding the output gap, thus making it look more like a Taylor (1993) rule. Interestingly, this change completely eliminates the perverse impact of the bubble noted in Figure 2.5. Instead, output now rises modestly, and inflation falls only slightly. (See Figure A2.3 in Appendix 2.1)

2.2.3.2. Introducing Policymaker's Objectives: Optimal Rules

So far we have only investigated policy rules where the size of the reactions of the interest rate to inflation, stock prices and the output gap has been determined exogenously. The natural question to whether we can find optimal reactions to these variables. To determine this, we must make explicit assumptions about the policymaker's objectives. We therefore postulate that policymakers seek to minimise a weighted average of the variability of output and inflation respectively, and search for the optimal interest rate policy as a function of the relative weights that are assigned to the two objectives. The results in are quite interesting. What stands out is that, regardless of the extent to which the loss penalizes inflation or output variability, the loss-minimizing rule always entails a reaction to stock prices. (See Table A5.2 in the Appendix 2.1.) Furthermore, depending on the objective function, reaction to inflation is often very aggressive, and reacting to the output gap is generally desirable.

Comparing our optimal rules with those that Bernanke and Gertler investigated, we see that in every instance ours are superior, and usually by substantial amounts. Their rule (2), the aggressive policy with no stock market reaction, is the best among the set they study. Even in this case, however, the loss is always more than 72% above that of the optimal rule regardless of the relative weights of inflation and output variability in the government's loss function. We also note that the ability to react to stock prices improves performance significantly, with the weighted sum of inflation and output variability falling by between 22% and 99%, depending on the exact circumstances.

Finally, we will simply note that these results are qualitatively unchanged if the rule includes a reaction to the stock market bubble, rather than the stock price itself. That is, if the policymaker can disentangle the fundamental from the speculative component of asset prices, the new information does allows policymakers to reduce the loss, but only very slightly.[14]

2.2.3.3. Interest-Rate Smoothing

In order to match the actual path of interest rates in economies, researchers have had to assume that interest-rate paths are fairly smooth. There are two ways in which we can introduce interest-rate smoothing. The first is simply to add the lagged interest rate to the policy rule. Doing so we find that some degree of interest rate smoothing does indeed reduce fluctuations in inflation and output, although the gain is very small unless the government is only concerned with the variability of inflation, and not at all of that of output. (See Table A2.3.) It is interesting to note that the optimal degree of interest rate smoothing in this model is very close to the estimates researchers obtain from the data.[15] More importantly, allowing for interest-rate smoothing does not change the fact that the optimal rule responds to asset prices.

A second way in which to study interest rate smoothing is to postulate that the government dislikes variability of interest rates as well as variability of inflation and output. We have identified the optimal interest rate policy for different weights attached to the variability of interest rates, and in each case we conclude that the optimal reaction to stock prices is broadly unchanged. That is to say, we find that the loss-minimizing rule continues to require the central bank to react to stock prices. (See Table A2.4.)

2.2.3.4. Changing the Degree to which the Private Sector is Backward Looking

Our third set of experiments, we examine the implication of making people more or less backward looking in their wage setting. The degree to which wages depend on past

[14] We emphasise that none of these rules is actually optimal, in the sense that there will surely be an interest rate path that is more complex and dominates the ones that arise from these restrictive rules.
[15] See, for example, Rudebusch (1999).

inflation as opposed to the expected future inflation is an important determinant of the elasticity of output and inflation with respect to an aggregate demand shock over time. For example, the greater the weight attached to past inflation, the larger is the impact of changes in aggregate demand on output in the short run.

We investigated four different variants ranging from one extreme where wage behaviour was completely backward looking to the other extreme where it was completely forward looking. Again, in all cases, some reaction to asset prices is called for in the optimal rule. Furthermore, the Bernanke-Gertler rules now perform very poorly under some specifications. For example, when the economy is either purely forward looking or purely backward looking, their best of the rules has a loss that is more than 20 times that of the optimal rule. (Table A2.4)

2.2.3.5. Varying Leverage

Bernanke and Gertler report the results of some simulations examining the impact of reducing leverage on the economy, finding that it mitigates the variability of both output and inflation. Their experiments examine the impact of increasing the required net-worth-to-capital ratio in the model. Our findings are clearly consistent with theirs, as we find that a reduction in leverage does not affect the choice of the optimal policy reaction function but it does yield smoother output and a lower overall loss.

This is significant for the following reason. If policymakers are known to target the stock market, then firms and households will react accordingly. In particular, an increase in the stock market will be met by a reduced taste for leverage. That is, if the policy rule targets stock prices, then leverage in the economy would be reduced, muting the financial accelerator effect of the bubble and stabilising the economy beyond what the simple simulations suggest.

2.2.3.6. Endogenising the Bubble's Size and Duration.

One of the main advantages of pre-emptive policy that looks at stock prices is that by preventing a bubble, you hopefully reduce the size of the run-up in the market, and the size of the eventual bust. In the Bernanke-Gertler setup, however, it is assumed that the size of the shock and the bust shock are independent of the monetary policy followed. What if it is not?

This is the case studied by Kent and Lowe (1997) that we summarised in the previous section. If the central bank can reduce the size of a bubble by tightening policy when the bubble is still in its formative stages, the imbalances created when it eventually bursts will be mitigated. Hence, by deviating slightly from the current inflation target, monetary policy can ensure less variability of output and inflation in the future.

2.2.3.7. Additional Experiments

We performed a number of additional experiments that had no material impact on the results --- theirs or ours. We will simply list them: (1) Firms investment decision are based on stock prices rather than fundamentals; (2) The policy rule is based on an average of two-period ahead inflation expectations; (3) Varying the size and persistence of the bubble.

2.2.4. Conclusions.

After all of these experiments, we are left concluding that things are not as clear-cut as Bernanke and Gertler suggest. In fact, the overall lesson of our numerous simulations is that you have to work very hard to find a case in which policy should not react to asset prices in the presence of a bubble. In the vast majority of cases we study, it is strongly advisable for interest rates to respond. While the reaction may not be very large, it should clearly be there. This result, which is consistent with our intuition and counter to the conclusions reacted by Bernanke and Gertler, appears to be very robust. In the next section we show, in particular, that it carries over to an open economy context, in the sense that it is in general advisable for a central bank to adjust its policy instrument to exchange-rate movements in addition to the inflation forecast itself.

2.3. Exchange Rate Misalignments and Monetary Policy.

2.3.1. Recent examples – the UK and Canada.

Currently, the perceived overvaluation of sterling is creating difficulties vis-à-vis the operation of monetary policy in the UK. Table 2.2 displays a variety of conventional estimates of the 'equilibrium' exchange rates, including Purchasing Power Parity (PPP, hereafter) and so-called Fundamental Equilibrium Exchange Rate (FEER, hereafter) based estimates. The 'equilibrium' estimates vary between DM2.04 and DM2. 60, while the actual exchange rate is DM3.25.

Table 2.2: Alternative Estimates of the Equilibrium Exchange Rate for Sterling – DM

PPP[1] estimates	
Consumer Price index based measure	2.57
Producer price index based measure	2.37
Measure based on unit labour costs	2.60
FEER[2] estimates	
IMF	2.44
Wren-Lewis and Driver (1998)	2.04 – 2.49
Church (1999)	2.30
Actual exchange rate	3.25

Notes: 1) PPP denotes Purchasing Power Parity
2) FEER denotes Fundamental Equilibrium Exchange Rate

Unsurprisingly, this has led to demands from some quarters that the MPC target a lower exchange rate as well as the rate of inflation e.g. the House of Commons Select Committee on Trade and Industry argued in a recent report that

> "The euro-sterling exchange rate is in essence only a problem for the UK. The remedy is therefore a responsibility of UK ministers. We consider that the time has come to reconsider the primacy in the Monetary Policy Committee's Remit given to an inflation target …" (Select Committee on Trade and Industry Fifth Report, 14th March 2000).

Many UK economists think that it would be a mistake to modify the framework, in part, because the 1986-88 experience of secretly shadowing the DM is still commonly regarded as having significantly contributed to the rise in inflation in 1989-90. Essentially, it is often asserted that UK interest rates were kept lower than they should otherwise have been during 1986-88 because the Chancellor was attempting to put a cap on sterling, and that this allowed the domestic economy to overheat so that when the exchange rate inevitably fell in 1989 (in response to the current account deficit that the domestic overheating had allowed to build up), inflation then rose very significantly. (See Stephens (1996) for a detailed account of the 1986-90 experience.)

Of course, other open economies with inflation-targeting regimes have also had to wrestle with how to incorporate the exchange rate into policy setting.
Deputy Governor Freedman (2000) points to the fact that when the exchange rate moves solely because of portfolio adjustments, then this requires an offsetting interest rate adjustment to keep monetary conditions unchanged. This is why the Bank of Canada developed the concept of the monetary conditions index (MCI) as a policy guide for a central bank in a small open economy. Of course, the Bank of Canada has always asserted that assessing the type of shock to the exchange rate was critical to determining whether an offsetting interest rate adjustment was necessary. For example, a terms-of-trade shock affecting the exchange rate would typically not require an offsetting interest rate adjustment. It is, therefore, interesting to note the argument of Smets (1997) that the reason that Canada chose to use the MCI for much of the 90's was that the typical shock affecting the exchange rate was a portfolio shock, while Australia did not use a MCI because the typical shock affecting the exchange rate was a real shock. More recently, the Canadian central bank has placed less emphasis on the MCI as a measure of monetary conditions both because real shocks have been more important than portfolio shocks in affecting the Canadian dollar and because, in the words of Freedman (2000), "…the markets started to treat all exchange rate movements as portfolio shocks and therefore came to expect an offsetting interest rate adjustment every time there was a movement in the exchange rate, whether or not such an adjustment was appropriate." (p. 4)

Given that movements in the exchange rate that are unwarranted by the underlying fundamentals can have relatively long-lasting effects on output and prices and can destabilise the economy, it behooves us to ask as to what, in theory, a central bank should do about it, and we turn to a discussion of this issue next.

2.3.2. Optimal interest rate rules in open economies.

In closed economy models, economists have, for some time (see e.g. Svensson (1997) and Ball (1997)) argued that "optimal" policies are versions of inflation targets and Taylor rules. In an extension of such models to the open economy, Ball (1999) finds that inflation target/Taylor rules are sub-optimal in an open economy. In the context of his model, he finds that the policy instrument is no longer just the interest rate, but is, instead, a weighted sum of the interest rate and the exchange rate (like a MCI). Further, he finds that it is optimal to target a measure of "long-run" inflation i.e. a measure of inflation that has been adjusted for the temporary effects of exchange rate fluctuations. This is a potentially important result, but some have questioned it on the grounds that the equation for the exchange rate in Ball's model is unconventional, firstly because it does not incorporate the uncovered interest parity condition (a cornerstone of most theoretical models of the exchange rate), and secondly because exchange rate expectations do not play any role in affecting the current exchange rate.

Therefore, we have re-examined the issue of the optimality of either a Taylor rule or inflation forecast-based rule in the context of a small-scale macroeconomic model in which these two aspects of exchange rate determination are present. In particular, we use variants of the Batini-Nelson (2000) model, which has been used at the Bank of England to analyse optimal inflation forecasting horizons. We are extremely grateful to Nicoletta Batini for running the simulations that we report on below. More details on the simulations and further robustness exercises will be found in Batini (2000).

2.3.2.1. The Batini-Nelson model.

The model used for the simulations is a relatively conventional small open economy model based on an aggregate demand and aggregate supply relationship together with an equation determining the exchange rate. Aggregate demand depends, uncontroversially, on expected income, the real interest rate and the exchange rate. Too account for the observed lag between exchange rate movements and changes in aggregate demand, it is assumed that the impact of the exchange rate is spread over five quarters.

Aggregate supply is specified in the form of a Phillips curve with both forward and backward looking elements as in the Bernanke-Gertler model of the previous section. In other words, current inflation depends in part on expected future inflation and in part on last quarter's inflation. In addition, the excess demand in the goods market and exchange rate changes are included as independent sources of inflationary pressures. The dynamics of exchange rate is determined by capital flows in the sense that the latter are sufficiently mobile to ensure that interest parity holds continuously (up to a random risk premium). In other words, the current exchange rate is assumed to adjust so as to equalize the expected return on domestic and foreign assets.

2.3.2.2. Interest rate policy rules.

The economy described by these relationships is assumed to be shocked each quarter by unobserved random disturbances in aggregate demand, aggregate supply and capital flows. For given nominal interest rates, these shocks lead to fluctuations in inflation and output. The central bank in this economy is setting the interest rate in an attempt to stabilise the deviations of inflation and output from their respective target levels. We specifically assume that the authorities are concerned not only with current inflation and output stability but with stability measured over a multi-period horizon.

An optimal interest rate policy would react directly to the three exogenous shocks affecting our economy. However, since we assume that that these shocks are unobservable, we limit our attention to two simple rules in which monetary policy reacts to observed and expected movements in inflation, output and the exchange rate. In the first rule, which we call the inflation forecast based rule (IFB), the central bank is assumed to set the nominal short-term interest rate in response to the difference between its inflation forecast two periods hence and the target inflation rate. In addition we allow for some interest rate smoothing and, what is the main concern of this report, the possibility of reacting to the deviation of the exchange rate from its long run equilibrium level.

The second policy rule we investigate is a variant of the Taylor rule already introduced in the previous section. Specifically, we assume that the central bank changes the short-term real interest rate in response to inflation, the output gap, and misalignment of the exchange rate.

2.3.2.3. Simulation results.

We first consider the case where there is an exchange rate shock (say, because of a change in the risk premium, or, equivalently, because of "irrational" forces) which leads the exchange rate to be overvalued.

Table 2.3 presents the value of the overall instability index (loss function) as well as the asymptotic variances of inflation (not annualised), output, the nominal interest rate (not annualised) and the real exchange rate, when the only shock to the economy comes from the interest parity relationship. This is a world of only portfolio shocks. In terms of the overall instability index, the ranking of the rules is as presented (in reverse order) in the table.

It is evident from these results that, in this particular case, responding to the exchange rate clearly reduces the welfare loss. Moreover, this ranking does not depend on caring about output as we have assumed in calculating the overall instability index. If all one cared about was inflation volatility, then the above ranking of the rules would be the same. This result is consistent with the 1999 Nobel laureate Robert Mundell's (2000) assertion that –

> "Central banks should recognise that the maintenance of price stability will be furthered rather than harmed by taking explicit account of the exchange rate to mitigate wild gyrations."

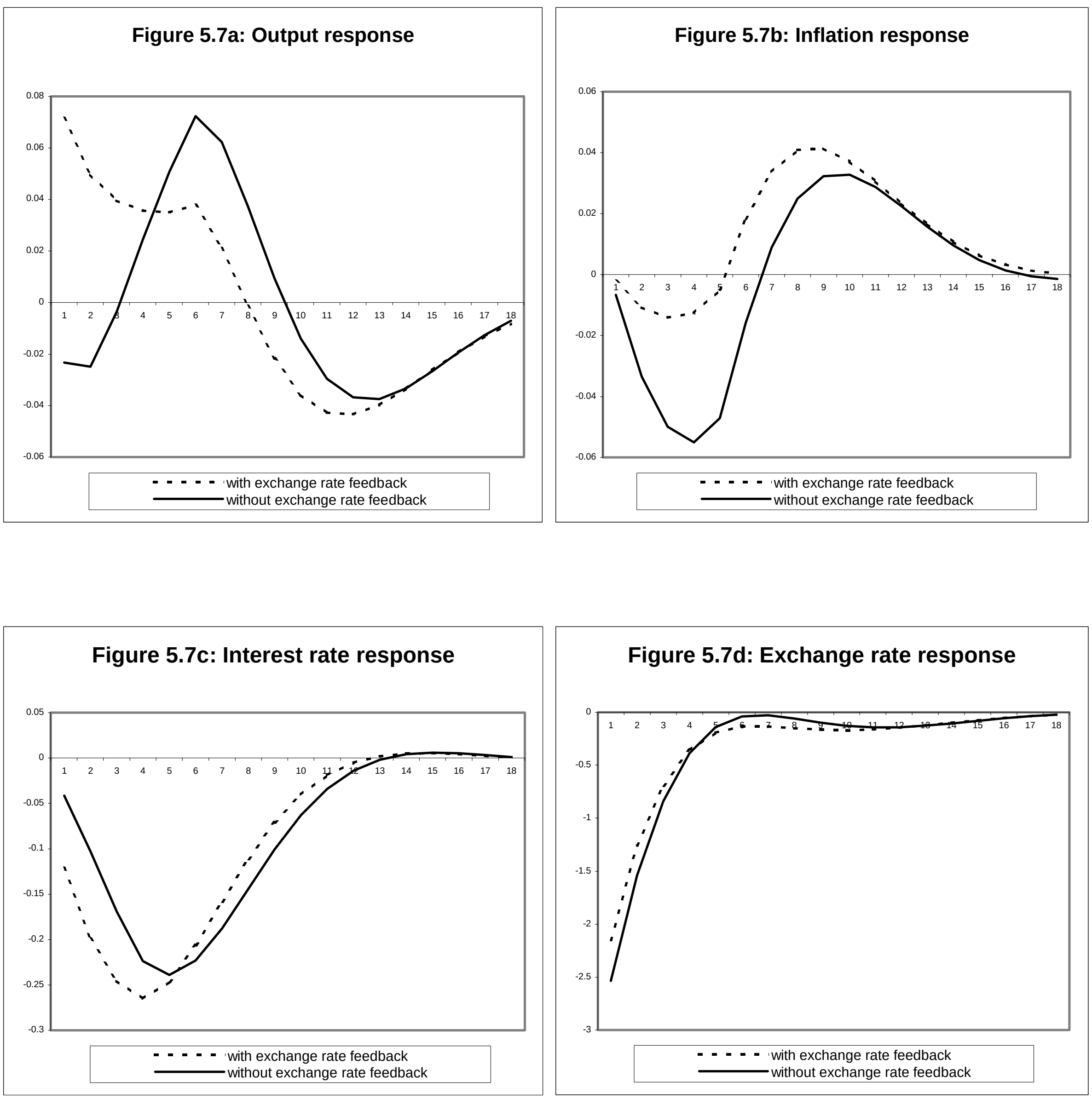
Table 2.3: Performance of Alternative Monetary Policy Rules under Portfolio Shocks.

		Variability of			
	Instability index	**Inflation**	**Output**	**Short-term nominal interest rate**	**Real exchange rate**
Portfolio shocks only					
Taylor rule, no reaction to the exchange rate	3.511	0.457	0.409	0.697	3.793
Taylor rule, with reaction to the exchange rate	2.619	0.396	0.330	0.715	3.499
IFB rule, no reaction to the exchange rate	0.204	0.107	0.134	0.479	2.888
IFB rule, with reaction to the exchange rate	0.137	0.0859	0.140	0.532	2.453

Figure 2.7 shows the responses of the four endogenous variables of the model to a portfolio shock that leads to a sudden appreciation of the domestic currency and when policy makers follow the inflation forecast based rule defined above. (The solid and the dashed lines illustrate the response of the model when the rule excludes and includes the real exchange rate feedback, respectively.) Figure 2.7d shows the exchange rate appreciation (negative number denotes appreciation). Under both monetary policy rules, the interest rate is lowered because the higher exchange rate lowers the inflation forecast. However, interest rates are initially obviously cut by more for the rule where there is an exchange rate response (see Figure 2.7c). Initially, this is associated with a smaller

exchange rate appreciation, and therefore with output initially falling by less (actually rises - see Figure 2.7a). Inflation also falls by less initially (Figure 2.7b). Over time, the higher level of inflation in the "leaning against the wind" case is associated with somewhat higher interest rates, and, therefore, output is also lower. However, the results in Table 2.6 showed that, on average, the degree of inflation and output volatility is diminished by directly reacting to the exchange rate misalignment. Hence, using interest

Figure 2.7: Exchange rate shock -- Inflation-Forecast-Based interest rate rule.



rates to insulate the economy from "exchange rate shocks" over and above the effect of such a shock on the central bank's inflation forecast appears to be welfare-improving.

This result is interesting because there are those who assert that central banks should ONLY attempt to hit an inflation forecast, and that if they were to allow themselves to be distracted by the exchange rate, this would compromise low inflation. Instead, we have seen that taking an exchange rate misalignment into account when setting interest rate policy can actually reduce inflation volatility. It is also important to note that the policy followed here is not exchange rate targeting. In fact, as might be seen in Figure 2.7d, the alternative policy only appears to induce a modest difference in the exchange rate path. It is primarily the lower interest rate that acts to reduce output and inflation volatility.

For example, The Financial Times (editorial, April 7, 2000) argues that –

> "… But since they (i.e. the MPC) have a bad record for predicting the level of sterling, there is little chance that they could control it, even if the wished to do so. They must focus single-mindedly on inflation."

Yet, the simulations above suggest that taking an exchange rate misalignment into account in addition to the inflation forecast can reduce inflation and output volatility with the exchange rate behaving almost in the same way as under a policy where the committee single-mindedly targets inflation.

Some might be surprised by our result that one can reduce inflation volatility by including an exchange-rate misalignment term in addition to the inflation forecast. However, it is important to recall that a monetary policy rule that just reacts to an inflation forecast is not, in general, an optimal policy rule. Batini and Nelson (2000) show that, in the context of their model, the optimal policy rule depends on a whole host of variables. Hence, it is not particularly surprising that we are able to improve upon the inflation-forecast rule, as it is, in general, a sub-optimal rule.

However, if the exchange rate were to appreciate because of an increase in aggregate demand, it is then less obvious that interest rates should be used to offset the effects of the exchange rate appreciation that is associated with the demand shock. Table 2.4

Table 2.4: Performance of Alternative Monetary Policy Rules underAggregate Demand Shocks

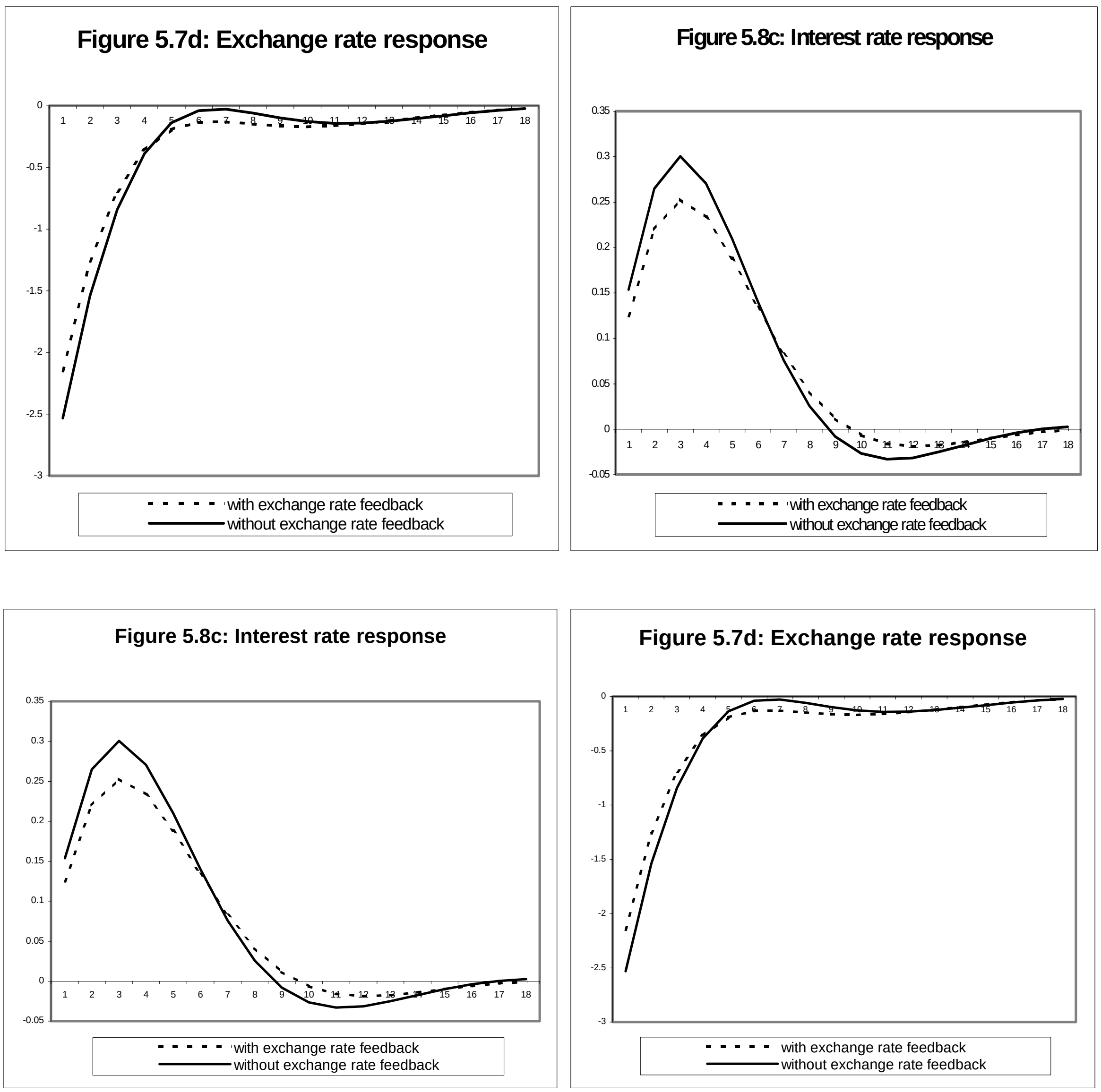
	Instability index	Variability of			
		Inflation	Output	Short-term nominal interest rate	Real exchange rate
Aggregate demand shocks only					
Taylor rule, no reaction to the exchange rate	3.761	0.381	1.196	0.602	1.069
Taylor rule, with reaction to the exchange rate	4.192	0.411	1.219	0.597	0.977
IFB rule, no reaction to the exchange rate	1.732	0.189	1.076	0.575	2.331
IFB rule, with reaction to the exchange rate	1.967	0.209	1.124	0.495	1.970

illustrates that, in that case, the ranking of the rules change significantly with the "leaning against the wind" strategies now under-performing relative to their respective counterparts.

Therefore, if the exchange rate were to appreciate/depreciate due to an increase (decrease) in aggregate demand, taking the exchange rate misalignment into account in addition to the inflation forecast would actually create greater inflation and output volatility (without helping vis-à-vis the exchange rate).

Figure 5.8 shows the responses of the model to an increase in aggregate demand when policymakers follow an interest rate policy based on the inflation forecast. Interest rates are initially held lower under the “leaning against the wind” strategy and this also reduces the degree of exchange rate appreciation. However, the degree of inflation volatility rises. Hence, it is clear that whether or not a central bank should respond to a shock depends importantly on the type of shock (i.e., in this case, aggregate demand or exchange rate). Similarly, how the authorities should react to a given exchange rate movement depends on what movement is due to.[16]

Figure 2.8: Aggregate demand shock -- Inflation-Forecast-Based interest rate rule.



[16] See, for example, Genberg (1989).

In this context it should be remembered that in reality a central bank can not directly observe the shocks that impinge on the economy. It must therefore attempt to infer from available data what is pushing the economy away from equilibrium. In this situation, how the simple rules we have considered in this and the previous section would perform, depends on how frequently the different shocks occur. Genberg and Kadareja (2000) use an estimated multi-country model to determine these frequencies, and use the results to investigate the stabilising properties of Taylor-type rules that exclude and include a reaction to exchange rate changes. They show that taking account of the exchange rate in setting interest rates would on average be stabilising in a world, which is characterized by the type of disturbances that typically occurred during the 1980s and 1990s.

2.3.2.4. Possible Extensions.

One extension to the model that we might investigate is to allow for a rational bubble process of the type used for the Bernanke-Gertler (1999) – style stock price simulations above. Intuitively one might expect that introducing some possible persistence in the exchange rate shock leads to much larger benefits being associated with an interest rate policy that attempts to offset the damage done by a volatile exchange rate.

Of course, if following Kent and Lowe (1997) in the stock price case, we also allowed the probability of a bubble starting up (or ending) to depend directly on monetary policy, it would only further enhance the potential attractiveness of a monetary policy rule that, in part, works to counteract exchange rate misalignments. To take a concrete example, suppose a bubble leads to an unwarranted appreciation of the exchange rate, but suppose the bubble can be affected by monetary policy. Then it might make sense to keep interest rates lower than otherwise today (thereby mitigating the deflationary impact of the bubble and reducing the deviation of inflation from the target today), with the added benefit of reducing the size of the 'shock' from the bubble while it lasts. Moreover, since the bubble is, on average, smaller under the proactive monetary policy, the destabilising effects of the bursting of the bubble are also smaller. Hence, in this case, a monetary policy that takes the exchange rate misalignment into account could, under certain circumstances, reduce the size of the deviation of inflation from the inflation target at all horizons.

The simulations above rely on the conventional assumption that exchange rates are well described by uncovered interest parity. However, as we will argue in Chapter 7, uncovered interest parity works very poorly empirically, and can actually be a rather misleading benchmark. In the simulations relating to the aggregate demand shock above, a policy of initially maintaining a lower interest rate on the rule that takes exchange rates into account does not translate into the benefit of a significantly smaller exchange rate appreciation, because the markets discount the higher expected path of future interest rates that would be needed as inflation is allowed to build up. However, given the empirical evidence that, on average, currencies that yield a higher interest rate differential (than normal) tend to outperform, it does seem, at least, possible that the rule that attempts to offset exchange rate strength would actually succeed in having a much larger impact if one used a more realistic model of exchange rate determination. We leave this as an issue for further investigation, but it is at least indicative of the possibility that a monetary policy rule that takes into account exchange rate misalignments might be welfare-improving even for a pure aggregate demand shock.

Our model might also underestimate the benefits of a monetary policy rule that allows for a direct impact of an exchange rate misalignment, because the framework does not capture costs of such misalignments associated with an effect on the level of potential output. Yet, to the extent that an overvalued exchange rate is associated with 'hysterisis' effects due to a withdrawal from overseas markets that is not restored by a mere reversal of the overvaluation, or to the creation of long-term unemployment, one might get adverse effects on the level of potential output, which would only strengthen the case for a policy rule that directly incorporates asset price misalignments.[17]

2.3.3. What about the UK's experience of the 1980s?

As discussed above, a commonly held view among economists in that looking at the exchange rate during the late 1980s was a mistake as it allowed inflationary imbalances to

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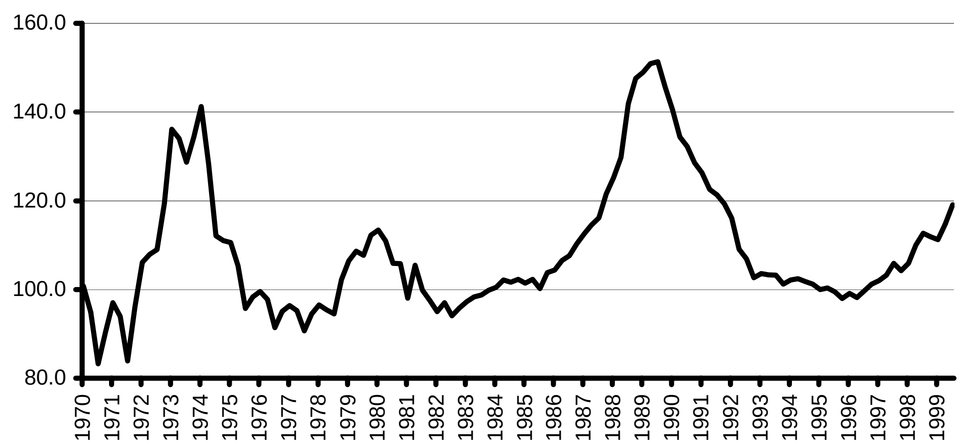
[17] In the context of a stock price bubble the hysterisis might involve too much physical investment in the affected sectors.

build up. How might one view that experience in the light of the theoretical simulations, discussed above?

First, at least a part of what happened then was a significant shock to aggregate demand associated with financial liberalisation. Hence, in that case, the experience might be said to have been consistent with the theoretical model, which suggests that one should only lean into portfolio shocks.

Second, we have only considered one asset price – the exchange rate, in the model above. Yet, as we saw earlier, there might be a case to include other asset prices (e.g. the stock price, the housing market) into one's reaction function as well. It is, perhaps, worth recalling that in the late 1980s, the housing market did appear overvalued, with the price-earnings ratio (Figure 2.9) being higher than at any other time during 1970-2000. A monetary policy rule that took all asset markets into account would surely have paid attention to the overheating housing market in the 1980s.

Figure 2.9: House P/E ratio



Appendix 2.1: Exploring the Bernanke-Gertler model - the details.

1. Bernanke and Gertler's simulations.

Bernanke and Gertler (B-G) use their model to compare the ability of different policy rules to stabilise output and inflation in the face of asset-market disturbances.[18] Specifically, they study the behaviour of the economy when the central bank follows a simple, forward-looking policy rule of the form

$$\text{(A2.1)} \quad r_t^n = \gamma_\Pi E_t \Pi_{t+1} + \gamma_s s_{t-1} \ ,$$

where r_t^n is the nominal interest rate, $E_t \Pi_{t+1}$ is the rate of inflation expected in the next model period and s_{t-1} represents stock prices. Results are reported for four policy rules that vary depending on the response to inflation and stock prices. The four combinations are: (1) accommodative with no response to stock prices (γ_π=1.01, γ_s=0), (2) aggressive with no response to stock prices (γ_π=2, γ_s=0), (3) accommodative *with a* response to stock prices (γ_π=1.01, γ_s=0.1), (4) aggressive *with a* response to stock prices (γ_π=2, γ_s=0.1).

To see the impact of a bubble, B-G subject their economy to a asset price bubble that begins as a one per cent exogenous increase in stock prices above fundamentals.[19] In the simulations, the bubble is "killed off" after five periods. It is assumed that agents in the model know the *ex ante* stochastic process for the bubble but not the time that it will burst.

Figure A2.1 is a reproduction of Bernanke and Gertler's Figure 2 and represents a comparison of policy rules (3) and (4) – those that include a response to the bubble.[20] The striking result is that the accommodative policy that reacts to stock prices, policy (3),

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[18] We are grateful to Ben Bernanke and Mark Gertler for generously providing us with their model. We thank Pau Rabanal for his patience in answering our questions about the simulations, and Roisin O'Sullivan, who actually did all of the work.
[19] Experiments show that the actual size of the bubble is irrelevant for the comparisons we report.
[20] We note that, while Bernanke and Gertler's figures are labeled "output gap," they in fact have plotted the response of output. We follow their lead, as it is our view that welfare comparisons in this model should be done by examining output fluctuations, rather than variation in the gap. The reason for this is that, in the presence of the bubble, the Bernanke-Gertler model implies that too much investment, and so potential

causes both output and inflation to fall precipitously; while policy (4) which reacts to stock prices as well but is much more aggressive in reacting to inflation,

Figure A2.1: Comparing Policies that React to Stock Prices.

Solid line - Aggressive reaction to inflation (($_{B}$ = 2, ($_{s}$ = 0.1)
Dashed line - Accommodative reaction to inflation (($_{B}$ = 1.01, ($_{s}$ = 0.1)

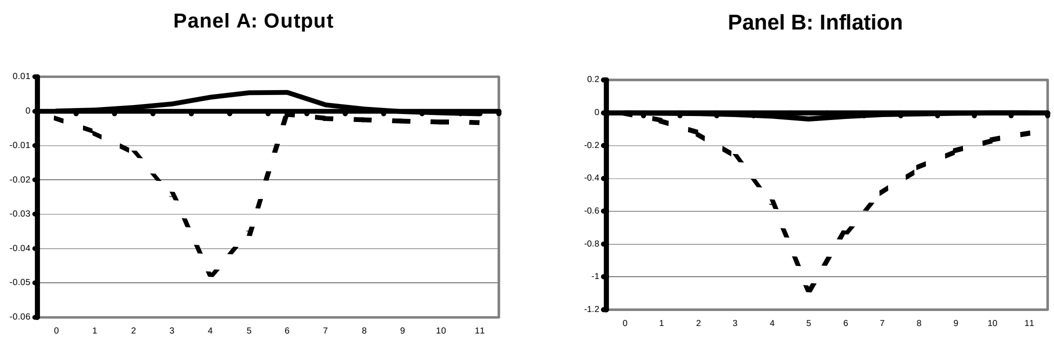
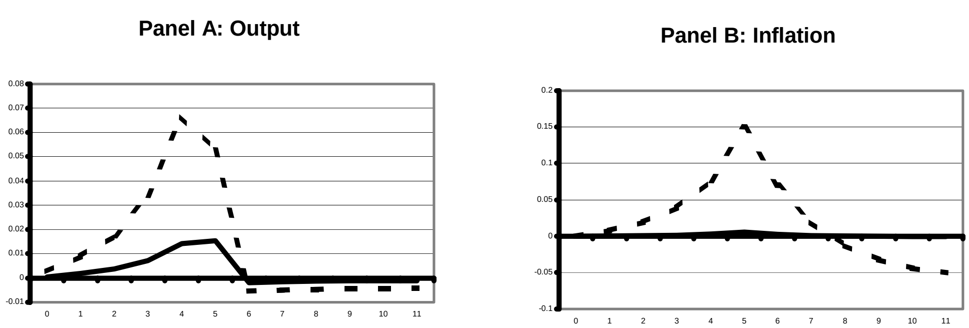


Figure A2.2: Comparing Policies that Do Not React to Stock Prices.

Solid line - Aggressive reaction to inflation (($_{B}$ = 2, ($_{s}$ = 0.1)
Dashed line - Accommodative reaction to inflation (($_{B}$ = 1.01, ($_{s}$ = 0.1)



output is distorted as well. The proper baseline, therefore, is not the absence of a gap, but the absence of any change in output at all.

leads to a modest increases in output and a very slight decrease in inflation. These patterns are very different from those of policies with no stock price reaction, policies (1) and (2). As shown Figure A2.2 (Bernanke and Gertler's Figure 1), in the absence of a reaction to stock prices, the aggressive policy stabilises both output and inflation.

A second way of comparing these policies is to look at the variance of output and inflation. Table A2.1 reports the results constructed directly from the Figures.21

Table A2.1: Variability of Output and Inflation under Different Policy Rules

	Bubble Shock	
Policy Rule	**Output**	**Inflation**
1: $r_t^n = 1.01 E_t \Pi_{t+1}$	6.2632	33.0870
2: $r_t^n = 2.0 E_t \Pi_{t+1}$	0.3809	0.0307
3: $r_t^n = 1.01 E_t \Pi_{t+1} + 0.1 s_{t-1}$	2.4085	995.6828
4: $r_t^n = 2.0 E_t \Pi_{t+1} + 0.1 s_{t-1}$	0.0481	1.4120

This is the corresponding table to Bernanke and Gertler's Table 1, where variances are calculated on a consistent basis with the graphs drawn (i.e. for one bubble lasting five periods).

The one thing that is clear from the table is that the accommodative policy is a disaster. The variation in both output and inflation is orders of magnitude higher than it is in the aggressive policy, regardless of whether one responds to asset prices. But whether or not it is advisable to respond to asset prices looks less clear-cut. That is, including asset prices raises inflation variability but lowers output variability, and so the choice depends on policymakers' preferences.

2. Robustness Experiments

2.1. Including the output gap in the policy rule

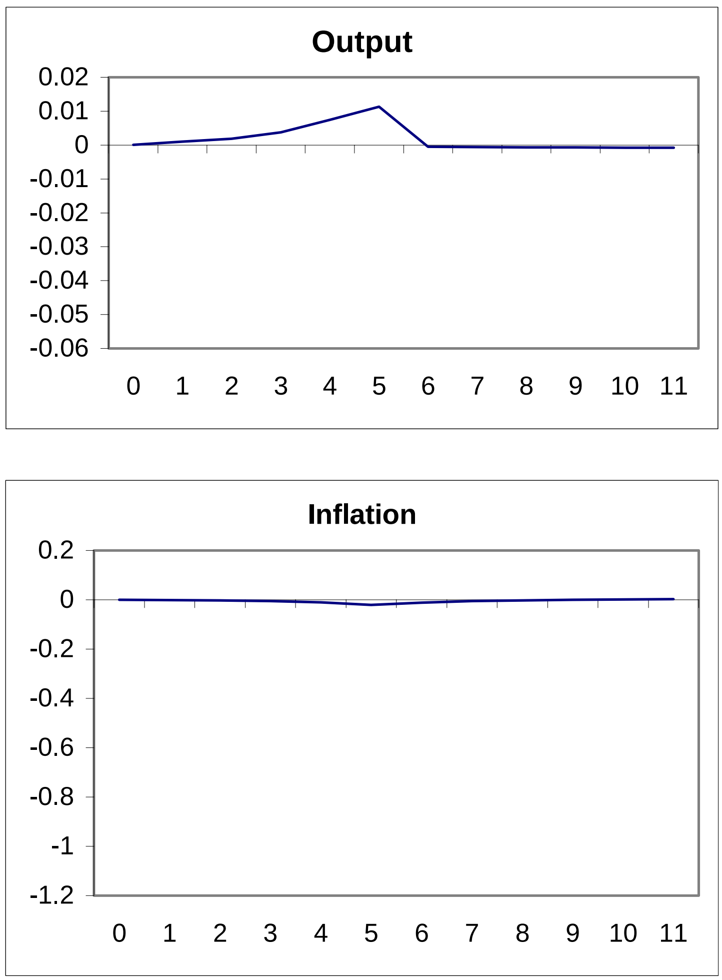
Our first adjustment to the policy rule is to add the output gap, thus making it look more like a Taylor (1993) rule. That is, we append a third term to equation (A2.1), giving us

[21] These numbers are intended to mirror the information in Bernanke and Gertler's Table 1. They differ in that we are using the information from the same simulations used to construct the graphs. That is, the bubble process we use is consistent between this table and the figures (and throughout our analysis). Bernanke and Gertler's table is based on substantially different bubble processes, and so gives different results.

(A2.2) $r_t^n = \gamma_\Pi E_t \Pi_{t+1} + \gamma_s s_{t-1} + \gamma_y (y_t - y_t^*)$.

We study the equivalent of rule Bernanke and Gertler's accommodative policy rule with a stock price reaction [their rule number (3) where γ_Π =1.01 and γ_s =0.1], but adding a response to the output gap by setting γ_y=1.0. Interestingly, this change completely eliminates the perverse impact of the bubble. Now, as we show in Figure A2.3, output rises modestly, and inflation falls only slightly.

Figure A2.3: Accommodative Policy, with Reaction to the Output Gap



Solid Line: Accommodative reaction to inflation (($_B$=1.01, ($_s$=0.1, ($_y$=1.0)

2.2. Introducing policymaker's objectives: optimal rules

To see what sort of policy rule is actually "best" in this model, we assume that policymakers seek to minimise a weighted average of output and inflation variability as in (A2.3),

(A2.3) $L = \alpha\,\text{var}(\Pi) + (1-\alpha)\,\text{var}(y)$,

where α is the weight on inflation variability in the loss, and is less than or equal to one. Cecchetti and Ehrmann (1999) refer to α as the policy maker's "inflation variability aversion."

The results in Table A2.2 are quite interesting. What stands out is that, regardless of the extent to which the loss penalizes inflation or output variability, the loss-minimizing rule entails a reaction to stock prices. That is the value of γ_S is always greater than zero. Furthermore, depending on the objective function, reaction to inflation is often very aggressive, and reacting to the output gap is generally desirable.

Table A2.2: Optimal Rules with Different Loss Functions

Inflation Variability Aversion	Parameters of Policy Rule			Loss	Comparison with Bernanke-Gertler Rules Ratio to Minimum Loss			
A	γ_π	γ_s	γ_y	**L**	**(1)**	**(2)**	**(3)**	**(4)**
0.00	1.01	0.5	3.0	**0.0023**	2723.13	165.61	1047	20.91
0.25	3.00	0.05	0.0	**0.1516**	85.55	1.94	1654	2.57
0.50	1.25	0.25	3.0	**0.1172**	167.88	1.76	4258	6.22
0.75	3.00	0.05	0.5	**0.0687**	384.00	1.72	10879	15.59
1.00	3.00	0.01	0.0	**0.0003**	110290.	102.33	3318942	4707

Note: The table reports the policy rules that achieve the minimum loss, under the base model configuration. We use a simple grid search, examining the following possible values: γ_π={1.01,1.1,1.25,1.5,1.75,2,2.5,3}, γ_s={0,.01,.05,.1,.25,.5} and γ_y={0,0.1,0.5,1,2,3}. The comparison with the Bernanke-Gertler rules is the ratio of the loss computed under their parameter configuration divided by the minimum loss.

Comparison with the Bernanke-Gertler rules shows that in every instance they are outperformed, and usually by substantial amounts. Their rule (2), the aggressive policy with no stock market reaction, is the best among the set they study. Even in this case, however, when α=0.75 the loss of the Bernanke-Gertler aggressive rule is still 72% above that of the optimal rule.

Finally, note that these results are qualitatively unchanged if the rule includes a reaction to the stock market bubble, rather than the stock price itself. That is, if the policymaker can disentangle the fundamental from the speculative component of asset prices, the new information does allow policymakers to reduce the loss, but only very slightly.[22]

3. Interest-rate smoothing

We introduce interest-rate smoothing in two ways. The first is to append the lagged interest rate to the policy as in (A2.4).

$$\text{(A2.4)}\quad r_t^n = \gamma_\Pi E_t \Pi_{t+1} + \gamma_s s_{t-1} + \gamma_y (y_t - y_t^*) + \gamma_i i_{t-1}\ ,$$

where the parameter γ_i is a measure of the degree of smoothing.

Table A2.3 reports the results of this exercise. There are several observations. First, the interest-rate smoothing is clearly optimal, but the gain is very small unless α=1. For example, when α=0.75, the gain is less than 1%. Interestingly, though, the value of the coefficient γ_i we find is 0.15, very near the estimates other researchers obtain from the data.[23]

Second, and more importantly, allowing for interest-rate smoothing does not change the fact that the optimal rule responds to asset prices. That is, allowing for a response to

Table A2.3: Optimal Rules with Different Loss Functions

Inflation Variability Aversion	Parameters of Policy Rule				Loss	Loss Relative Minimum Loss in Table 2
A	γ_π	γ_s	γ_y	γ_i	L	
0.00	1.01	0.50	3.00	0.00	**0.0023**	1.00
0.25	3.00	0.05	0.00	0.00	**0.1516**	1.00
0.50	1.01	0.25	3.00	0.25	**0.1160**	0.99
0.75	3.00	0.05	0.50	0.15	**0.0686**	0.99
1.00	3.00	1.01	0.00	0.15	**0.0010**	0.33

Note: The table reports the policy rules that achieve the minimum loss, under the base model configuration. We use a simple grid search, examining the following possible values: γ_π={1.01,1.1,1.25,1.5,1.75,2,2.5,3}, γ_s={0,.01,.05,.1,.25,.5}, γ_y={0,0.1,0.5,1,2,3}, γ_i={0,0.15,025,0.50,0.75,0.95}. The comparison with Table 2 is to the parameter policy rule that achieves the minimum loss for each value of α.

[22] We emphasise that none of these rules is actually optimal, in the sense that there will surely be an interest rate path that is more complex and dominates the ones that arise from these restrictive rules.
[23] See, for example, Rudebusch (1999).

lagged interest rates does little to the qualitative conclusions that we should react.

Another way in which to study interest rate smoothing is to put it directly into the objective function. Such a loss function could be written as

(A2.5) $L^{*} = \alpha\,\mathrm{var}(\Pi) + (1-\alpha)\,\mathrm{var}(y) + \rho\,\mathrm{var}(\Delta i)$,

where the last term is the variance of the change in the interest rate. We have run a full set of simulations with this loss function, and find that the optimal coefficient on stock prices is broadly unchanged. That is to say, regardless of the size of ρ, we find that the loss-minimizing rule continues to include positive values of γ_s.[24]

4. Changing the degree to which the private sector is backward looking.

Our third set of experiments, we examine the implication of making people more or less backward looking in their wage setting. To help understand this, we reproduce the inflation expectations equation from Bernanke and Gertler (their appendix equation A.12):

(A2.6) $E_{t-1}\Pi_t = \kappa mc_t + \theta_f E_t \Pi_{t+1} + \theta_b \Pi_{t-1}$,

where *mc* is marginal cost, κ is a parameter (set to about 0.02 in the simulations), and θ_b and θ_f are the degree to which individuals look backward and forward in forming their price expectations. The expression is a portion of the aggregate supply apparatus in their model, and determines elasticity of output and inflation with respect to an aggregate demand shock over time. We think of this as a parameter associated with the structure of the economy.

In the baseline simulations, θ_b is set equal to 0.40, and so θ_f equals 0.60. We examine cases in which θ_b equals 0, 0.5 and 1.0. The results are reported in Table A2.4. For the

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[24] Interestingly, for even most levels of ρ, the optimal rule implies incredibly smooth interest rates, with γ_i near one. When $\rho \geq 0.75$,, in most cases the optimal γ_i exceeds one. It is possible for γ_i to exceed one and models to remain well behaved. See, for example, Taylor (1999).

purposes of these simulations we set α=0.75, our preferred value.[25] Again, in all cases, some reaction to asset prices is called for in the optimal rule. Furthermore, the Bernanke-Gertler rules now perform very poorly under some specifications. For example, when the economy is either purely forward looking (θ_b=0) or purely backward looking (θ_b=1), their best of the rules has a loss that is more than 20 times that of the optimal rule.

Table A2.4: Optimal Rules with Different Degrees of Wage Stickiness.

Degree Agents are Backward Looking	Parameters of Policy Rule			Loss	Comparison with Bernanke-Gertler Rules Ratio to Minimum Loss			
Θ_b	γ_π	γ_s	γ_y	L	(1)	(2)	(3)	(4)
0.00	2.50	0.25	3.0	**0.0494**	**	123.23	42533	61.23
0.40	3.00	0.05	0.50	**0.0687**	384.0	1.72	10878	15.58
0.50	3.00	0.10	1.00	**0.0660**	96.04	1.78	4205	9.89
1.00	3.00	0.10	0.50	**0.0218**	21.59	7.23	159.35	16.36

Note: The table reports the policy rules that achieve the minimum loss for different degrees of backward-lookingness. We use a simple grid search, examining the following possible values: γ_π={1.01,1.1,1.25,1.5,1.75,2,2.5,3}, γ_s={0,.01,.05,.1,.25,.5} and γ_y={0,0.1,0.5,1,2,3}. The comparison with the Bernanke-Gertler rules is the ratio of the loss computed under their parameter configuration divided by the minimum loss. For the entry with "**" the model would not converge.

[25] Cecchetti and Ehrmann (1999) suggest that U.S. policy has operated in the neighborhood of α=075 over the past few decades or so.

Appendix 2.2. The Batini-Nelson model.

The structural equations of the Batini-Nelson (2000) model, when all variables are expressed in terms of deviations from equilibrium, are:

(A2.7) $y_t = E_t y_{t+1} - \sigma(R_t - E_t \pi_{t+1}) + \delta \tilde{q}_{t-1} + e_{yt}$

(A2.8) $\pi_t = \alpha\pi_{t-1} + (1 - \alpha)E_t\pi_{t+1} + \phi_y y_{t-1} + \phi_q \Delta \tilde{q}_{t-1} + e_{\pi t}$

(A2.9) $E_t q_{t+1} = q_t + R_t - E_t\pi_{t+1} + \kappa_t$,

where y_t denotes (log) output, R_t is the nominal rate of interest (measured as a quarterly fraction), π_t is quarterly inflation, q_t is the log real exchange rate (where by construction a rise is a depreciation), and $\tilde{q}_t = ¼ \Sigma_{j=0}^{3} q_{t-j}$ is a four-quarter moving average of q_t. Finally, e_{yt}, $e_{\pi t}$, and κ_t are exogenous IS, Phillips curve, and uncovered interest parity (UIP) shocks, respectively.

The model's IS equation is represented by equation. (A2.7). This states that output, y_t, depends on a lead of itself, on the real rate of interest, and on lags of the real exchange rate. Equation. (A2.8) is an open-economy Phillips curve. Batini and Nelson set $\alpha = 0.8$, $\phi_y = 0.1$, $\phi_q = 0.025$; and assume $e_{\pi t}$ is white noise with standard deviation 1%.

In equation (A2.9), κ_t is a disturbance term that causes deviations from strict UIP. This is assumed to be AR(1) with coefficient 0.753 and innovation standard deviation 0.92%, in line with their estimates of this process using quarterly UK data. The shocks in (A2.7)-(A2.9) are assumed to be mutually uncorrelated.

One set of monetary policy rules that we considered can be described by:

(A2.10) $R_t = P_0 R_{t-1} - + P_1(E_t\pi_{t+2} - \pi_t^{TARG}) + P_2(q_t - qbar_t)$

where $P_0 = 0.98$ and $P_1 = 1.24$ in line with Batini and Nelson (op. cit.). As they show, these values of the parameters minimise the policymakers' loss function defined as an equally weighted sum of output gap variance and quarterly inflation variance.[26] If $P_2 = 0$,

[26] Note that the horizon in the rule is also optimal in this sense.

we simply have an inflation forecast-targeting rule, with interest rates being set in the light of inflation deviations from the target 2 periods out.

Alternatively, instead of a pure inflation forecast-targeting regime, the central bank might, in addition to focusing on the inflation forecast, also take into account the deviation of the exchange rate from its long-run equilibrium. Therefore, if, say, the exchange rate were overvalued (equivalent to q_t being low relative to $qbar_t$), then, other things being equal (for $P_2 > 0$), the central bank would hold interest rates lower than they would be if one were only looking at the deviation of the inflation forecast from the target. (We initially set $P_2 = 0.05$). This is sometimes described as a "leaning against the wind" strategy. Hence, we consider a hybrid regime, where the central bank takes, both, the inflation forecast and the exchange rate into account when setting interest rates, rather than the commonly observed corner solutions of either pure inflation-forecast targeting or pure exchange-rate targeting.

In addition, we also consider a variant of the commonly used Taylor rule, whereby

(A2.11) $R_t = E_t\pi_{t+1} + \omega_1 B_t + \omega_2\, y_t + \omega_3\, (q_t - qbar_t)$

where, following Taylor, we set $\omega_1 = 0.5$, $\omega_2 = 0.5/4$, and the modification to the standard Taylor rule that we consider here is to assume a non-zero value for ω_3 (initially 0.05).

In order to compare the efficiency of the alternative monetary policy rules considered in equations (5.10) and (5.11) above, we assume a loss function:

(A2.12) $$L_t = E_t \sum_{j=0}^{\infty} \beta^j \left[\lambda_\pi (4^*\pi_{t+j} - 4^*\pi_{t+j}{}^T)^2 + \lambda_y (y_{t+j} - y_{t+j}{}^T)^2\right]$$

where, initially, $\lambda_\pi = \lambda_y = 0.5$, i.e., we assume that the authorities attempt to minimise the weighted sum of inflation and output volatility, and β is a discount rate (initially set equal to 0.99).

3. Identifying Misalignments and Bubbles.

3.1. Some Commonly Held Views.

Many central bankers and academics are hostile to the notion of taking direct action to deal with misalignments because, in part, of the difficulties associated with detecting bubbles or misalignments. For example, in a recent symposium on asset prices and monetary policy, representative examples of what was said includes:

(i) An academic:-

"…. it is not clear why central bankers should have more information about asset fundamentals than private market participants. Perhaps there has been a rise in trend productivity growth that can support a higher rate of dividend growth than in the past …. In short, while we cannot rule out that the sharp stock price increase does reflect a bubble, we cannot rule out that it does not." (Gertler, in CEPR, 1998, p. 8)

or

(ii) a US central banker:-

"…. central bankers have no particular expertise in valuing future corporate earnings, that is, in pricing equities, which is a full-time job carried on by armies of stock analysts and investors. On this basis central bankers should feel no obligation to make public their personal views on equity prices." (Goodfriend, in CEPR, 1998, p. 18)

or, indeed,

(iii) a European central banker:-

"…. how can monetary policy detect periods of fundamental misalignment of asset prices …. The problem of diagnosis cannot easily be solved, because over or undershooting of asset prices has to be defined in relation to their 'true' value – as defined by the expected movements in their underlying determinants. Expectations are not directly observable,

> however, and although survey data could provide some orientation, they are probably biased and hardly available for long-term horizons. …. (As for) econometric models …. it is difficult to model expectations adequately and to identify structural breaks in time …. (therefore) monetary policy operates in a state of uncertainty. (Issing, in CEPR, 1998 – pp. 20-21).

3.2. An Example Of Trying To Detect A Misalignment.

To illustrate the difficulties associated with detecting a misalignment, we shall consider the current topical example of whether US equities are overvalued. A more detailed discussion of this issue may be found in Wadhwani (1999).

For simplicity, we begin with a steady-state version of the dividend discount model (DDM), i.e. Gordon's (1962) growth model. We use this model as it is a commonly used workhorse in the financial community, and is a convenient vehicle to illustrate some of the relevant arguments.

The model asserts that:

$DY + g = r + rp$

where

DY = Dividend yield

g = Expected long-term, real growth rate of dividend

r = Real interest rate

rp = Equity Risk Premium

In practice, the variables in equation (1) are difficult to measure. We may initially proxy the variables as follows:

(i) Real interest rates, r:

We use the yield on US Treasury Inflation-Protected Securities (TIPS, hereafter), which is currently[27] about 4.1 per cent.

(ii) Real growth rate of dividends, g:

One possible assumption is the actual, long-term growth rate of real dividends, which, over the 1926-97 period, is only about 1.9 per cent p.a. This is a little less than the historical growth rate of GDP, because of variations over time in share issuance, the payout ratio and the share of profits in GDP.

(iii) The expected dividend yield:

If we make a consensus-like assumption that the dividend to be paid for the year ahead will be 5 per cent higher than the one paid for the last year, then the dividend yield is about 1.20 per cent.

(iv) The Equity Risk Premium:

This is a controversial area, both theoretically and empirically. The textbook answer to this question is to use the actual, ex post returns on shares versus. bonds (or cash) to estimate its value. Over the 1926-97 period, US equities outperformed US bonds by around 7 per cent p.a. Some authors (e.g. Blanchard, 1993, Wadhwani and Shah, 1993, or Siegel, 1998) feel that such an ex post historical average is misleading, and we shall examine such arguments in greater detail below. If equities are correctly valued today (at S&P500 = 1466), assumptions (i) – (iii) above in the formula in (1) imply that the risk premium, rp is –1.0 per cent (i.e. actually negative). This is, of course, extraordinarily low by historical standards.

Table 3.1 illustrates the hypothetical case where the current ERP rises to levels comparable with the 1926-97 historical average. If, indeed, it were to rise to its ex post average value over 1926-97, the 'fair value' for the S&P would only be 191, versus the current level of 1466, before allowing for any second round effects on output, profits etc.

[27] All market prices are as of March 20, 2000.

Of course, our result is entirely driven by our assumptions, which we need to discuss more carefully.

For example, there might be issues relating to measurement error in the case of the ERP. Over some of the 1926-97 period, ex post real interest rates have been negative; some think that it is difficult to believe that ex ante real interest rates could have been negative. Undoubtedly, the inflation of the 1970s was, in part, unanticipated and it is, therefore, plausible that ex post real, long-term interest rates did underestimate their ex ante counterpart.

We have attempted to deal with this issue by trying to estimate the ex ante ERP. Our method involves making the assumption that investors base their estimates of the real growth of dividends and the longer-term inflation rate on a trailing ten-year moving average of these variables. Using this method, the 1926-97 historical average of the ERP falls to 4.3 per cent. Note that our estimate is fairly similar to that of Blanchard (1993), who uses a more sophisticated approach (regressions rather than moving averages) to forecast real dividend growth and inflation. If we do use this alternative estimate of the 'warranted' ERP in Table 3.1, the warranted fair value of the S&P500 rises to 270.6 but is still pretty low compared to the current value (1466). We shall now relax some of the simplifying assumptions in the above model and see how much the conclusions change.

Many argue that one should not use the dividend yield as a valuation indicator, because the increase in share repurchase activity has artificially depressed the measured dividend yield. (Examples of academics who have advocated this line include Cole et al., 1996, and Malkiel, 1998). Therefore, one might adjust the measured dividend yield to incorporate the effect of <u>net</u> share repurchases, and the effects of merger/acquisition/LBO activity. On doing so, the implied fair value rises to around 474.

Of course, it is plausible that in the light of much recent discussion about the 'new economy', it might well be appropriate to raise up one's estimate of the underlying productivity growth of the US economy (see, e.g. Oliner and Sichel (2000)). Indeed,

Table 3.1: Alternative implied fair values for the S&P500.

Alternative scenario	Current risk premium (1)	'Warranted' risk premium yield (2)	Current expected div. yield (3)	'Warranted' div. Yield (4)	Current price (5)	'Warranted' price (6)
I Risk premium reverts to historical, ex post average for 1926-97	-1.0%	7%	1.20%	9.2%	1466	191.2
II Same as I, but assume reversion to the estimated, ex ante average risk premium for 1926-97	-1.0%	4.3%	1.20%	6.5%	1466	270.6
III Same as II, but adjustment for share buybacks	-1.0%	4.3%	2.1%	6.5%	1466	473.6
IV Same as III, but assume long-term real dividend growth rate of 3.8% p.a.	0.9%	4.3%	2.1%	5.6%	1466	559.7
V Same as IV, but zero warranted risk premium	0.9%	0%	2.1%	1.2%	1466	2566

Notes: Col (1); Obtained by feeding in assumed inputs into equation (1). Col. (2): The level of the risk premium if it were equal to its 1926-97 average. Col. (4): The level of the dividend yield that would be approximately required to lead the current risk premium to equal the 'warranted' risk premium. Therefore, Col. (4) – Col. (3) = Col. (2) – Col. (1). Col. (6): The Change in price that would be required to lead to the current dividend yield to equal the warranted dividend yield. Hence, Col (6)/Col. (5) = Col. (3)/Col. (4).

estimates of the potential growth rate of the US economy have risen from around 2 ½% to around 3 ½% - 4% p.a. over the last 2 years or so. We might, therefore, somewhat generously raise up our estimate of long-term real dividend growth to, say 3.75% p.a. (which would be twice the long-term historical growth rate). On doing so, the measured ex ante risk premium would rise from –1% to around 0.9%. This would lead to a higher implied fair value of around 550.

Of course, an important problem with the analysis so far is that many would question the assumption of estimating the ERP on the basis of historical data, for example, Siegel (1998) asserts that

> "…… stocks have been chronically undervalued throughout history. This has occurred because most investors have been deterred by the high short-term risk in the stock market and have ignored their long-term record of steady gains …. One interpretation of the current bull market indicates that investors are finally bidding equities up to the level that they should be on the basis of their historical risks and returns."

Siegel's key argument about the relative riskiness of shares and bonds over different time horizons is summarised in Table 3.2. Although, over a one year horizon, equity returns are about three times as volatile than bond returns, over a 20-year time horizon, shares are actually less volatile than bonds. This is because, while long-term equity returns display mean reversion (i.e. several bad years are more likely to be followed by good ones), and therefore the standard deviation of n-year returns decreases faster than the square root of n, long-term bond returns display the opposite tendency, and therefore the standard deviation of n-year returns decreases more slowly than the square root of n. Hence, for n high enough (in this case n = 20 is sufficient), we would expect equity returns to become less volatile than bond returns.

Relatedly, Table 3.3 shows the percentage of times that equity returns outperform bond returns over various (overlapping) holding periods. Note that, as the horizon extends, the probability that equities will outperform bonds rises from a lowish 60 per cent on a one-year horizon to almost 100 per cent for a 30-year horizon (i.e. the last 30-year period in which bonds beat equities is that ending in 1861, at the onset of the US Civil War). Hence, for long-term investors, fixed income securities have almost always underperformed, with no 20-year period in US history (since 1802) when the average annual return on shares has been negative, although this is not true of bonds.

Glassman and Hassett (1998), writing in March 1998, argued that Siegel's findings suggested that "…. there should be no need for an ERP at all", and that, therefore, the market could justifiably rise at least another 100 per cent (the S&P500 = 1094 on that day), and have since argued that the Dow should reach 36,000 by 2004.

Table 3.2: Volatility of US returns over different time horizons, 1802-1995

	Equities	%	Bonds
1 year	18.15		6.14
20 years	2.76		2.86

Source: Siegel and Thaler (1997)

Notes: Standard deviation of (overlapping) n-year returns.

Table 3.3: Holding period comparisons: percentage of periods when US equities outperform US bonds, 1802-1996

Holding period	% of periods equities outperform bonds
1 year	60.5
5 years	70.2
10 years	79.6
20 years	91.5
30 years	99.4

Source: Siegel (1998)

Clearly, if one believed that the warranted risk premium was zero, then, on our numbers, the warranted level of the S&P500 would be around 2560, about 75% above current levels! However, the notion that the ERP should be zero is problematic.

First, to the extent that Siegel's argument is predicated on long-horizon returns, note that there are good reasons for why risk over the short horizon is relevant. For example, some individuals may be close to retirement, and borrowing constraints may preclude the young from driving the price of equities up to yield a zero risk premium. Second, with a probabilistic length of life, not even the young would accept a zero risk premium. Third, once investment decisions are delegated to a fund management company, asymmetric information and moral hazard considerations give rise to standard agency problems. Pension fund managers are reviewed regularly. It would be extremely rare just to leave one's money with the same manger for twenty years without regular, interim performance reviews.

Furthermore, one is uncomfortable about relying on a hypothesis that investors have suddenly discovered that equities are not particularly risky and that, therefore, the ERP should be lower. Recall that this argument has been used to justify previous re-ratings of equities vis-à-vis bonds. For example, Burck (1950) appealed to the historical superiority of equities versus bonds in arguing that equities should yield less than bonds. In the 1920s, Smith (1924) made a similar argument, and Fisher (1929), in referring to this work argued

> "These writings threw a bombshell into the investing worlds… It was only as the public came to realise, largely through the writings of Edgar Lawrence Smith, that stocks were to be preferred to bonds …. that the bull market began in good earnest to cause a proper evaluation of common shares.[28]"

Further, and perhaps most fundamentally, given that shares are a residual claim on a corporation after all other creditors have been paid, it is implausible that there should be a zero risk premium on stocks versus bonds. Specifically, few would assert that corporate bonds should yield the same return as safer, government bonds, so there is something odd about requiring a lower total return on shares versus bonds issued by the same company, which appears to be the implication of what Glassman-Hassett and others assert.

Even if one accepts the above arguments for why it would be implausible for the risk premium to be equal to zero, one is still left with the difficult task of deciding as to what the appropriate level is. However, historical evidence over the last two centuries for the US and the UK suggests that the risk premium varies significantly between different decades (see Table 3.4). Note that, for the sub-periods leading up to 1926, using arithmetic returns, the US risk premium varied between 3-4 per cent, before rising to the historically anomalous 7 per cent in the 1926-97 period. The story for the UK is similar – a risk premium in the 2 ½-3 per cent range up to 1938, but much higher after WWII.

It might be tempting to look at the rather lower risk premium in the 1982-97 period (3.3 per cent) and argue that this is the new equilibrium level, but it is important to be careful about drawing that conclusion from such a short sample period. For example, would it have been appropriate to assume that the correct risk premium was –0.1 per cent after the 1966-81 experience?

In the light of our discussion above of the difficulties associated with valuing the US market, it is probably easy to adopt a nihilistic attitude and move on to other issues. However, notwithstanding the genuine uncertainties, there are useful (to a policymaker) things that can be said about the current valuation of the US stock market.

First, we noted above that even if one makes the rather brave assumption that the 'New Economy' has approximately doubled the long-term growth rate of dividends (in inflation –adjusted terms) to 3.75% p.a. (versus the long-term historical average of 1.9% p.a.), one is still left with an implied ERP of only 0.9%, which is well below its average value for any sizeable sub-period since 1800.

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[28] Cited in Shiller (2000)

Table 3.4: Equity risk premia in a historical context

Sample period		Equity return		Bond return		Risk premium	
		Arithmetic	Comp.	Arithmetic	Comp.	Arithmetic	Comp.
US	1802-70	8.1	7.1	4.9	4.9	3.2	2.2
	1871-1925	8.4	7.2	4.4	4.3	4.0	2.9
	1926-97	12.6	10.6	5.6	5.2	7.0	5.4
	1946-97	13.4	12.2	5.9	5.4	7.5	6.8
	1966-81	8.3	6.6	8.4	7.8	-0.1	-0.8
	1982-97	17.4	16.7	14.1	13.4	3.3	3.3
UK	1870-1913	6.4		3.3		3.1	
	1919-38	8.3		5.8		2.5	
	1946-91	12.9		5.5		7.4	

Source: US: Siegel (1998); UK: Wadhwani and Shah (1993)

Now, the latter matters because historically, when the current ERP has been below (above) average, that presages equity returns that are also below (above) average. Table 3.5 documents the evidence in favour of this proposition. It shows that the strength of this statistical association rises over time, with the R^2 rising from only 0.055 on a 2 year horizon, to a rather more respectable 0.35 on a 5 year horizon. (We are grateful to Joanne Cutler of the Bank of England for estimating these regressions for us). While not wishing to over-estimate the 'edge' that using the ERP as a predictive tool (one can be 'wrong' for long periods of time), it does seem inappropriate to ignore it altogether.

Second, and perhaps more importantly, is that although today's ex ante ERP is low, there is no sign that investors are actually reconciled to low returns. Surveys of individual investors in the US regularly suggest that they expect returns above 10 per cent, which is obviously unsustainable. For example, in a Business Week/Harris Poll carried out in December 1999, the median, long-run return expectation was 10%-12% for years (see

Table 3.5: The effect of the ERP on subsequent equity returns

Time horizon	Coefficient	t – statistic	R^2
2 years	1.14	2.71	0.055
5 years	8.57	4.30	0.35

Notes:- Based on US data, 1930-99. Regression of the form (Equity returns over period t to the t+m) = constant term + coefficient + (ERP at time t).
t-statistic based on Newey–West adjusted standard errors.

Business Week, December 27, 1999). Most US pension funds operate under actuarial assumption of equity returns in the 8-10 per cent area which, with a dividend yield under2 per cent, is, again, unsustainably high. A recent survey of financial economists indicated an average estimate of the ERP of 6 per cent, with most suggesting a figure between 4 and 8 per cent (see Welch, 1998).

Although the measured ERP seems low and has, in part, for good reason, been declining in the post-WWII period, its current level does not appear to be a sustainable equilibrium.

Ultimately, we have to accept the fact that notwithstanding a variety of intriguing papers on the subject, our theory of the equity risk premium is seriously incomplete. Moreover, in practice the ERP appears to display an ability to move pretty substantially, and we, as economists, have not always been able to explain it fully. Hence, it would be dishonest to pretend that one can assert confidently that the S&P500 is x per cent overvalued. In a memorable phrase, Malkiel (1998) argues that "I don't think it's possible for even the Almighty to know whether a market is 'over' or 'under' valued".

While we would not pretend to know the precise level of over/under-valuation of the US equity market, we know that:

(i) The ERP has fallen, and is currently towards the lower end of its historical range. (Our best guess estimate is that it is, currently, less than 1 per cent). It is, therefore unlikely to fall much further over the medium-term. There is econometric evidence suggesting that it is mean-reverting.

(ii) Investors do not appear to be prepared for the lower returns implied by (i).

(iii) The ERP can change quite rapidly.

The combination of (i)-(iii) tells us that there is above-average risk associated with owning US equities now, although none of this precludes the market going higher in the near term.

However, we believe that a nihilistic attitude to asset prices is inappropriate – one can usefully attempt to predict the longer-term evolution of the asset prices for policy purposes. It is useful to remind ourselves that the Japanese stock price bubble of the late 1980s was something that was noticed at the time (i.e. before it burst) by several people – e.g. see Ueda (1990) [His paper was submitted to the journal on December 20, 1989 – just before the peak in the Nikkei index].

3.3. Is Estimating the 'Fair Value' of Asset Prices Intrinsically More Difficult Than Preparing an Inflation Forecast?

It is often asserted that central bankers should not try to estimate the degree of asset price misalignments, but stick to setting policy in the light of their inflation forecast <u>instead</u>.

However, estimating asset price misalignments in any case, is likely to improve one's inflation forecast – we noted above that, e.g. the ERP has some predictive content for future stock price changes, and we also discussed (in section 3) that asset prices have an important effect on the inflation forecast.

More importantly, is it really true that estimating the degree to which an asset price is misaligned is any more difficult than estimating an output gap (or the NAIRU), concepts which are commonly used in helping frame monetary policy? Indeed, one could argue that one needs to use the same inputs to estimate the prospective output gap as one needs to accurately estimate a stock price misalignment. Specifically, the output gap estimate depends importantly on underlying productivity growth (which affects prospective potential output) and the equilibrium ERP (which affects corporate investment, which in turn, affects trend growth) – the same uncertain inputs that were seen to be necessary to estimate the degree of stock price misalignment. Moreover, one's estimate of the prospective output gap also depends on what is likely to happen to the actual level of output, which, through the standard wealth effect channel, depends directly on the degree to which asset prices are misaligned.

Hence, the correct notion that it is difficult to estimate the degree of asset price misalignment makes inflation forecasting just as difficult as it would make targeting asset prices directly.

Lest anyone think that it is easy to estimate the NAIRU, Table 3.6 shows how the consensus forecasts in the UK have been consistently too gloomy about the inflation–unemployment trade-off in the UK since 1992! (For further discussion of his phenomenon, see Wadhwani (2000)).

The table displays the forecast errors that were made vis-à-vis unemployment and average earnings growth together to illustrate the improvement in the inflation-unemployment trade off. Although unemployment was lower than expected in every year between 1993

Table 3.6: Unemployment and average earnings forecast errors.

Year	Unemployment forecast error (Q4, millions)	Average earnings forecast error (percentage change on year earlier)
1993	-0.36	-1.9
1994	-0.27	-0.3
1995	-0.03	-1.3
1996	-0.18	-0.6
1997	-0.38	-0.4
1998	-0.01	0.3
1999	-0.31	0.3
Average forecast error	-0.22	-0.5

and 1997, earnings growth was also lower than expected, a clear case of an improvement in the trade-off. It is only in 1998 and 1999 that earnings growth has been (modestly) higher than expected, though in 1999 that is probably attributable to the level of unemployment being 310.000 lower than had been expected.

As both inflation and unemployment have turned out better than expected, there would appear to be prima facie evidence of the Panel having systematically overestimated the NAIRU and/or some change in the historical relationships that these economists were (implicitly or otherwise) relying on.

For another example of the difficulties associated with conventional inflation forecasts, consider the uncertainties attached to estimates of the output gap in the United States. Orphanides (1998) contains a comparison of real time estimates (i.e. those used by a putative inflation forecaster) of the output gap in the United States with subsequent revisions, and arrive at astonishing conclusions. During the period 1980 H1 to 1992H2 the real time estimates of the gap (measured as output minus potential output divided by potential) averaged -3.99 percent with a standard deviation of 3.46. Subsequent revisions in measures of both actual and potential output led to changes in the estimated gap such that by 1994 the revised figures for the 1980-'92 period implied a gap or only -1.64 percent with a standard deviation of 2.44! In other words the revised gap was on average 2.35 percentage points lower than the real time estimates, which presumably were used in the preparation of inflation forecasts and as inputs into the formulation of monetary policy at the time. If interest rates in the United States during this period had been set mechanically by a Taylor-type rule with a weight on the output gap of one half, the above revisions in the estimates of the gap implies that the interest rate was on average over 100 basis points lower than what it would have been using the revised data.[29] With the much smaller reactions to asset price misalignments that we found to be optimal in the simulations of the Bernanke-Gertler model, errors in estimates of these misalignments

[29] Of course, interest rates were not set in this mechanical fashion, but the fact remains that the large size of the revisions of the output gap imply considerable uncertainty with respect to monetary policy decisions that use this gap as one of the important inputs.

would have to be very large indeed in order to arrive at similar implications for interest rates.

3.4. Summary and Conclusions.

In this chapter we have argued that commonly accepted valuation formulas of common stocks, together with consensus estimate of the ingredients of that formula, lead to the conclusion that stocks are currently overvalued in the United States. More generally we have argued that some of the difficulties that arise in the estimation of the fair value of stocks also plague the estimation of the size of the output gap and the unemployment rate, two elements that are routinely used by central banks to prepare their inflation forecasts.

We therefore conclude that measurement difficulties, as real as they are, should not stay in the way of attempting to incorporate information from asset markets into the design on monetary policy.

4. Asset Prices in an Inflation-Targeting Framework.

We argued in Chapter 2 that paying attention to asset prices can improve macroeconomic stability. Our model simulations reported there suggest that central banks wishing to minimise the volatility of inflation and/or output would do well to set interest rates both in response projected inflation and, to some degree, in response to the degree of estimated misalignments in the asset markets (equities, housing and the exchange rate). This is the case even if the inflation projection itself makes use of information in asset prices.

An immediate implication of our analysis is that a central bank pursuing an inflation target will not achieve optimum performance in terms of its inflation objective by setting its interest rate solely in response to shifts in its inflation forecast at a fixed horizon, reacting to nothing else. A purist might argue that the central bank should really look at inflation forecasts at several (all) future time periods, and set the interest rate so as to achieve the smoothest path consistent with hitting the pre-specified target on average. While in principle correct, such a procedure is, however, much too ambitious given the uncertainty related to the time lags in the effects of policies and shocks in general. Moreover, such a policy might not be easy to implement. As Kazuo Ueda, member of the Bank of Japan Policy Board says in his contribution to this volume, a Japanese central banker who would have looked at inflation forecasts 5-10 years out would have been raising interest rates in 1987-88. However, given that the central bank was focused on inflation only 1-2 years out, it was much more difficult to justify increasing interest rates. Our proposal for incorporating asset price misalignments can be interpreted as an alternative way of allowing for considerations relating to longer time-horizons.

An alternative justification for our procedure is to recognise that, of course, in conventional macro-models, once one allows for either non-linearities in the model, or for non-additive uncertainty, then, the conventional theoretical argument for inflation forecast-targeting is no longer valid (see e.g. Svensson (1999)). In that particular case, policy should be set by looking at the forecast of the entire distribution of possible outcomes rather than just a point forecast. Once again, looking at asset price misalignments might be thought of as providing information about the distribution of possible outcomes over and above looking at the forecast of the mean outcome for inflation.

Yet another way to rationalise our recommended policy rate is that in an uncertain world where central banks necessarily operate on the basis of rather limited knowledge about some of the crucial variables (e.g. the size of the output gap), asset price misalignments can, sometimes, convey information that was not necessarily available in the inflation forecast. For example, as Ueda emphasises, inflation was low in Japan during the 1986-89 period, and estimates of total factor productivity growth had risen (see also Yamaguchi (1999)). Indeed, as Ueda points out, the IMF said as late as February 1989 that there was no inflationary threat in Japan. Yet, if the framework had explicitly allowed for asset price misalignments, monetary policy would have been tighter than what was implied by just looking at a near-term inflation forecast based on a fairly optimistic view of the likely growth rate of potential output.

4.1. An augmented Taylor rule.

One possible way to implement our suggestion would be to adopt an augmented Taylor-type rule in which the asset price is given a role together with the inflation forecast and some measure of an output gap. This is exactly the type of rule that we showed to be superior to a 'pure' Taylor rule in the context of the Bernanke-Gertler models we simulated in Chapter 2 section 2. If the FOMC were to follow such a rule to take account of current asset price levels in the United States, what would their policy be?

Following our discussion of the Bernanke-Gertler model, we examine the following rule:

$$r_t^{ff} - \Pi_t = 2.5 + 0.5\ (\Pi_t - 2) + 0.5(y_t - y_t^*) + 0.05 s_{t-1}$$

where we r_t^{ff} is the federal funds rate, Π_t is four-quarter inflation measured by the median CPI, 2.5 is the assumed equilibrium real interest rate, $(y_t - y_t^*)$ is percent deviation of GDP from potential (measured using the Congressional Budget Office series), and s_{t-1} is the size of the stock market bubble measured as the percentage deviation of the inverse of the current equity risk premium from a twenty year lagged moving average. The coefficients on inflation and the GDP gap follow Taylor's and are chosen so that the rule matches observed movements in the funds rate fairly well (the correlation is 0.9). The more aggressive rules suggested by Bernanke and Gertler and by our simulations of their model, as well as by the work discussed in Taylor (1999), yield interest rate paths that are so much higher and so much more volatile than the actual funds rate as to be implausible. The coefficient on asset prices is based on our Bernanke and Gertler simulations.

Table 4.1: Federal Funds Rate Path Implied by Various Policy Rules

Year	Inflation	GDP Gap	Equity Risk Premium		Federal Funds Rate		
			Actual	Equilibrium	Actual	Taylor Rule	Augmented Taylor Rule
1996Q4	2.89	-0.16	2.2	3.01	5.28	5.75	9.83
1997Q4	2.80	0.74	1.0	2.83	5.51	6.07	10.35
1998Q4	3.02	2.15	1.2	2.59	4.86	7.11	9.52
1999Q4	2.22	3.46	1.2	2.36	5.31	6.56	7.39

Over the brief four-year period for which we report results in Table 4.1, inflation has fallen and the output gap has risen substantially, having somewhat offset effects on the implied interest rate path. Nevertheless, the interest rate path implied by the simple Taylor rule has been both more volatile and higher than the actual funds rate.[30] Currently, in Spring 2000, the Taylor rule suggests a setting of between 6½% and 6 ¾% compared to the actual 6%. Not surprisingly, taking account of asset prices raises the implied interest rate even further. Even if we assume that the equilibrium equity risk premium is a very low 2.36%, the augmented Taylor rule implies interest rates of nearly 7½%. This result is merely illustrative for several reasons. First, the coefficient on the asset price in

[30] We could reduce the volatility substantially by simply adding a lagged interest rate term, and smoothing the implied path.

the rule was deduced from our simulations with the Bernanke-Gertler model. It is quite possible that this coefficient would be smaller if it was obtained from studies based on models that are calibrated more closely to US data. With a smaller coefficient on the asset price, the implied interest rate in the augmented Taylor rule would also be smaller. Secondly, if the rule had been followed literally, then there are reasons to believe that the run-up in asset prices would have been less spectacular than it has been in fact during the past two years. This in turn would dampen the increase in the interest rate, exactly the result that we are striving for. We are not recommending an immediate jump in U.S. interest rates to this level. A crucial element of our proposal is that interest rates would move gradually in response to deviations of asset prices from perceived fundamentals.

Third, while some academic research suggests that central banks follow relatively simple and quantifiable rules for setting interest rates,[31] policy makers themselves "seem to regard the use of rules to guide policy as questionable in part because they are quite uncertain about the quantitative specifications of the most basic inputs required by most rules."[32] As Kohn goes on to detail, implementation of specific policy rules usually requires assumptions about the current level of potential output and the equilibrium exchange rate and interest rate

Fourth, as Svensson (1999) points out, forecast targeting has advantages over simple instrument rules like the Taylor rule. We now turn to a more explicit consideration of our suggestion within that framework.

4.2. Extending current inflation-targeting practice.

The most common practice in the world today is for governments to set inflation goals for their central banks, and then delegate the authority over interest rates and hold policy makers accountable for meeting the objectives. This practice usually entails specifying a loss function that specifically states that deviations of inflation and, possibly, output from their respective targets should be minimised over a **multiple-period horizon**. In other

[31] See, for instance, Clarida, Gali and Gertler (1998).
[32] See Kohn (1999), p. 195.

words, the idea is to mimic the loss function we generally use in theoretical models to evaluate different policies. As we have shown, doing so would almost certainly imply that asset price developments would be assigned a non-negligible role in policy decisions over and above the usual two-year inflation forecast.[33] Discussions in monetary policy committees and explanations of policy actions to the public would then routinely take asset price developments into account over and above their influence on a fixed-horizon inflation forecast.[34]

Some would argue that the fixed-horizon, inflation forecast-deviation strategy is simpler to implement and to explain than our alternative. We believe that on this account the differences between the two strategies are easily exaggerated.

In terms of implementation, it is true that the central bank needs to undertake the rather difficult task of estimating the degree of misalignment. But, in order to forecast inflation accurately, the central bank already needs to do that (see Chapter 6). Moreover, as we argued in Chapter 3, estimating the degree of asset price misalignment is no more difficult than trying to estimate potential output in that, at a conceptual level, one has to make judgements about the same unknowns.

There is, though, one factor which would make the job of the central bank a little more difficult i.e. it would have to make a decision about how much weight to attach to the asset price misalignment relative to the projected deviation of the inflation forecast from target in its interest rate function. Clearly, the answer would be rather model-specific, but that is also true of inflation forecasts. There is no a priori reason to believe that the judgements involved here are intrinsically more difficult than those that go into formulating an inflation forecast.

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[33] It is interesting to note here that Otmar Issing, a Member of the Executive Board of the European Central Bank, has argued that giving a role to monetary aggregates in the formulation of policy may serve a similar role. He writes: " Asset prices cannot develop, over and extended period of time, without a corresponding increase in money and credit. By giving money a prominent role in its strategy, the ECB takes into account its responsibility to contribute to the stability of the financial system." (Swedbank (2000), p.11.)

[34] The last point is important since, as we have pointed out, many central banks already do take asset prices into account in preparing their inflation forecasts.

What about the argument that a system with one variable (the inflation forecast) is easier to explain than one with several variables? Once again, we are not persuaded. Explaining and justifying one's inflation forecast requires much analysis, as can be attested to by the size of most 'Inflation Report'-style documents. Indeed, a 'leaning against the wind' strategy might be easier to explain to the general public. Suppose that a central bank has an inflation target of 1.5%, but that it believes that a 'bubble' has led to an unwarranted and significant appreciation in its exchange rate. Moreover, assume that it thinks that lower interest rates would reduce the expected size of the misalignment, and also make it more likely that it disappears more quickly. Note that the central bank would be conscious of the possibility that allowing the bubble to build up further could, at some point, lead to a very significant depreciation of the exchange rate, which could, at that point, be associated with a very significant rise in measured inflation. In this case, it would be rather easy to explain to the public that interest rates had been set a little lower than they would have been in a regime which fed mechanically off an inflation forecast n periods out, because by reducing the likelihood of a sudden and sharp change in the exchange rate, the central bank would likely minimise the average deviation of inflation from its target level over the entire future.

Our proposal for considering a change in the interest rate reaction function is perfectly consistent with the remit to the central banks in some inflation-targeting regimes, though this is not always how it is actually implemented. For example, in the UK the "framework is based on the recognition that the actual inflation rate will on occasions depart from its target as a result of shocks and disturbances. Attempts to keep inflation at the inflation target in these circumstances may cause undesirable volatility in output." (see, e.g., letter from the Chancellor to the Governor, 3 June 1998) Indeed, it is for this reason that the framework allows for a letter-writing procedure whereby the MPC can explain why inflation is away from its target by more than 1 percentage point, say what it intends to do about it, and explain how its approach is consistent with the Government's monetary policy objectives.

Hence, in the UK context, our proposal vis-a-vis the interest rate reaction function incorporating asset prices is wholly consistent with the Chancellor's remit to the Bank, though it might require some adjustment to the way in which the Bank is seen as implementing its remit (which is in terms of an interest rate rule that feeds back off an inflation forecast 2 years or so out). An important argument against the Bank changing its procedures is that the system is still new (it only dates back to May 1997), and a change could be damaging to credibility. As Sir Samuel Brittan(2000) argues about a change in the remit to incorporate exchange rate considerations:

> "I have to admit that, if made now, such a change would only increase the impression that the British adopt a bewildering succession of monetary objectives, only to drop them when the going gets rough."

Although Sir Samuel is talking about a much more far-reaching change than we would contemplate, the effect on credibility might be similar, unless the change in operating procedure were explained extremely carefully. If, hypothetically, the Monetary Policy Committee were to say that it took asset price misalignments into account separately, there is a clear risk that the markets would, in the current conjuncture, think that the Bank had gone soft on inflation. Moreover, our simulation results have been obtained on the basis of a few macroeconomic models-it would obviously be important to further assess the robustness of our results-something that is probably true of all economic research.

It is sometimes argued that allowing for asset price misalignments would make accountability more difficult as the central bank would have more excuses for why it had missed the target. There may be something in that argument, though, if implemented correctly, our proposal would actually reduce the volatility of inflation out-turns versus the target, and, therefore, over time, the central bank should actually have less explaining to do.

Further, in addition to the benefits in terms of reduced inflation and output volatility, an important advantage of our proposal is that it would explicitly require central banks to react in a symmetric fashion to rises and falls in asset prices, and this might help correct the widely-held view that central banks are implicitly underwriting a particular level of the stock market. In the next section we investigate this view in some more detail.

4.3. Asymmetry and moral hazard in policy.

For some time, policy makers have been concerned with the potential for moral hazard arising from perceived asymmetry in their policies. What if the central bank has the ability to insure equity holders against significant drops in the market? If that is so, then they could encourage something that looks like a bubble, whereby risk premia fall artificially driving prices up.[35]

In fact, policy makers may be symmetric, reacting equally to large ups and downs, but if there are no large ups, their behaviour may appear to be asymmetric. That is to say, the world may be asymmetric, with only sudden crashes and no abrupt booms, giving no opportunities for symmetric responses. This difficulty arises from the fact that the investors know this, and so they are aware that policy will insure them against big losses, allowing them to place one-sided bets.

Does the behaviour of asset prices bear out this argument? This asymmetry of policy, leading to moral hazard of investors, is surely a problem at very short time horizons. It is well known that asset returns are negatively skewed, with more large downs than large ups, at a daily frequency. But as we average returns over longer and longer time periods of months and years, this asymmetry should go away.[36] If the asymmetry of the distribution of stock returns disappears sufficiently quickly, then it would be possible for the central bank to be symmetric over horizons that are meaningful.

To examine the prospect of policy acting symmetrically, we look at daily returns over the period from 1885 to 1998. These are a combination of the data collected by Schwert

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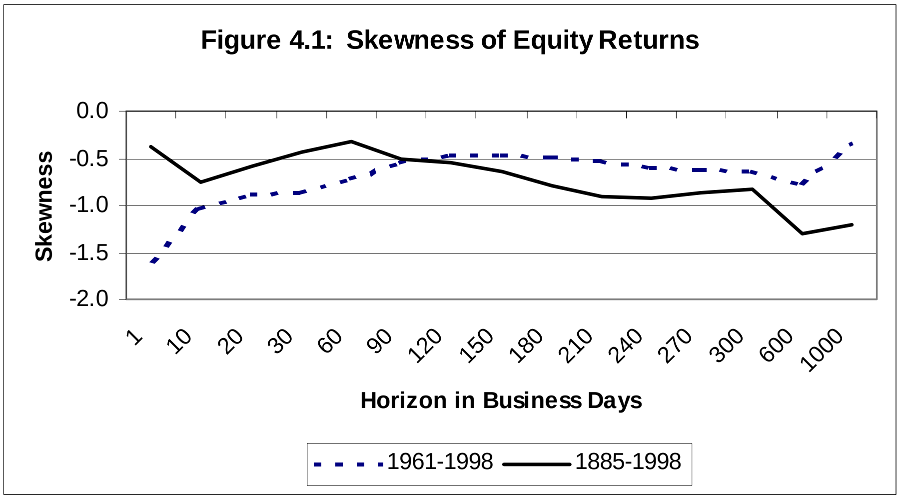
[35] Miller, Weller and Zhang (1999) suggest that recent behaviour of the U.S. stock market is well characterized by a situation in which investors behave as if the Federal Reserve has given them a put option with an exercise price that is 25% below the previous market peak. If this explanation is correct, it must be a new phenomenon, as this policy response would have eliminated the negative skewness in the data.

[36] In fact, the central limit theorem guarantees that this will happen over long enough time periods.

(1990) and a series from the Centre for Research on Securities Prices (CRSP).[37] Figure 4.1 presents the skewness of equity returns at various holding periods, all measured in business days, for both the full sample and the past forty years. We examine returns for holding period ranging from one to five thousand business days (roughly 20 years).[38]

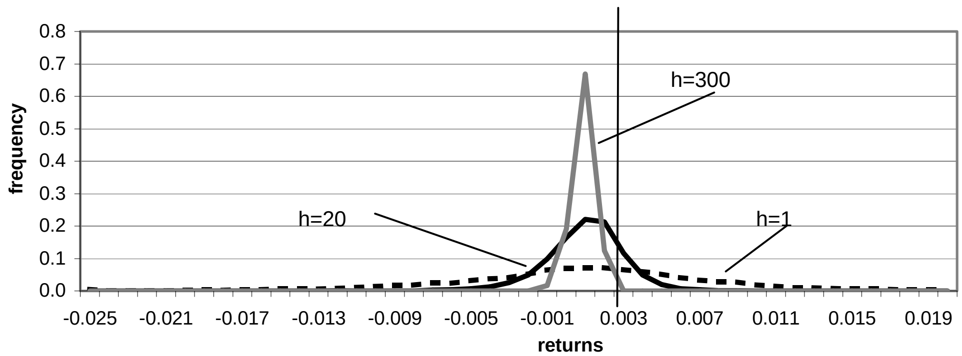


The results are striking, in that the returns continue to have significant skewness, with skewness coefficient below –0.5, at holding periods of several years. For the longer time period, the skewness does not approach even at a horizon of 1000 business days, which is approximately four years. This seems far too long to be useful for policy purposes, leaving the difficult issue of how to appear symmetric in a world that is clearly not.

Figure 4.2 makes a complementary point. Here we plot the histogram of returns for holding periods of one day, twenty days (just under one month) and three hundred days

[37] As Schwert suggests on his homepage, we use his series, which the Dow Jones composite portfolio from February 16, 1885 through January 3, 1928, and to the Standard & Poor's composite portfolio from January 4, 1928 through July 2, 1962. The CRSP daily returns file starts on July 3, 1962, so these data should be used to complete the daily returns series. We thank C.Y. Choi for helping us with these calculations.
[38] Following the suggestion of Campbell, Lo and MacKinlay (1997) we examine the properties of the natural log of gross returns. Throughout, we use overlapping data.

Figure 4.2: Distribution of Stock returns, 1961-1998



(about one and one-quarter years). As the horizon lengthens, the distribution becomes much more concentrated near the mean. That is, the variance declines.[39] But, importantly, the distribution remains significantly skewed, as there are substantially more large negative returns than large positive ones.

These results make the important point that given that asset returns are asymmetric, it is difficult for central banks to appear symmetric and, hence, the findings of our informal survey that all respondents believe the Fed to be asymmetric are not surprising. One advantage of our proposal is that central banks would have a policy rule that would be explicitly symmetric. This might help reduce misperceptions among market participants.

4.4. Some commonly expressed objections to our proposals

Both at the Conference, and elsewhere, we have heard some arguments against our proposal. We attempt to give our view on these objections below.[40]

One common argument is that we should not attempt to target asset prices, not least because the effect of an interest rate change on an asset price is pretty uncertain. Yamaguchi (1999) points out that the Japanese market shrugged off the first two Bank of Japan tightenings in 1989, and started to fall only after the third rate hike. However, at

[39] As one might expect, the kurtosis declines as well. For a one-day horizon, the kurtosis is over 30. At a horizon of 200 days, the kurtosis is only 3.5.
[40] We are especially grateful to Jose Vinals of the Bank of Spain for his insightful comments on this section of our report.

that point, he contends that a self-feeding process developed between a weakening market and an increasing risk premium, which then led to a rather abrupt collapse in share prices. Therefore, deflating asset price bubbles can be problematic in that attempting to achieve a “soft landing” is extremely difficult.

We find it difficult to quarrel with the proposition that the effects of monetary policy on asset prices are difficult to predict. However, in our proposal, we are <u>not</u> attempting to target a particular level of asset prices. Instead, we merely attempt to allow for the degree of misalignment in monetary policy-setting without necessarily believing that the misalignment will disappear. Of course, if monetary policy were run on the basis of our suggested framework, we believe that such misalignments would be less likely to occur and that their magnitude would be likely to be smaller. This is very different from saying that our proposal involves targeting asset price bubbles. It does not. Our proposal is predicated on (consumer) price stability being the paramount objective of central banks.

A related concern is that even if we do not set out to prick asset price bubbles, we may end up destabilising the economy because interest rate hikes that occur because stock prices are “too high” might lead to a very large, self-reinforcing price drops. That is to say, “soft landings” might be very difficult to achieve. Of course, if asset prices were to begin to fall rapidly, our recommendation would be to cut interest rates quickly both in response to stock prices falling below their warranted levels and in response to the likely decline in the inflation forecast. Indeed, in this situation our proposal suggests cutting interest rates more aggressively than would be the case if one responded solely to moves in expected future inflation.

Another common objection to our proposal is that looking at asset prices rather than domestic inflation alone may cause domestic inflationary pressures to build up to the point where a hard landing is inevitable. Proponents of this view point to several historical examples. One is the case of Japanese monetary policy in the 80s. At that time, the argument goes, domestic inflation was distorted by the strong yen (as we mention in the next chapter and Ueda emphasises in this volume). A second example is found in the 1987-89 UK experience, when shadowing the DM arguably prevented interest rates from being set at levels that were appropriate to the domestic economy (see Chapter 2). However, we believe that the lesson to be drawn from these episodes is not that looking at asset prices leads to bad policy, but that, if you look at asset prices, you should look at all of them. Hence, in the Japanese case, the authorities should not have just focused solely on the yen, but should also have paid heed to land and stock prices. Similarly, in the UK, as we argued in Chapter 2, the authorities should have paid more attention to the housing bubble. Moreover, our proposal would not involve attempting to manage the exchange rate within a narrow range (which was true of the 1987-89 experience in the UK).

To summarise, our proposal is motivated purely by price stability considerations. Asset prices should be taken into account because it is misalignments in these that are most likely to generate significant boom-bust cycles in the economy. We do not expect our policy prescription to prevent asset price bubbles and do not set out to prick them. However, we do believe that our framework might deliver fewer and/or smaller misalignments.

4.5. Non-conventional policy responses.

As we have emphasised in several places already, this report focuses on the conduct of conventional monetary policy in response to asset prices movements. In this section we examine arguments suggesting that other policy instruments can be used independently of the interest rate for the same purpose. We look at two suggestions that have received particular attention: margin requirements on the one hand, and attempts to influence expectations using policy signals on the other. We conclude that neither of these are substitutes for traditional monetary policy for the purpose of achieving macroeconomic objectives.

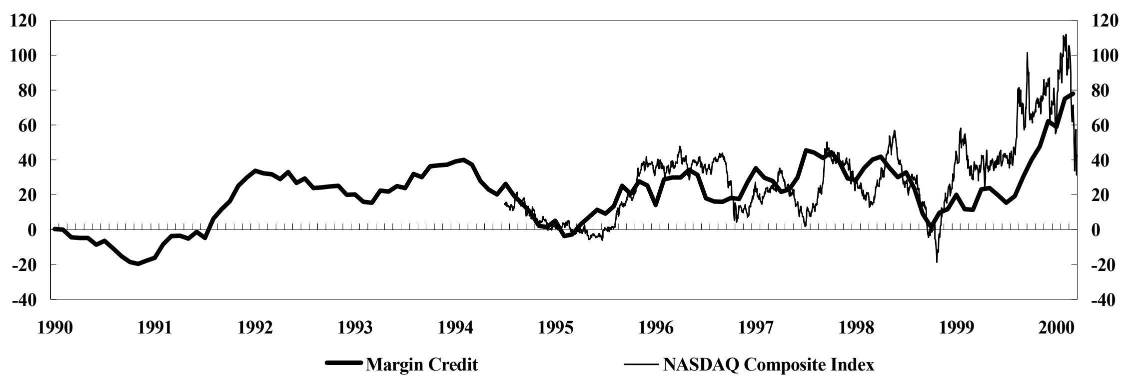
4.5.1. Manipulating margin requirements.

In many countries, central banks are charged not only with establishing and sustaining price stability, but also with maintaining the liquidity and solvency of the payments system. This is certainly an important issue, but treating it adequately is beyond the scope of the present study. Our focus is on the macroeconomic consequences of asset price shifts, and with this perspective, the question we address in this section is whether a response via changes in the regulatory environment is appropriate

In general, there is little literature about using regulatory policies as a means of influencing asset prices. The principal exception is that of margin requirements, a policy tool that is mainly relevant to the US market, because margin requirements for securities market broker-dealers are set by the Federal Reserve.

The role of margin requirements is a perennial issue for U.S. policy makers. In particular, the recent sharp rise in margin borrowing from U.S. securities brokers to finance securities purchases — that coincided with a dramatic increase in the NASDAQ index (Figure 4.3) — has rekindled demands that the Federal Reserve raise margin requirements

Figure 4.3: Margin Credit and the NASDAQ
Percentage Change from 12 Months Earlier



in an effort to slow the rise in asset prices.[41] Previously, margin requirements have been changed for this purpose.[42] However, several factors raise doubt whether such use of margin requirements would be advisable at present.

[41] The Securities Exchange Act of 1934 charged the Federal Reserve with the task of setting margin requirements for securities purchases, but the Securities Exchange Commission is legally responsible for enforcing these requirements..
[42] The minimum initial margin requirement has been changed 23 times since its inception. However, the current rate of 50% was set in 1974.

Federal Reserve Chairman Alan Greenspan on several recent occasions has indicated his opposition to altering margin requirements in order to influence asset prices. His reasoning is straightforward: margin debt is small relative to equity market capitalization, and such debt is used principally by individual investors. Institutional investors and sophisticated individuals have access to other forms of credit, or can obtain leverage in ways that are not influenced directly by the terms on margin debt. Mr. Greenspan has concluded that the connection between margin requirements and asset values is highly uncertain; in any case, margin shifts are uneven in their impact on different types of investors.

It is easy to find justification for Chairman Greenspan's views on this subject. As was pointed out in a recent review by the Federal Reserve Bank of San Francisco,[43] the only available exposure to stock market risk when the 1934 legislation was adopted was through direct purchase or sale of stock. Thus, control over margin requirements at that time could have had an important influence on stock prices. After all, margin debt grew in the late 1920's to the equivalent to more than 10% of U.S. stock market capitalization. Today, even following the recent rapid expansion of margin debt, total margin debt outstanding amounts to little more than 1.5% of market capitalization.

Today, investors can acquire exposure to the US equity market in many forms that do not involve margin debt. For example, stock futures and options provide highly leveraged exposure, but are not financed by margin debt. Moreover, individuals can obtain credit to finance securities purchases in many forms, including home equity loans, and other highly fungible forms of credit.

Academic studies also reinforce skepticism about the efficacy of margin requirements. For example, Hsieh and Miller (1990) found that "the data…offer no support for the view…that Federal Reserve margin requirements are an effective tool for dampening stock market volatility." Similarly, Stephen Pruitt and K.S. Tse (1996) concluded that "empirical tests…offer *no support* [author's italics] for the view that Federal Reserve

[43].Federal Reserve Bank of San Fransisco (2000).

margin requirements function as originally conceived or that changes in margin levels are associated with changes in margin-imposed binding constraints on security investors." The Federal Reserve Bank of San Francisco reports that "the growth in stock market capitalization precedes the growth in margin credit, not vice versa."[44] Thus, "the data are consistent with investors reacting to a rise in stock prices by borrowing more against stocks, and likewise, reacting to a fall in stock prices by borrowing less." According to this conclusion, the recent sharp pullback in prices of NASDQ stocks should lead — with a lag — to a reduction in margin debt. Furthermore, taken together with the other studies, it implies that changes in margin requirements are not likely to have any perceptible independent effect on either asset price volatility or macroeconomic stability.

4.5.2. Can we rely on policy signals only?

The Holy Grail for policy makers is to find as many policy instruments, as there are potential targets for policy. In some countries this has, as a practical matter, taken the form of pursuing a monetary policy aimed at a domestic objective such as the inflation rate on the one hand, and attempting to influence the exchange rate by some other means, on the other. For example, a policy-determined interest rate is set so as to keep inflation under control, and interventions in the foreign exchange are used simultaneously used to steer the exchange rate towards some target value. In order not to jeopardize the control of inflation, the interventions in the foreign exchange market are sterilized, making sure that they do not influence internal monetary conditions. The problem is that by systematically neutralizing the domestic consequences of the interventions, the central bank may also rob them of any impact on the exchange rate itself. This is not to say that it is impossible to find episodes where sterilized interventions do seem to have been effective. [45] Furthermore, empirical tests of the effectiveness of interventions in the foreign exchange market are not conclusive. As shown for example in Edison (1993) and Frankel and Dominguez (1992), the strength as well as the direction of the effect is highly

[44] Federal Reserve Bank of San Francisco, op.cit. p. 7. The authors conducted a Granger test to examine the time-series dynamics between the growth in margin credit and the growth in market capitalisation.
[45]. See Frankel and Dominguez (1992) for examples.

dependent on the time period studied, suggesting that other factors are crucial in determining the outcome

If, however, sterilized interventions in the foreign exchange market are ineffective, it is of course a puzzle that most countries actually do practice neutralization operation in conjunction with such interventions. Mussa (1990) proposed an explanation of this practice, which was to argue that by intervening in the foreign exchange market, the central bank signals future changes in monetary policy. Like all asset prices, the exchange rate reacts to anticipations of future monetary conditions, so this signal will influence the exchange rate even though current monetary policy is unchanged. In other words, signaling through interventions gives the central bank an additional monetary policy instrument.

This raises the intriguing possibility that official policy signals can be used to influence asset prices independently of conventional monetary policy, and that policy makers therefore have found a second instrument. One can, for example, point to a number of episodes where public officials have attempted to use public statements to influence exchange rates, suggesting that they believed such statements could have an effect on the exchange rate independently of the monetary and fiscal policies pursued at the time.

Recently many statements of Governor Greenspan about high valuations on the stock market have been interpreted as falling under the category of using 'talk' to signal that he would like to see an orderly return of stock prices to their fundamental level. On this interpretation he may, in other words, have been signaling to market participants that future monetary policy will be adjusted if necessary in order to achieve this goal.

The obvious question that this raises is whether signaling really gives an additional degree of freedom for monetary policy. Empirical evidence on this has been provided in Kaminsky and Lewis (1996). Taking Mussa's hypothesis as a point of departure, Kamisky and Lewis study the period from 1985 to 1990 in the United States, during which the Federal Reserve intervened regularly in the foreign exchange market. The authors first test whether an intervention to weaken (strengthen) the dollar was systematically followed by a more expansionary (contractionary) monetary policy. They conclude that this was not the case, since the information content in intervention policies "comes from interventions to sell dollars, followed by tight monetary policy". (p. 305) Next Kaminsky and Lewis examine the effects of the interventions on the exchange rate itself. The results indicate interventions have no independent influence on the exchange rate, which appears to react to the expected future change in monetary policy regardless of the direction of the intervention policy pursued by the FED. Overall therefore, the empirical work casts serious doubts on the signaling hypothesis.

Sellin (1998) provide additional evidence on the effects of policy signals, in his case speeches by the Governor and Vice-governor of the Bank of Sweden. Sellin investigates the impact of monetary policy on the returns on stocks and bonds in Sweden. In addition to the Swedish Central Bank repo rate he includes a dummy variable designed to capture the effect of speeches on both the mean return and its volatility. While the repo rate has a significant influence on both returns, there is no independent additional effect of speeches on the mean. In other words, there does not seem to be any independent signaling effect of monetary policy speeches on average stock or bond returns once the actual policy has been appropriately controlled for in the test. However, the results also show that the volatility of stock price returns is reduced as a result of the speeches. Since in the sample, it is generally the case that speeches by the governor and the vice-governor correctly reflect future policies, this is consistent with an interpretation according to which speeches by policy makers that correctly reveal their longer-term strategy have a soothing effect on asset markets.

In conclusion, and pending further empirical work, it appears that policy signals do not by themselves influence asset price levels or returns, but to the extent that they are followed by actions consistent with the signal, they may have an effect on asset price volatility. It would be interesting to test the converse as well, i.e. whether signals that are not followed by consistent actions leads to increases in volatility.

5. Reacting to Asset Price Misalignments: Historical Lessons and Perceptions of Market Participants.

In the preceding three chapters we have argued that macroeconomic stability can be enhanced if interest rates react directly to information in asset prices. We have also emphasised, however, that we are not advocating that central banks should target asset prices in the sense of setting goals for the levels of asset prices, nor that they should make it their priority to puncture asset price bubbles. In the first two sections of this chapter we underscore the last point by looking at two historical examples, the United States in 1929 and Japan in the late 1980s. During these episodes the Federal Reserve and the Bank of Japan respectively arguably felt the need to break what they saw as dangerous speculation in asset markets. Their accomplishment was not followed by equal success in containing the financial distress that followed, however, and we argue that this is partly the reason for the subsequent prolonged slumps in real economic activity in both cases.

Another important historical episode is the direct intervention in the equity market by the Hong Kong Monetary Authority in 1998. Although apparently successful in stemming both the downward pressure on the exchange rate and the fall in stock prices, we caution against drawing conclusions from this episode for other countries and situations as the context surrounding the HKMA intervention appears to have been rather special.

We end the chapter by reporting the results of an informal survey of market participants that we conducted to check whether central bank policy is perceived to be reacting symmetrically to asset price increases and decreases.

5.1. The U.S. stock market in 1929

What happened to the U.S. stock market in October 1929? Was there a bubble that burst? And, if so, why? The answers to these questions are still somewhat perplexing. But we do know quite a bit about what happened leading up to the famous crash, and there are surely some lessons to be learned.[46]

[46] This section is based largely on Cecchetti (1992) and Cecchetti (1998).

First, was there a bubble? This is a difficult question. Looking at various sources of data, we see that the price-earnings ratio for the Standard and Poors' composite index was in excess of 30 in mid-1929 – a level not reached again until the late 1990s.[47] In the intervening 70 years the S&P P/E ratio hovered in the range of 10 to 20. There is an additional piece of statistical evidence suggesting that the stock prices prior to the crash may have been artificially inflated by irrational investor sentiment. As first noted by Galbraith, and recently discussed by DeLong and Shleifer (1991), the value of closed-end mutual funds was as much as thirty percent above the market value of the securities that made up their portfolios in the late summer of 1929.

Rappoport and White (1990) supply an addition piece of evidence for the case that stocks were significantly overvalued. They note that, prior to the crash in October 1929, the interest rate on overnight call loans that were collateralized by stock was far above interest rates on very short-term commercial loans such as banker's acceptances. Rappoport and White's interpret this premium as compensation for the presence of a bubble.[48]

Given this, some decline may have been inevitable. Shiller's calculations suggest that a decline of at least one third would not have been surprising. In fact, the market fell by nearly one quarter in the final two trading days of October 1929, and by the end of November was almost exactly 33% below the August 1929 peak. This history, and what came next, is well known. Over the next 3 years, the U.S. economy fell into the Great Depression.

What caused the precipitous decline in U.S. stock markets in 1929, and what role did policy play in the collapse? The best evidence we have is that it was Federal Reserve behaviour, together with the public statements of numerous government officials. It was not margin debt, fraud or illegal activity. As has been amply documented, initially by Friedman and Schwartz (1963) and more recently by Hamilton (1987) and others,

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[47] See Shiller (2000) Figure 1.3, pg. 8.
[48] There is substantial disagreement about whether a bubble was actually present at this time. Cogley (1999a, 1999b), for example, argues that the 1929 valuations could be justified by fundamentals.

monetary policy became substantially tighter in the fall of 1928, almost immediately follows the death of Benjamin Strong, the President of the Federal Reserve Bank of New York. While he was alive, Strong controlled Federal Reserve policy, as the Federal Reserve Board was not as powerful as it is today. But when Strong died, Adolph Miller of the Federal Reserve Board was able to take control of monetary policy. Miller believed that speculation was causing share prices to be too high, and that this was damaging the economy. Together with Herbert Hoover, who had just been elected President, he set out to bring down the stock market.

Beginning in the winter of 1929, the Federal Reserve began warning banks that they were "not within [their] reasonable claims for rediscount facilities at it Federal reserve bank when [they borrow] either for the purpose of making speculative loans or for the purpose of maintaining speculative loans (*Federal Reserve Bulletin*, February 1929, pg. 93-4)." In this context, the term `speculative' referred to loans made for the purchase of equity. That is, the Federal Reserve clearly felt that there was a speculative bubble in the stock market, and that it was being promoted by bank lending, which was not "conducive to the wholesome operation of the banking and credit system of the country." In this same spirit, in March of 1929, Hoover "sent individually for the editors and publishers of major newspapers and magazines and requested them systematically to warn the country against speculation and the unduly high price of stocks."[49]

Following these official announcements, the stock market nearly crashed on 26 March 1929. By noon of that day, call money rates rose to 20 percent and stock fell by nearly 10 percent. But George Harrison, Strong's successor at the Federal Reserve Bank of New York, and Charles E. Mitchell, President of First National Bank, stepped in to provide liquidity to the markets and reverse the decline. Both men were later roundly criticized for their actions, as official Washington was clearly hoping for a significant fall in share prices.

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[49] See Hoover (1952) pg. 17.

This story suggests that the Federal Reserve could have stopped the crash of 1929, if they had wished. But the position of the Board of Governors and the President was clearly that there was a bubble in the market that needed to be deflated for the good of the country. More traditional measures of monetary policy reflect this position as well. Hamilton (1987) and Cogley (1999a, 1999b) both note that the Federal Reserve shifted toward tightening in 1928, raising the discount rate (the policy instrument of the time) from 3½% to 5% in the first half of the year. With the mild deflation that was occurring at the time, the real interest rate stood at 6% by the end of the year.

The crash had several consequences. First, it led to a general decline in economic activity in 1930, and second, it set off a series of changes in the regulation of the financial sector. While the crash does appear to have slowed the economy in 1930, it was almost surely the monetary policy of the period that led to the depth and length of the Great Depression. On the regulatory side, it led to the overhaul of the Federal Reserve System; the (temporary) separation of commercial banking, investment and insurance; and the substantially closer regulation of financial markets.

What lessons does the 1929 episode hold for current policy makers and their approach to asset price movements? The answer is that they need to proceed with caution, but not complete neglect, as the identification of a bubble is extremely difficult. First, at very high frequencies, liquidity needs to be provided to insure orderly markets. The experience of October 1987 strongly suggests that this lesson has been learned. Second, institutional design is very important to insure that if an asset price bubble develops that, when it bursts, the damage does not wipe out the financial intermediation system. That is, the balance sheets of banks and brokerage firms must be relatively well insulated from the volatility of asset prices. Finally, it is difficult even at this distance to determine if policy makers' actions were stabilising or destabilising.

5.2. The build-up and collapse of Japan's bubble economy.

The emergence in the mid-1980's of Japan's "bubble" economy — and its unhappy aftermath — appears to provide an example of monetary policy's failing to respond to sharp asset price changes in a clear or systematic fashion. In broad terms, the outlines of this period are well known: The prices of both Japanese equities and urban real estate (at least as measured by the price of land in Japan's major cities) roughly tripled in value between the beginning of 1986 and the end of 1989. While many factors contributed to this rapid rise, the consensus view remains that Japanese markets exhibited the characteristics of a classic financial bubble.[50]

Also well known is the difficulty of the post-bubble period. Following a sharp tightening of monetary policy beginning in 1988 — and more decisively by 1990 — stock prices dropped precipitously in the following two years. By 1992, the Nikkei index of Japanese equity prices had fallen to less than one-half its bubble period peak. Land prices also fell sharply. This asset price collapse devastated the Japanese banking system, while virtually paralyzing the market for commercial real estate.

The negative repercussions of this collapse on the Japanese economy remain vividly present a decade later. The sustained weakness of the Japanese banking system is viewed commonly as one of the principal sources of the Japanese economy's disappointing 1990s performance. Real economic growth averaged only 1.3% per year, compared with 3.8% in the 1980s.

5.2.1. Monetary Policy and the Japanese Asset Bubble.

The accelerating growth in Japanese asset prices after 1985 — the beginning of the bubble period — was associated with a significant 1985-87 drop in Japanese short-term interest rates (Figure 5.1). The Bank of Japan lowered the overnight call money rate from 5.0% in September 1985, to 2.5% at the end of February 1987. These policy moves coincided with concerted international policy actions intended to influence the foreign exchanges. The original meeting of the Group of Five (G-5) industrial countries in September 1985 produced the "Plaza Accord" agreement to push the U.S. dollar lower against other G-5 currencies. The February 1987 meeting of the (by then expanded)

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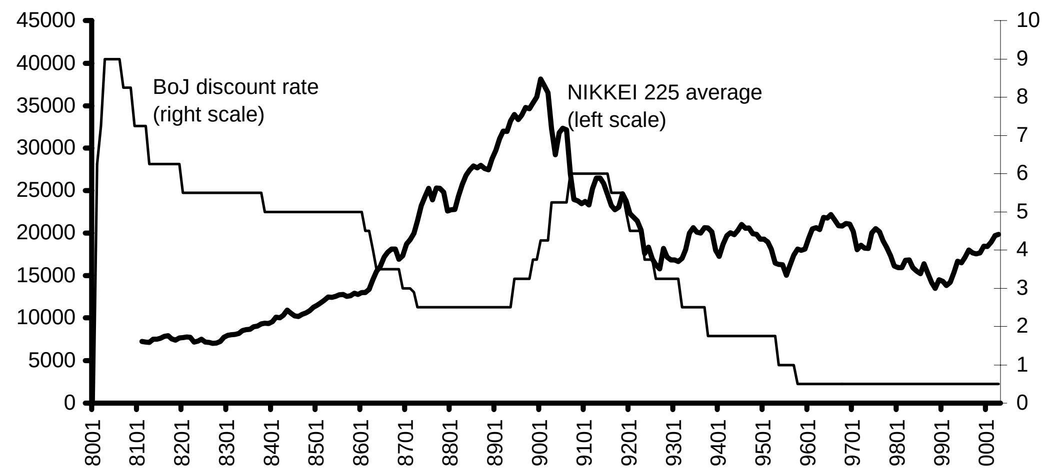
[50] For example, see Cargill, Hutchinson and Ito (1997) and McKinnon and Ohno (1997)..

Group of Seven countries produced the "Louvre Accord" agreement that the dollar's value had fallen to an appropriate level, and that its decline should be halted. Between

Figure 5.1: Bank of Japan discount rate and the Nikkei



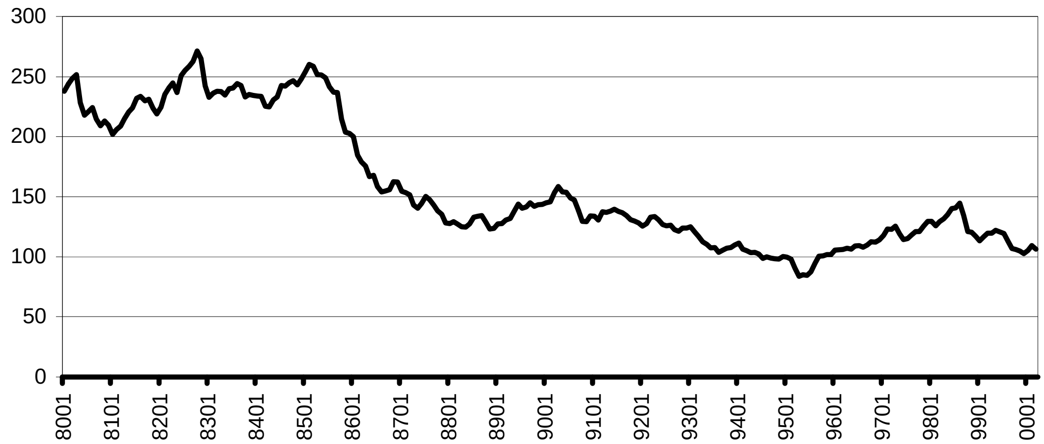
September 1985 and February 1987, the dollar dropped from ¥237/US$ to ¥153/US$ (Figure 5.2).

Japan's asset bubble therefore appears to have been associated with a period during which Bank of Japan policy was focused on influencing the yen's external value, rather than on domestic factors. The drop in nominal (and real) short-term rates at this time was accompanied by an acceleration in money growth (that is, in the targeted M2 + CDs aggregate). During the first years of the bubble period (1985-1987), money growth oscillated narrowly around an 8% annual rate. By late 1987, however, money growth had accelerated to more than 10%. By early 1988, the growth rate had reached about 12% per annum.

The Bank of Japan's actions during this period remain controversial. The Bank has been widely criticized for having helped to initiate and feed the asset price bubble through its 1985-1987 rate cuts. More broadly, Japan's economic policy mix appears to have been inappropriate, given the apparent policy goal of complying with international (and especially US government) pressures to boost domestic growth and strengthen the yen.

Following conventional analysis, these goals should have suggested a policy mix of more expansionary fiscal policy, and tighter monetary policy. Instead, the Bank of Japan

Figure 5.2: Yen/$

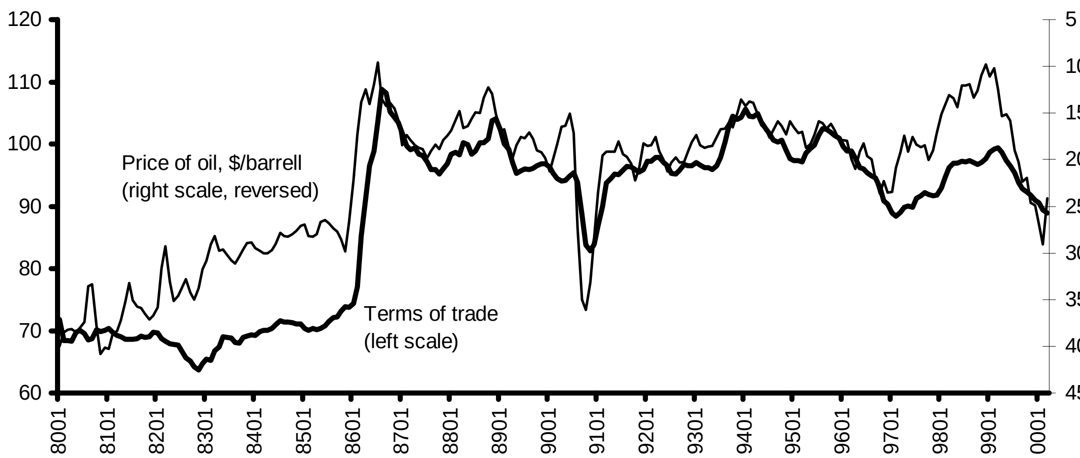


implemented repeated — and expansionary — short-term rate cuts, while fiscal policy remained roughly unchanged.

According to the Bank, its policy remained focused on sustaining price stability. Senior Bank officials, in discussing this period, have noted that inflation remained very low (under 1% per year) until late 1988. According to the Bank's view, their response was reasonably prompt when signs of rising inflation pressures appeared in late 1988, as the official discount rate was raised by May 1989.

At the conference, Mr. Ueda pointed out that an inflation-targeting central bank of the conventional variety would have found it difficult to tighten policy because inflation was low, and given commonly-held views that the potential growth rate of the Japanese economy had grown, near-term inflation was expected to remain low. However, the behaviour of land and stock prices was consistent with a build-up of longer-term inflationary pressures. Yet, the central bank could hardly tighten in 1986-88 on the grounds that its very long-term projection for inflation was high - this would have been very difficult to do politically. However, a central bank that was following a policy rule of the kind that we discuss in chapters 2 and 3 would have found it much easier to justify tightening given what had happened to land and stock prices. Moreover, our policy rule might have prevented the unhealthy, exclusive focus on the strong yen.

Figure 5.3: Japan's external terms of trade and the price of oil.



The implausibly rapid rise in asset prices (including prices of real estate as well as equities) should have provided a warning signal to the Japanese authorities that their financial system was under severe strain. The Bank has explained that the changing structure of the financial system in response to liberalizing policy moves had made it difficult to be confident about the relation between money growth and inflation, or asset prices. Regardless, Japan's experience suggests that a single-minded focus on narrowly defined inflation may not always provide the best guide to monetary policy.

In fairness to the Bank, factors other than monetary easing appeared to have influenced Japanese asset prices during the bubble phase. For example, the decline in the dollar versus the yen during 1985-87 was accompanied by a sharp drop in the dollar price of oil. Thus, the Japanese economy enjoyed a dramatic strengthening in external terms of trade during 1985-86 that effectively boosted Japanese real incomes. (Figure 5.3) This terms-of-trade gain was larger in magnitude than in other G-7 countries, reflecting Japan's relatively greater reliance on imported energy.

At the same time, the broadening of the range of activities permitted for banks and other deposit-taking institutions was not matched by any cutback in the complete deposit guarantee system, increasing the potential impact of moral hazard. Moreover, it is likely that bank supervision did not keep pace with the expanding scope of bank lending as regulations were liberalized, especially those permitting risk-taking activity outside of traditional channels. In fact, even traditional bank lending grew between 1985 and 1988 at an annual rate of about 10%, nearly double the growth rate of nominal GDP.

5.2.2. Monetary Policy and the Post-Bubble Deflation

Beginning in 1989, both the Bank of Japan and the Ministry of Finance began to implement measures designed to reverse the asset bubble. The official discount rate was raised between May 1989 to August 1990 by 350 basis points to 6.0%. The Ministry of Finance also adopted direct controls over banks' real estate-related activity. Lending to this sector by non-banks continued to expand, however. In addition, several tax and regulatory measures were promulgated with the express intention of discouraging land purchases, many of which reduced the attractiveness of land as an estate planning tool.

Other regulatory measures tended to discourage new bank lending. In particular, the 1988 Basel Accord on risk-based capital requirements required Japanese banks to hold 45% of their Japanese equity holdings as part of their tier II capital. This measure raised the banks' cost of capital, lowering their incentive to lend. Moreover, margin requirements for the Nikkei futures market were raised, reflecting a widely held belief that this market was being used as a speculative tool for manipulating equity prices.

The policies intended to puncture the asset price bubble after 1988 were, if anything, too successful. The Nikkei index peaked at 38,915 at the end of 1989. By October 1990, the index was testing 20,000. As is well known, the decline was sustained during the next few years. By mid-1992, the Nikkei index had dropped to less than 15,000, and it would not return to 20,000 again until early 1996. Land prices dropped by about 50% by 1995, about equal to prices registered at the beginning of the economy's bubble phase.

In response to persistent, slow GDP growth in the immediate post-bubble period,[51] the Bank of Japan repeatedly lowered the discount rate. With banks immobilized by bad debts and capital losses on equity holdings — a painful aftermath of the bursting bubble — lower rates did little to expand bank credit, or to rekindle the economy. Moreover, the yen appreciated on trend over this period, reaching a record high of nearly ¥80/US$ in April 1995, further dampening the recovery

5.2.3. Lessons of the Bubble and its Aftermath.

While a number of factors — including the combination of financial liberalization, and outdated regulatory and supervisory institutions — rendered the policy environment difficult, it is hard to avoid placing the Bank of Japan at the Centre of the problems plaguing the Japanese economy during the bubble and post-bubble periods. After having acted late, the Bank also acted sluggishly in response to the subsequent signs of substantial distress in the banking sector. Perhaps more notably in the post-bubble period, the Bank has not communicated clear guidelines for policy management, leaving investors uncertain about policy prospects, even today. . A policy rule of the kind that we recommend would have had the Bank of Japan reacting aggressively with interest rate cutes once it became clear that inflation was going to undershoot the target level that might have been set. In addition, the sharp falls in stock and land prices would have led our hypothetical central bank to be even more aggressive than an inflation-targeting (deflation-avoiding) central bank.

5.3. Direct intervention in the stock market by the Hong Kong Monetary Authority.

Hong Kong's recent experience represents an unconventional policy response to sharp asset price swings. Since 1983, the Hong Kong dollar has been pegged to the US currency, leaving money growth and interest rates to be determined mainly by market forces. The Hong Kong Monetary Authority operates in a manner similar to a classic

[51] Real annual output growth averaged less than 1 percent from 1992 through 1995.

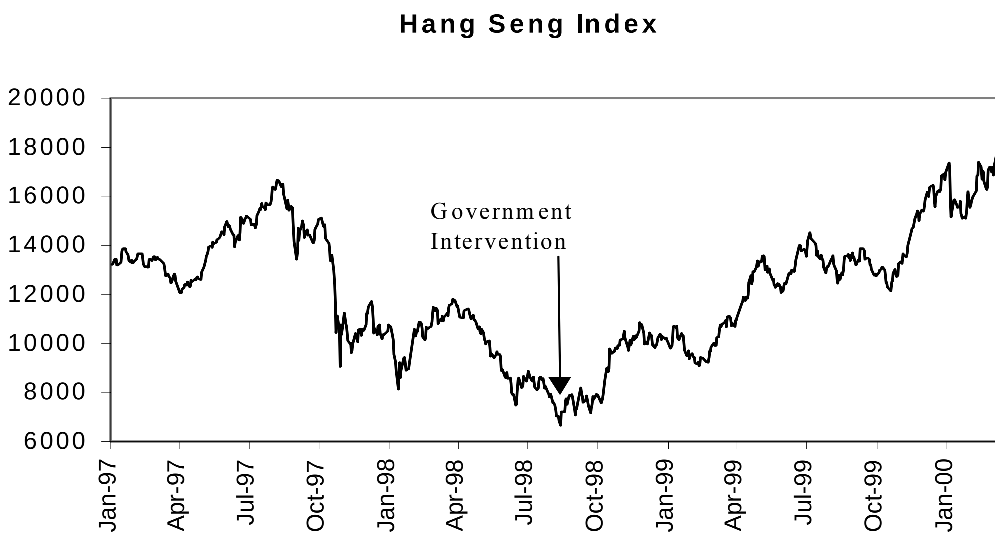
currency board. Consequently, typical discretionary policy shifts are unavailable to respond to asset price shifts, even if they had been desired.

The spiraling 1997-98 Asian crisis severely dented Hong Kong's economy and financial markets. This was hardly surprising, considering that the currencies of several of Hong Kong's principal Asian trading partners fell precipitously versus the U.S. dollar, while their economies dropped into deep recessions. Moreover, valuations in Hong Kong's stock and property markets had become stretched by the rapid rises experienced in the few preceding years.

With regional financial and economic turbulence mounting in the early months of 1998, international financial market participants increasingly wondered whether the Hong Kong authorities might abandon their currency's fixed peg to the US dollar. One casualty of this growing uncertainty – and of the emerging recession -- was Hong Kong's equity market. By August 1998, the bellwether Hang Seng index had dropped nearly to 6,600, down from the record high of 16,673 reached in August 1997. (See Figure 5.4) The Hong Kong authorities became convinced that their currency had become the target of a concerted speculative attack. This attack, ascribed by the authorities to non-resident hedge funds, consisted in their view of simultaneously shorting Hang Seng futures, and the Hong Kong dollar. The result was upward pressure on Hong Kong interest rates, and downward pressure on domestic equity prices.

In order to counter this attack, the Hong Kong authorities unexpectedly intervened directly in the local equity market, beginning on August 14. Over several days, the HKMA (Hong Kong Monetary Authority) used HK$118 billion (US$15 billion) to directly purchase the 33 constituent stocks of the Hang Seng Index. Management of the portfolio was assigned to the newly created Exchange Fund Investment Limited (EFIL).

Figure 5.4: Evolution of the Hang Seng Index before and after the intervention by the Hong Kong Monetary Authority.



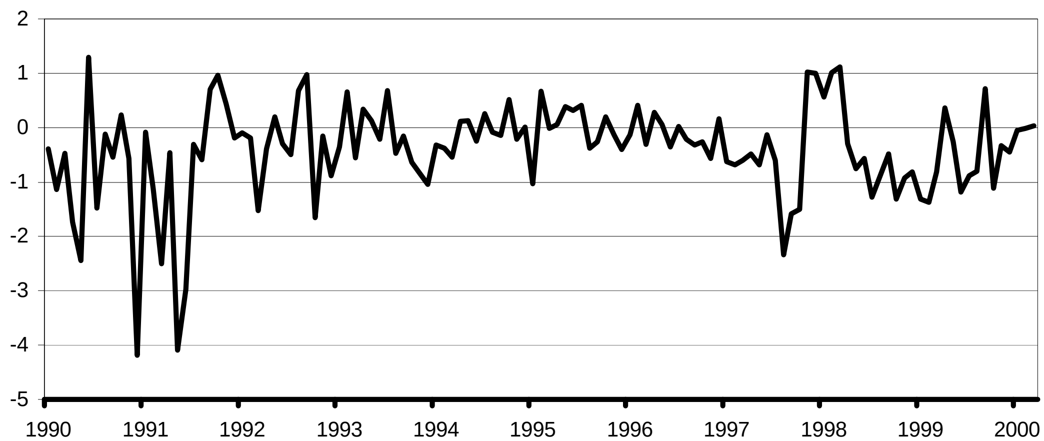
These purchases represented about 18% of total official foreign exchange reserves, or 42% of the excess foreign exchange reserves.

This effort helped to stem the drop in the Hang Seng index (Figure 5.4), but left the Exchange Fund owning about 5% of the market capitalization of the Hong Kong stock market. Although the Hong Kong authorities were criticized widely at the time for having breached their laissez-faire principles, pressure on the Hong Kong currency subsided, as reflected in the subsequent narrowing of the US/Hong Kong short-term interest rate differential (Figure 5.5). In addition to the HKMA's stock purchases, the Hong Kong market ironically seemed to benefit from the emerging Russian crisis: The evident distress at that time of several prominent hedge funds created the impression that the speculative attacks would be subsiding. Moreover, the HKMA moved in September 1998 to limit interest rate movements by improving its liquidity management system.

The 92% rebound in the Hang Seng index over the following year rewarded the Hong Kong authorities with handsome capital gains on their equity holdings. However, the problem remained of disposing of these holdings without producing unwanted volatility in Hong Kong's equity market. In June 1999, the EFIL announced the sale to the public of a unit trust product designed to track the Hang Seng index. The ultimate goal was to reduce the Exchange Fund's domestic stock holdings to 5% of the Fund's total assets.

To reach this goal, the authorities decided that the Exchange Fund's share holdings were to be sold to the especially-created Tracker Fund of Hong Kong (TraHK) through an Initial Offer, followed by a series of "Tap" facilities. The Initial Offer in November 1999 was substantially over-subscribed, and the size was increased to HK$33.7 billion. By end-December 1999, the equity portfolio of the Exchange Fund was valued at HK$219 billion, roughly twice its value at the time of acquisition. Thus, an additional disposal of equities with a market value of about HK$150 billion will be required to reach the 5%

Figure 5.5: US-Hong Kong short term interest differential



maximum goal. This is to be accomplished through future recourse to the Tap Facility mechanism and various other options still under consideration.

The dramatic events in the Hong Kong equity market were mirrored in other asset markets. In particular. real estate values in Hong Kong also dropped during 1998. By some estimates, average housing prices plunged by 51% by October 1998 from the peak a year earlier. The HKMA didn't intervene directly in the market, as was the case of the equity market. However, the authorities halted temporarily the release of public land for sale to private investors. The Hong Kong government owns most of the undeveloped land in the Special Administrative Region, and by controlling the release of land for new private development, the authorities can influence property values to some degree. Public land sales subsequently resumed in April 1999. By January 2000, housing prices were about 11% higher from the trough.

Several obvious questions are raised by these unique events. For example, can it be concluded with confidence that the HKMA's action was either a necessary or sufficient condition for the equity market's recovery, and the coincident easing of pressures on US/HK interest rate differentials? Given the dramatic external developments that immediately followed the HKMA's action, and the unexpectedly rapid 1999 improvement in Asian economies and markets, it is hard to conclude confidently whether the HKMA's action was independently successful or not. Was the size of the HKMA's excess reserves (some $X billion dollars, or y% of Hong Kong's 1998 GDP) an important factor underlying the interventions apparent success? The correct answer is not obvious.

While this study is focused on central bank responses to asset price shifts, the principal intent of the Hong Kong authorities was to use their equity market intervention to signal the seriousness with which their currency peg would be defended, rather than to prop up the equity market. The implied message was that the HKMA was willing to sacrifice their often-stated laissez-faire principals if that were necessary, in order to preserve the stability of their currency. Thus, the size of the intervention itself may have been less powerful than the mere act of intervening openly.[52]

Thus, while the HKMA's equity market intervention succeeded on its own terms -- in the sense that the US dollar peg was preserved -- it is hard to judge in a broader context whether the effort should be viewed as a success, even in hindsight. After all, the Hong Kong economy has not yet regained 1997 output levels, and the overall price level continued to fall in 1999. The brevity and uniqueness of this episode suggest that interpretations should remain cautious. It is hard to imagine that it offers much reliable guidance to central banks in large countries. In fact, if is far from certain how investors would react to similar moves if Hong Kong's currency peg once again comes under substantial market pressure.

5.4. Perceptions of Market Participants.

In his recent book *Irrational Exuberance*, Robert Shiller reports results of a number of surveys that he has carried out over the years concerning investor attitudes in the United States. One of these relate to their current high confidence in an almost continuously rising market. Not only do a majority of the investors in Shiller's sample believe that

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[52] An alternative — and not mutually exclusive — interpretation of these events is that market intervention is more effective the weaker are the potential substitution effects between the intervened market, and those of other markets. In this case, the Hong Kong experience is potentially interesting, in that it suggests that

stocks are the best investment in the long term, they also respond that they would expect the market to recuperate relatively rapidly after a correction.[53] According to the survey answers, the belief that the market would rebound after a fall has increased during the past ten years.

Shiller provides a very interesting behavioural explanation of the spectacular current confidence of investors, and he is surely right to a large extent. But another hypothesis would also be interesting to explore, namely that the confidence in an ever increasing stock market is due to the belief that monetary policy will be used to support the market, and that corrections will elicit reductions in interest rates until the market turns around. In this case the enthusiasm for stocks and the historically low implied risk premia would be a reflection of investors view that the FED would come to the rescue, if prices of equities would show sign of sufficient weakness.

In order to investigate this hypothesis, we conducted a small survey of some twenty major fund managers and chief economists in London and New York. We asked:

Q1. *Do you believe that the US Federal Reserve*

(a) reacts more to a rise in share prices than to a fall? ....

(b) reacts more to a fall in share prices than to a rise? ....

(c) reacts symmetrically to a rise or fall in share prices? ....

(d) don't know ....

Q2. *Do you believe that US stock prices are higher than they would otherwise be because at least some market participants believe that the Fed would cut interest rates if the stock market fell by more than 25%?*

(a) Yes ....

(b) No ....

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even sterilized intervention in foreign exchange markets could be effective, provided that the assets used are sufficiently imperfect substitutes for foreign assets.

[53] See pages 45 ff.

Although only fifty percent of the questionnaires have (so far) been returned, the results are quite clear. All respondents believe that the Fed reacts more to a fall than to a rise, and all except two believe that this type of reaction is in part responsible for the high valuations on the US market.

We also wanted to determine whether professional investors believe that the Monetary Policy Committee of the Bank of England pay particular attention to asset prices in their analysis by asking:

Q3. The Bank of England act prescribes the primary and over-riding target to be inflation.

i. Is it your belief that the MPC has an implicit exchange rate target, which receives some additional weight over and above any indirect effect of the exchange rate on future inflation?

(a) yes ....

(b) no ....

ii. Is it your belief that the MPC has an implicit desired maximum rate of house price appreciation, which receives some weight over and above any indirect effect of house prices on future inflation?

(a) yes............

(b) no ....

Here again the answers were unequivocal; all but two respondents answered 'No' to both questions.

We do not claim that these survey results are representative of the entire universe of investors, but the uniformity of the answers are intriguing. Clearly more research needs to be done to determine whether the current exuberance is in fact due to the (irrational or otherwise) belief among investors that the Fed will come to the rescue if the market turns sour.

Part 2. Inflation Measurement and Inflation Forecasts.

6. Asset Prices and Inflation Measurement.

In order to formulate a monetary policy a central bank must adopt a yardstick by which to measure its objective: inflation. Usually this standard is based on a measure of prices at the retail level such as the standard consumer price index (CPI). The rationale for using this index is that it reflects the monetary cost of a household's current expenditures, and is therefore intimately linked with the real economic welfare of its members. In some cases, however, central banks have chosen to modify this index by excluding certain items such as indirect taxes or energy prices that are thought to be influenced mainly by transitory factors unrelated to monetary conditions. The intention is to find an measure that best reflects pure, or 'core', inflation that is determined primarily by central bank policy.

In this chapter we examine two arguments that have been put forth to suggest that conventional CPIs may not be an adequate guide for monetary policy. Alternative measures, with a more prominent role for asset prices, have been proposed as the more appropriate. In section 6.1 we examine the implications of an influential argument according to which prices of <u>future</u> consumption, as well as prices of <u>current</u> consumption, should be included in a proper price index. We conclude that, irrespective of the theoretical merits of this argument, the practical difficulties associated with its implementation are so great as to render it virtually useless.

In section 6.2 we propose an alternative method for calculating inflation that is based on a statistical criterion designed to discover the core rate of inflation in the economy. An illustrative empirical implementation leads us to the conclusion than housing inflation should be given an larger weight in a measure of core inflation that it is given in conventional CPIs. Equity prices, on the other hand, do not play a significant role in our preferred index.

6.1. Alchian and Klein

In 1973 Armen Alchian and Benjamin Klein published a paper entitled "On A Correct Measurement of Inflation" where they argue that monetary policy should be concerned with broader measures of prices than those constructed from the income and product account deflators or standard expenditure weighted consumer price indices. They contend that, in order to measure inflation properly, policy makers should take account of asset-price movements as well changes in the prices of current consumption goods.[54]

What is the Alchian and Klein argument, and should we be concerned with asset-price changes when we are measuring inflation? Alchian and Klein propose that we focus on measuring the purchasing power of money generally, rather than on prices of current consumption specifically. Instead of looking at the cost of a particular (carefully designed) basket of goods and services meant to measure current consumption, as is typically done by consumer price indices, they suggest focusing on the price of lifetime consumption. To be clear, recall that both consumer price indices and consumption expenditure deflators are designed to measure the change in the price of consumption at a point in time. Alchian and Klein suggest that we measure the change in the cost of purchasing a lifetime stream of consumption, all measured in current prices.[55]

Over the past decade or so, both academic and central bank economists have examined Alchian and Klein's argument. Robert Pollack (1989) provides the theoretical basis for the claim that asset prices can be used to help measure inflation; while Shibuya (1992), Wynne (1994), Shiratsuka (1999), Flemming (1999) and Goodhart and Hofmann (2000) provide empirical work on the subject. Both Pollack and Shibuya demonstrate how, under straightforward circumstances, the current prices of existing assets, which are

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[54] Note that while Alchian and Klein argue that monetary policy should be conducted so as to stabilise their preferred measure of prices, they do not base their analysis on an explicit argument about the costs of inflation. Yet one might conjecture that the sources of these costs would be important for the choice of which inflation rate to stabilise. Following the existing literature, however, we do not pursue this line of reasoning further in this report.

[55] Charles Goodhart (1999) has become the most prominent advocate of the view that asset prices should be an important element in inflation measures that are relevant for monetary policy.

claims on future consumption, can be used in place of a direct measure of the prices of future goods and services. This leads to the concept of an intertemporal cost-of-living index (ICOLI), which measures the cost of claims, at current prices, to a consumption basket that yields a fixed level of lifetime utility.

The existing empirical work on the Alchian-Klein argument is of two types. Shibuya, Wynne and Shiratsuka seek to operationalise the ICOLI, while Goodhart and Hofmann ask whether the current price of assets, such as equities and housing, can help forecast future inflation, as measured by conventional indices.

In his implementation, Shibuya notes that construction of an ICOLI will necessarily put the bulk of the weight in the price index on future consumption, and thus on asset prices. The reason for this is very straightforward. The intertemporal index is constructed from the present value of the sum of future consumption. Ignoring changes in consumption over time, and assuming that the rate of time discount is about 3%, current consumption is only one part in about 33, and so the weight on asset prices (claims to future consumption) will be 97%, while that on current consumption prices will be 3%.[56]

In Shiratsuka's application to the case of Japan, the weight of 97% on asset prices implies that there was both much higher inflation in Japan in the 1980s, and much worse deflation in the 1990s, than the standard measures of consumer prices suggested --- implicitly suggesting that monetary policy was initially too expansionary, and later too contractionary. But the high weight accorded the price of future consumption, and the implicit policy prescription, results in the recommendation that policy makers target asset prices. Such advice suffers from a number of difficulties, the primary one of which is that asset prices move for a number of reasons, including changes in expected future real growth and attitudes toward risk.[57] If, for example, equity prices rise as a consequence of an increase in the sustained growth rate of the economy, targeting an index such as Shiratsuka’s that is largely based on nominal equity prices, would result in contractionary

[56]The rule-of-thumb for such a calculation is that the weight on the index of current consumption prices will be approximately equal to the rate of time discount.
[57] See Chapter 3 and the discussion of equity valuations.

policy following the asset price run up. The likely result would be deflation and an unnecessary recession.

John Flemming (1999) provides another proposal for how one might implement the Alchian and Klein recommendations. He notes that a 10 to 15% (or more) of compensation in the U.K. is devoted to the financing of pensions,[58] and that changes in the real interest rate have a direct impact on the purchasing power of household income, when one includes both current consumption and expected future consumption. A fall in the real interest rate, for example, will lead individuals to increase current saving in order to insure a given level of welfare over their lifetimes.[59] Flemming recommends the inclusion of the nominal price on a 20-year indexed zero-coupon bond in the computation of current inflation, and proposes that it be given a weight between 1/5 and 1/3.

Many central bank economists dislike the idea of integrating asset prices into measures of inflation.[60] John Vickers (1999) of the Bank of England believes that monetary policy should only be concerned with the money price of current consumption and goes on to suggest two arguments. First, he states that he believes that price stability "should mean stability over time of the money price of current consumption, and *not* the money price of current-and-future consumption. (p. 4)" (The emphasis is his.)

Second, Vickers notes that we have enough problems in trying to measure the current price of achieving a particular level of utility or welfare, let alone the price of a particular level of lifetime utility, measured at today's prices. And so, for both theoretical and practical reasons, he concludes that we should stick with what we are currently doing. We take up this argument in more detail in our brief empirical implementation below.

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[58] In the U.S. it would be hard to get to a number that large. Total private and government pension contributions, including tax-deferred individual retirement accounts and annuities, account for at most 5% of compensation. Social Security, which is really just a tax and transfer system, accounts for another 5%.
[59] Any change in real interest rates will have both an income and a substitution effect. Flemming implicitly assumes that the income effect dominates, which is only true for certain types of consumer preferences.
[60] As Charles Goodhart (1999) points out, in believing that asset prices should play a role in monetary policy, he is "in a minority amongst both economists and on the MPC. (p. 6)"

There is a notion pervading much of the discussion of the inclusion asset prices in measures of inflation, and it concerns that idea that asset-price movements give information about *future* inflation. The claim is that an asset price will increase in anticipation of future goods price increases. If this occurs while current goods prices are stable, then a central bank that only targets current consumption flow prices will fail to respond adequately to stabilise future goods prices. This is the argument that has led both Shiratsuka and Goodhart and Hofmann to focus attention on the ability of current prices of assets, including residential property and share prices, to forecast movements in conventionally measured consumer price inflation several years ahead. It is our view that this is a purely empirical issue. Anything that can profitably be used to improve inflation forecasts should be. Does inclusion of information about asset prices help reduce inflation forecast errors? This issue is discussed in section 7.2.

However, note that if the underlying justification for inclusion of asset prices in the measure of inflation is that they help to predict future inflation, then it is far from obvious that they should attract a weight based on the discount rate as the Alchian-Klein logic implies. Instead, the weight should be more closely related to their relative contribution to an inflation forecast or, as we propose in the next section, the information they carry about core inflation in the economy.

6.2. An alternative measure of inflation incorporating asset prices.

Returning to the issue of how we might employ asset prices in the measurement of *current* inflation and the purchasing power of money, consider the simplest possible case of what we will call *pure* inflation. Pure inflation is the case in which there are no relative price changes --- it is as if we were to wake up one morning and suddenly all nominal quantities have been multiplied by some factor. If all prices change proportionally, then measurement of inflation is trivial, as we can look at any individual price and it is a perfect indicator of what happened to all prices. That is to say we could compute the amount of inflation by looking at the price of houses, equities, restaurant meals or chewing gum. It just would not matter. In fact, measuring the change in the purchasing power would simply require that we measure the change in a single price.

Unfortunately, real life is not quite so simple, and inflation tends to come with relative price changes as well. These changes in the nominal price of one product relative to another are caused either by changes in technology or in tastes, and they are entirely real. In measuring inflation, the goal is to get rid of the relative price changes by finding a set of prices in which they cancel out.

We can appeal to earlier work of Bryan and Cecchetti (1993) and Cecchetti (1997) for a simple framework to understand the problem. Using their intuition, we can think of the current change in the price of each goods, service and asset as having a common component reflecting 'pure' inflation and an idiosyncratic component reflecting a change in relative prices. Our task is to find an index of overall inflation that reflects as much as possible the common trend in all prices and as little as possible the idiosyncratic behaviour of each individual good, service and asset. As usual, the index will be a weighted average of all price changes in the economy, but the weights will be chosen so that the relative changes cancel out.

But once we formulate the problem in this way, we can see that the issue of including or excluding any given price is an empirical one, having to do with how much information it carries about the common trend. If, for example, we knew that the price of a particular variety of shoes never experienced any relative price changes, then we could save government statistical agencies quite a bit of money. We would simply use this price as the measure of overall inflation. Alternatively, if there were only two goods in the economy, and they experienced substantial relative price shocks, then focusing attention on one price alone, rather than a properly constructed average, would be very misleading.

To implement the suggestion of Bryan and Cecchetti we must compute the relative weights to put on the different prices that we observe. For the purpose of this report we are interested in finding out whether the inclusion of asset prices in the set of prices that is used adds any information to our estimate of the common trend? To address this question directly, we implement a static version of what Bryan and Cecchetti refer to as their 'dynamic factor index' (DFI). That is, we ignore the time-series properties of the data, and simply ask about the quality of the price signal that arises from various price data, including asset prices. Wynne (2000) argues that in this case the weight attached to each component of the inflation index should be inversely proportional to the volatility of the price change of that component. (See the appendix at the end of the chapter for a formal description.) The intuitive reason is simple. A price that change very erratically from month to month is likely to be influenced mostly by idiosyncratic factors, and will carry relatively little information about the common price trend in all prices. It will therefore receive a small weight in an index that is meant to reflect this common trend. On the other hand, a price that evolves relatively smoothly will receive a larger weight because it contains more information about the pure or 'core' inflation that we want to measure.

6.2.1. Calculating core inflation in twelve countries.

To investigate whether asset prices belong in an index based on these ideas, we use the set of quarterly data for 12 countries assembled by Goodhart and Hofmann (2000).[61] These data allow us to calculate the weights of housing prices and equities in a measure of core inflation for each of the twelve countries in the sample. The results, presented in Chart 6.1, are what we would expect.[62] Since stock prices are so much more volatile that consumer prices, their implied weight is very low, never exceeding 2.5%, and usually below 2%. Housing is quite a different story, however, because in this case prices are less volatile and therefore carry more information about core inflation.[63]

Figures 6.1-6.3 illustrate the differences between the CPI and the measure of core inflation using the weights we have estimated for three of the countries in the sample.[64] Although the two indices follow each other quite closely most of the time (partly as a consequence of the dominating weight of the CPI in the core inflation index), there are

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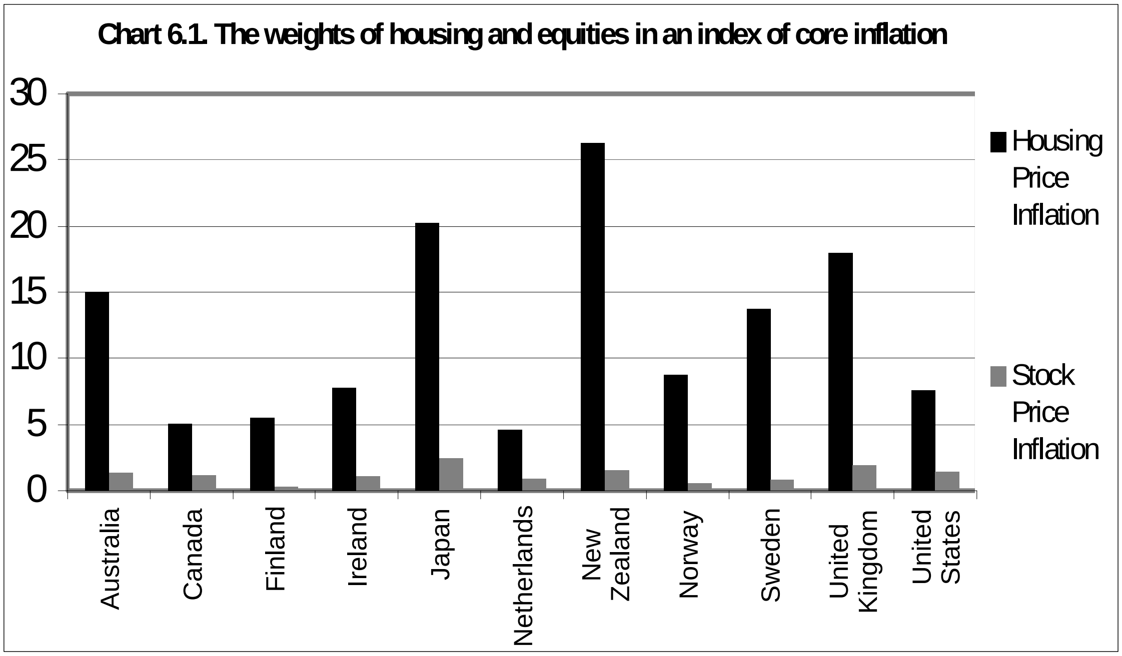
[61] We thank Boris Hofmann for sharing the data with us.
[62] The chart only gives the weights attached to housing and equities. The remainder is that of the CPI itself. See Table A6.1 in the appendix for the detailed results.
[63] Much of the discussion surrounding the inclusion of asset prices in inflation indices does concern itself with the manner in which housing is treated. Beginning in 1981, the U.S. consumer price index has treated housing purely as a service flow. For the purposes of inflation measurement, owner-occupied housing prices are imputed as a rental-equivalence measure. In most countries, rental markets are very thin, and so such a methodology would be impractical.



periods of significant differences. In particular, the UK housing price inflation in 1987-90 that we discussed in Chapter 2, and the asset price inflation associated with the Japanese bubble economy in 1987-88 (section 2 of chapter 5) show up clearly as relatively large discrepancies. Similarly, the housing and equity boom Sweden in the late 1980s that followed a period of financial liberalization, rapid growth of credit, and substantial increases in real estate and stock prices is visible more rapidly in the measure of core inflation than in the conventional CPI. One can only speculate about whether central bank policy would have been more appropriate in these episodes, if it had been geared towards stabilising our measure of core inflation.

6.2.2. A further investigation with United States data.

To examine the role of asset prices a bit further, we have collected a more comprehensive monthly data set for the United States, with a sample from the beginning of 1967 through 1999. Here we are able to assemble data for energy prices, food prices, housing purchase prices, housing rental and operating costs (labeled "CPI Shelter"), stock prices, and a

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[64] The inflation rates in the figures represent yearly averages.

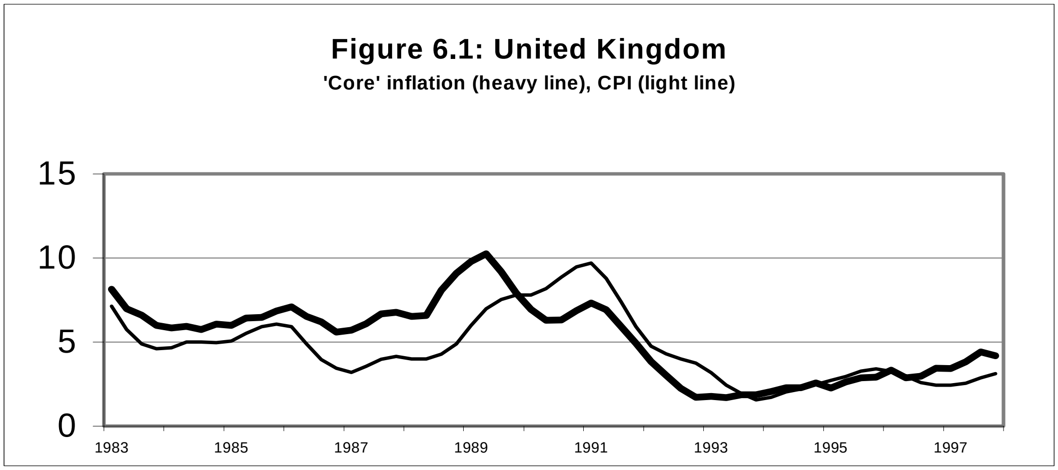


Figure 6.1: United Kingdom
'Core' inflation (heavy line), CPI (light line)
15
10
5
0
1983
1985
1987
1989
1991
1993
1995
1997

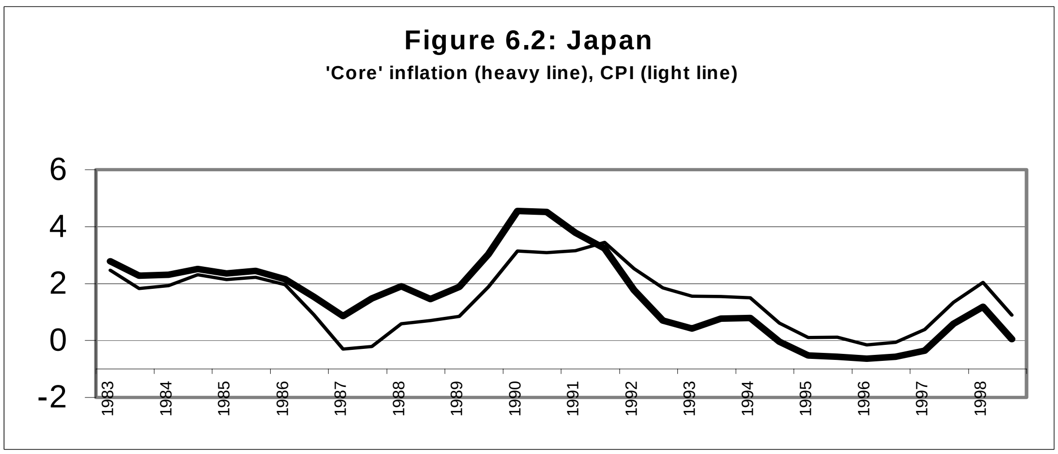


Figure 6.2: Japan
'Core' inflation (heavy line), CPI (light line)
6
4
2
0
-2
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998

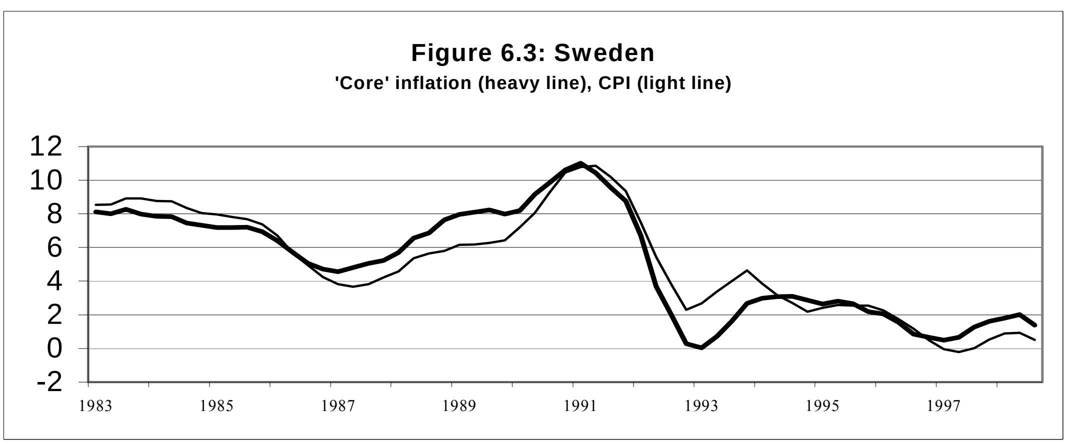
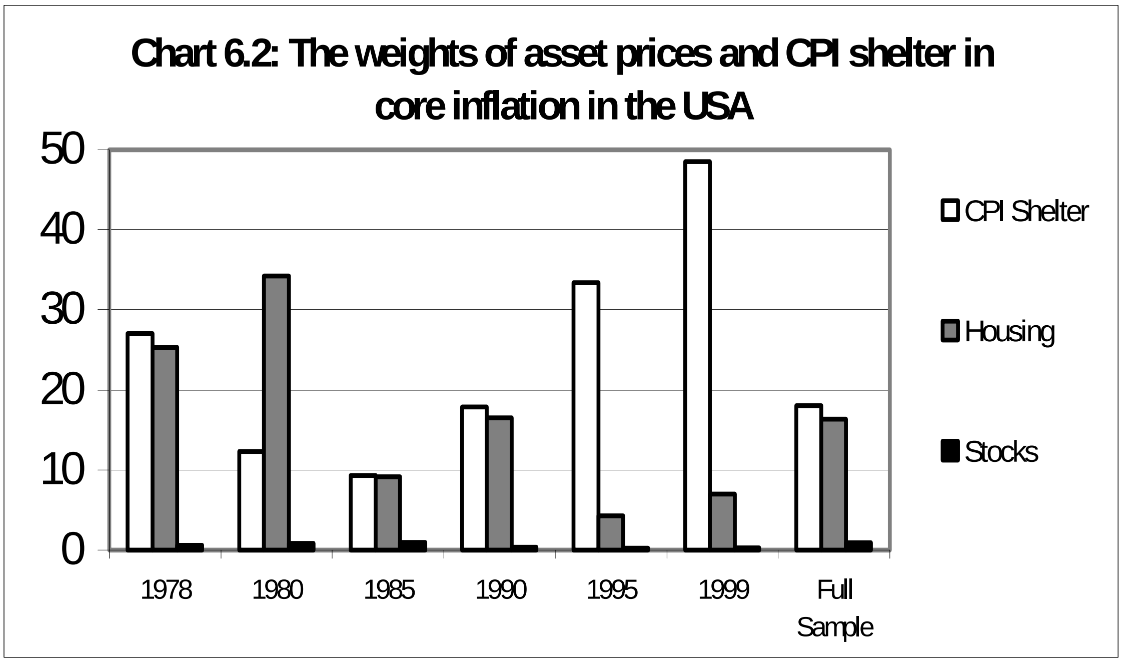


Figure 6.3: Sweden
'Core' inflation (heavy line), CPI (light line)
12
10
8
6
4
2
0
-2
1983
1985
1987
1989
1991
1993
1995
1997

residual category of the consumer price index that excludes food, energy and shelter. We look at the inflation rate over 12-month periods, and examine the consequences of computing variances of rolling ten-year periods. The results are summarised in Chart 6.2 (Table A6.2 in the appendix contain the details) , and suggest that stock prices are much too volatile to be useful in computing a price index, but that the treatment of housing is crucial.



Interestingly, the combined weight on changes in the shelter component of the CPI, which represents primarily rent, and inflation in the sale price of existing houses, has a broad range. The implied variance weight for the decade ending in 1985 was below 20%, while in the decade of the 1990s it is in excess of 55%.

Does it make much difference that we have included housing and equities in this way? Or, could we have done just as well using alternative measures of core inflation? To answer these questions, we look at the correlation of the variance-weighted inflation index with the headline CPI, the CPI excluding food and energy (the traditional core measure), and the Federal Reserve Bank of Cleveland's Median CPI. The results are reported in the three columns on the right-hand side of Table A6.2 in the appendix. Clearly, these series are all very highly correlated with the new series. But the Median CPI is the most reliable, as its correlation is around 0.95 and higher, regardless of the sample period.

The implication is that on average, the price indices currently available in the United States are adequate. There is, however, a caution. In the past few years, the price of existing houses has been rising at a rate well in excess of the housing component of the consumer price index. The explanation for this is that, in measuring the rental-equivalence of owner-occupied housing, the U.S. Bureau of Labor Statistics now uses a sample based on rental units alone. But the price of rentals depends largely on the rental vacancy rate, which has been rising as people increasingly buying new homes. While this suggests that the CPI is temporarily understating inflation, as the value of rental properties rise much less rapidly than the price of owner occupied housing, the implication for the overall index is fairly clear. This will have to reverse itself eventually, as the rental and owned housing markets come back into equilibrium. But the process of people selling relatively expense houses, and moving into cheaper apartments is likely to be slow. In the meantime, the CPI may understate inflation.

6.2.3. Conclusion.

The upshot of this exploratory exercise is that straightforward attempts to include asset prices in measures of inflation need to proceed with care. While there may be justification for including equity prices, their inclusion is likely to create more problems than they solve. Specifically, the extremely high variance of stock returns (hundreds of times that of conventional inflation measures) may simply add noise. Housing, though, needs to be considered very carefully. Here, we believe that there is clear room for improvement of price indices.

Appendix 6.1: The Bryan-Cecchetti Dynamic Factor Index.

Think of the change in the price of each goods, service and asset today as having a common (B_t) and an idiosyncratic component (x_{it}). We can write this as

(6.1) $$\Pi_{it} = \Pi_t + x_{it} ,$$

where *i* indexes the set of goods, services or assets, and *t* is time. Importantly, the common and idiosyncratic elements are assumed to be uncorrelated at all leads and lags) and the idiosyncratic part has zero mean for all elements.

An inflation index, I_t, can be obtained by weighting together these individual inflation measures. If we have a set of weights, this would be:

(6.2) $$I_t = \sum_i w_{it}\Pi_{it} ,$$

where the weights are w_{it} and can change over time, but have the property that at any given time they sum to one. That is

(6.3) $$\sum_i w_{it} = 1$$

Using this fact, we can now rewrite the inflation index I_t as

(6.4) $$I_t = \Pi_t + \sum_i w_{it} x_{it}$$

Bryan and Cecchetti (1993) refer to the index Π_t as a dynamic factor index (DFI). It is derived from the joint statistical properties of a set of price series, rather than from consumer theory. The computation of a DFI involves the calculation of the relative weights to put on the different prices that we observe. Starting with a set that includes asset prices, we can ask whether their inclusion adds any information to our estimate of the common trend? To address this question directly, we implement a static version of the DFI. That is, we ignore the time-series properties of the data, and simply ask about the quality of the price signal that arises from various price data, including asset prices. Wynne (2000) describes the implementation of a simple variance-weighted price index where

(6.5) $$w_i = \frac{\frac{1}{\sigma_i^2}}{\sum_{i=1}^{N} \frac{1}{\sigma_i^2}}$$

for all of the series in the data where $\Phi^2{}_i$ is the variance of the rate of change in the price of good i.

A simple variance-weighting scheme of this type is a good indicator of the likely importance of a particular series in the construction of more complex (and difficult to compute) dynamic factor indices. To see why, note that the variance of the "common" element in any scheme, similar to that describe in equation (6.1) above, will have the property that the estimated inflation index will have variance equal to or less than the variance of the least volatile component used. As a result, the variance-weights derived from (6.5) will give a good indication of the likely importance of each series in constructing measures of core or trend inflation.

Table A6.1: Importance of Consumer, Housing and Stock Prices in Variance Weighted Price Indices, Various Countries

		Implied Variance Weight		
Country	**Sample Period**	**Consumer Price Inflation**	**Housing Price Inflation**	**Stock Price Inflation**
Australia	1960:2-1998:4	0.836	0.150	0.014
Canada	1980:2-1998:4	0.937	0.051	0.012
Finland	1978:2-1998:3	0.942	0.055	0.003
Ireland	1980:3-1998:4	0.911	0.078	0.011
Japan	1957:2-1998:3	0.774	0.202	0.024
Netherlands	1970:2-1998:4	0.946	0.046	0.009
New Zealand	1967:2-1998:3	0.722	0.263	0.016
Norway	1966:2-1998:4	0.907	0.088	0.006
Sweden	1976:3-1998:4	0.855	0.137	0.008
United Kingdom	1968:3-1998:1	0.801	0.180	0.019
United States	1963:2-1998:4	0.910	0.076	0.015

Source: The implied weight is computed as the inverse time-series variance, divided by the sum of all of the inverse variances, as in equation (5). Numbers may not add to one due to rounding.

7. Asset Prices and Inflation Forecasts.

7.1. The importance of inflation forecasts for monetary policy.

During the past ten years, a large number of countries have adopted price stability as the main objective of their monetary policy replacing other variables such as the money supply or the exchange rate. In a recent survey of 77 central banks from industrialized and developing countries a majority (44 countries) considered inflation targets as the Centrepiece of their monetary policy strategy in 1998 whereas only four did so in 1990.[65] This change in the main objective of monetary policy requires important adjustments in implementation. Whereas targets for the exchange rate or the (narrow) money supply can be reached almost continuously, the impact of changes in policy instruments on inflation is felt only after a substantial lag. Estimates vary, but it is generally recognised that it takes somewhere between eighteen to thirty months for a change in a policy-determined interest rate to have its major effect on the rate of inflation. As a consequence, central banks need to know not only how their own actions will affect inflation, but also what inflation is likely to be in the absence of any policy action, in other words they need reliable inflation forecasts.

As described for example in the Inflation Reports of the Bank of England or the Swedish Central Bank, the inflation targeting strategy is usually based on a forecast of inflation under the hypothesis that monetary policy (the short term interest rate) is unchanged. If this forecast is above the target for the inflation rate, a more restrictive policy stance will be called for and vice versa if the forecast is below the target rate.[66] Clearly, the success of this strategy will depend importantly on how good the inflation forecast is. It is in this context that asset prices might have a role to play as a useful source of information about future inflation. The literature contains a large body of work on asset prices as signals of future inflation and business cycle developments, and more recently the possibility of an inflationary wealth effect of asset price increases has generated considerable interest in

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[65] The survey was conducted by the Centre for Central Banking Studies at the Bank of England, and the results are presented in Fry, Julius, Mahadeva, Roger, and Sterne (1999).
[66] In view of this procedure, some prefer to give the label 'inflation-forecast targeting' to this policy strategy.

the United States. The next section looks at some of the recent evidence on these relationships.[67]

7.2. Some empirical evidence based on reduced form relationships.

A large amount of empirical evidence has been published in the past twenty years on the relationship between asset price movements and subsequent changes in inflation and real economic activity. Much of this work was motivated by the negative relationship between stock returns and inflation that had been documented by, *inter alia*, Fama and Schwert (1977) for the United States and by Gultekin (1983) for a larger sample of countries. In Fama (1981) the negative relationship was explained by the combination of a positive relationship between stock returns and real economic growth on the one hand, and a negative relationship between real growth and inflation on the other. Geske and Roll (1983) went a step further to argue that the negative relationship between real growth and inflation was due to a policy chain whereby a fall in economic growth would lead to a budget deficit which in turn would be financed by an inflationary monetary policy. These explanations suggest that the reduced-form relationship between asset prices and inflation might depend on the institutional and policy environment, and could therefore be unstable, both over time and across countries.

Another strand of literature has examined the information content of interest rates, both the level and the long/short spread, with respect to future inflation.[68] Generally speaking, the results show that the yield curve does contain information about future inflation in the United States, whereas the evidence is mixed when other countries are studied. Again, the explanation for this difference across countries might be that the changes in the institutional and policy environment can affect the reduced-form correlation between the variables.

A recent compendium of studies published by the Bank for International Settlements (BIS (1988)) confirms the variety of results that emerge when experiences from a number of

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[67] The May 2000 issue of the IMF's *World Economic Outlook* contains an informative chapter on related issues.

countries are compared. The compendium contains contributions from fourteen central banks, and although the studies do not all use the same methodology and indicators for asset price movements, the overall picture that emerges is quite revealing, especially since it presumably reflects the prevailing view in central banks about how asset prices can be used in design of monetary policy. In some countries, e.g. Canada and Germany, yield spreads do seem to have predictive power for future inflation, but in others such as Austria and Switzerland, they do not. In Spain the out-of-sample explanatory power of financial variables vanishes when past values of inflation and output are used as in the forecasting equation, and in Italy changes in the monetary policy regime has resulted in severe instability in the relationship between asset returns and inflation.

Goodhart and Hofmann (2000) estimate equations for CPI inflation for twelve countries with the goal of ascertaining whether asset prices have significant explanatory power once the effects of the usual candidates for explaining inflation have been accounted for. The 'usual candidates' the authors include are lagged values of inflation, as well as lagged values of output growth, money growth, the exchange rate changes, and the interest rate. The asset prices included changes in housing and equity prices and the yield spread. Rather than describing the details of the many regression results obtained by the authors, we quote two of their conclusions:

"The three explanatory variables that appeared in these results much stronger (than we had earlier anticipated), especially at the two-year horizon, are the change in monetary-type variables, the rate of growth of broad money itself, current and past short-term interest rates, and, especially current and prior house price inflation. What is perhaps something of a relief at a time when equity prices have reached such high levels, is that such movements appear to be a relatively limited predictor of future inflation (as also does the yield spread)." (page 16)

"At the beginning of this paper we noted that most economists would agree that movements in asset prices should be taken into account by monetary authorities insofar

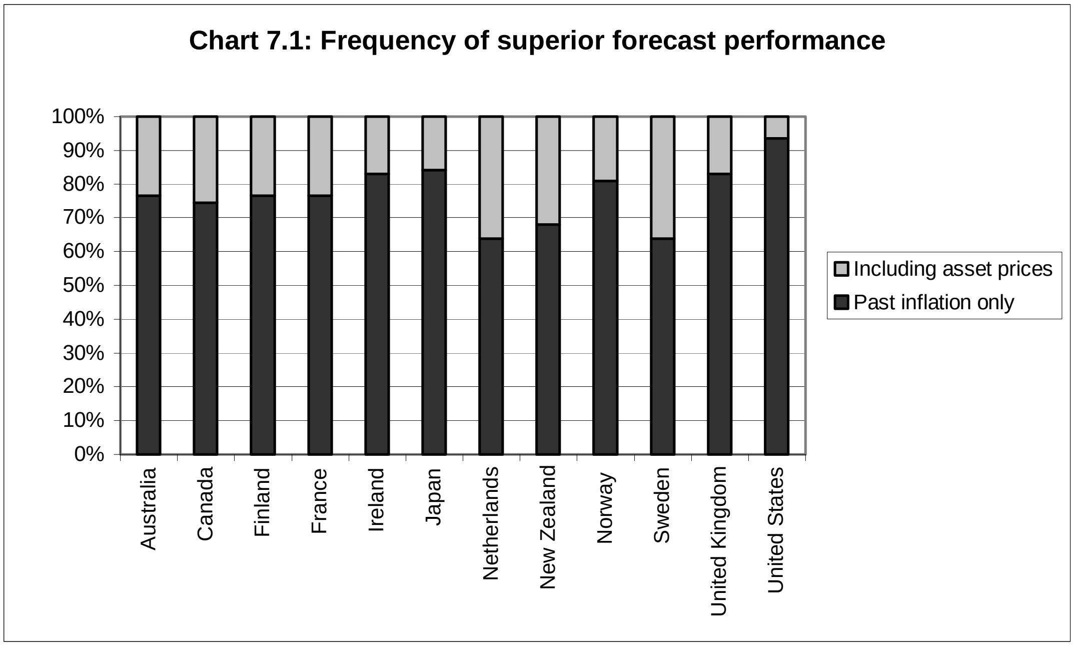
[68] See, for example, Fama (1990), Gerlach (1995), and Jorion and Mishkin (1991).

as they signal changes in expected inflation. .... We claim that such asset price, especially house prices, do help in the majority of cases in the context of our data set to assess (predict) future CPI inflation." (page 17.)

Goodhart and Hofmann base their conclusions on the statistical significance of the regression coefficients estimated over the their entire sample period. In a real time forecasting context, a possibly more relevant criterion would be some measure of the relative out-of-sample forecasting performance of equations that do and do not include asset prices. Cecchetti, Chu, and Steindel (2000) perform such a test for the United States. They compare a simple autoregressive forecasting model for inflation with models where an 'indicator' variable is used in addition to the lagged inflation rate. As indicator variables the authors use financial asset variables, monetary variables and real activity variables.

The conclusions of the Cecchetti, Chu, and Steindel study are considerably less optimistic than those of Goodhart and Hofmann in the sense that "There is no single indicator in our simple statistical framework that clearly and consistently improves autoregressive projections." (p. 12) Apparently there is room for further empirical work to reconcile the message from the significant regression coefficients of Goodhart and Hofmann with the unimpressive out-of-sample forecast results of Cecchetti, Chu, and Steindel.

In a first attempt to apply the methodology of Cecchetti, Chu, and Steindel to a larger group of countries, we conducted out-of-sample forecast comparisons with the Goodhart-Hofmann data. Specifically, we started by estimating two types of inflation equations for each of the twelve countries in our sample; one in which only lagged inflation rates were used as explanatory variables, and one in which the other variables considered by Goodhart and Hofmann - notably housing and stock market prices - were also included. The initial estimation period was the first quarter of 1975 to the fourth quarter of 1984. Using the estimated relationships, we generated a two-year-ahead forecast with each of the two inflation equations, and these forecasts were compared with the actual inflation outcome. We then added one quarter to the data set, re-estimated the equations, calculated new two-year-ahead forecasts that were again compared to the subsequent outcomes.



Proceeding in this way until the end of the sample produced 52 forecast-error comparisons between the two models, allowing us to judge whether inflation forecasts that make use of asset prices produce smaller or larger errors on average than forecasts that rely only on past inflation itself.

The results presented in Chart 7.1 suggest two preliminary conclusions. First, although the model based purely on past inflation provides superior forecasts more frequently than the one that includes other variables as well, there are still many periods were the model including asset prices performs better. Secondly, it is evident that there are substantial differences between countries suggesting that the role of asset prices in the inflation process depends importantly on the country-specific contexts, a point that we had occasion to make already in the previous chapter.

7.3. Transmission mechanisms and expectations effects involving asset prices.

Differences between countries in responses of inflation and economic activity to asset price changes can, as already noted, be due to differences in structural characteristics and policy strategies. The link between a change in an asset price and economic activity is traditionally described in terms of wealth effects on household spending, the effect on corporate investment due to a change in the value of existing capital relative to its replacement cost (Tobin's q), and to a financial accelerator effect due to the impact on improvements in the balance sheets of households and enterprises on bank credit. It is easy to explain why the strength of each of these channels might be quite different from one country to another.

The wealth effect on consumption depends materially on the share of the asset in question in households' total assets. For example, there are substantial differences across countries in the ownership patterns of equity shares and residential dwellings. The dependence of corporate investment on share prices is likely to differ depending on the importance of bank versus equity financing of investment, a factor that in turn may depend on the structure of the banking system as well as on the degree of development of the national stock market. Likewise, the strength of the financial accelerator effect will depend on the nature of the bank-customer relationship in an economy, in particular on the importance and type of collateral in bank lending decisions.[69]

Finally, it is important to remember that asset prices depend to a crucial extent on expectations about the future in general, and about future economic policies in particular. Differences across countries in the information content of asset prices may therefore reflect differences in economic policies and differences in the way these policies react to asset prices, in particular the exchange rate.

To evaluate the importance of these structural differences one must have recourse to structural economic models. We have looked at simulations with three models of that type and report some results in the next section.

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[69] For a discussion and international comparison of the importance of the structure of the financial system and the composition of private sector's balance sheet for the impact of financial disturbances and monetary policy on economic activity see Dornbusch, Giavazzi, and Favero (1999).

7.4. Results Based on Structural Models.

Many central banks use formal structural macro-econometric models as an important input in helping prepare inflation forecasts. These models typically include asset prices, which can have an important effect on the inflation forecast and thereby, on interest rate policy. Here we illustrate how the size and timing of the effects of asset market disturbances may differ across countries by reporting results from simulations of models of the US and UK economies as well as one explicitly multi-country model.

7.4.1. Simulations on the FRB/US model.

As an illustration, consider the FRB/US model of the US economy, which is maintained at the Federal Reserve Board for use in policy analysis and forecasting. (See Reifschneider, Tetlow and Williams (1999) - RTW, hereafter - for a brief description of the model's properties). RTW showed the effect of a change in the equity risk premium, which they modeled as a movement in stock market wealth that is not explained by changes in interest rates and other "fundamentals".

Table 7.1 shows the impact of a permanent rise in the equity risk premium that is sufficient to bring about an initial 20 percent decline in stock market wealth. If, hypothetically, the Fed were to hold its Federal Funds rate constant, then this model implies a decline in inflation of 0.4 percentage points by Year 3, with the level of GDP being 1.2 percentage points lower.

Alternatively, if the Fed were assumed to be following a Taylor rule, whereby the Federal Funds rate is reduced in response to both a reduction in inflation and a fall in GDP, then the Fed would, according to this simulation, have to cut the Federal funds rate by around 40 basis points to offset the effect of the stock market wealth shock on inflation. By doing so it would also have limited quite substantially the drop in GDP.

Of course, all such simulations cannot and are not used mechanically, and are merely an aid to judgement. For example, Cecchetti (2000) argues that a fall in the US stock market might have a smaller effect on consumption than conventional econometric models imply because, in his judgement, consumers are wary of the levels of the market and have not,

Table 7.1: Simulated macroeconomic effects of a rise in the equity risk premium in the FRB/US model.

		Response at end of year		
		1	2	3
Constant FED Funds Rate	GDP (level)	-0.4	-0.9	-1.2
	Consumer Inflation	0	-0.2	-0.4
Taylor Rule	GDP (level)	-0.2	-0.3	-0.3
	Consumer Inflation	.0	.0	.0
	Nominal Federal Funds Rate	-0.3	-0.4	-0.4

Source: RTW (1999)

therefore, fully adjusted their level of consumption to their new-found wealth,[70] which is consistent with the fall in the consumption–wealth ratio in recent years.

7.4.2. Some simulations on Bank of England's Macroeconometric Model.

The core model used in the Monetary Policy Committee's (MPC, hereafter) forecasting process is the Bank's macro-econometric model (MM, hereafter), though it should be noted that other models are also useful in the forecast process (see Bank of England (1999) for a description of the Bank's suite of models).

As we have already emphasised in Chapter 2, the implications of a particular change in an asset price for inflation depends importantly on <u>why</u> an asset price changed. Therefore, in considering the potential inflationary impact of a particular change in asset prices, the MPC typically spends some time trying to understand why the relevant market price moved. That is why there can be no mechanical links from a model simulation to the MPC's forecast.

Nevertheless, it is sometime of interest to consider the potential effects of an exogenous change in an asset price (that is assumed to be unrelated to the fundamentals in the model). One might think of these asset price changes as being attributable to a change in the implicit risk premium, or as the bursting of a bubble.

Table 7.2: Simulated macroeconomic effect of changes in various asset prices in the MM/BoE model.

	Effect on			
Experiment	GDP (level)		RPIX inflation (percentage point)	
	Year 1	Year 2	Year 1	Year 2
A: 10% fall in exchange rate	0.7	1.2	1.1	1.4
B: 10% rise in UK equity prices	0.1	0.2	0	0.1
C: 10% rise in house prices	0.4	0.2	0.3	0.3

Source: BoE

Table 7.2 reports on some simulations carried out on the Bank of England's Macroeconometric Model of a 10% exogenous change in three different asset prices (one at a time) assuming that short-term interest rates are held constant. Other assumptions are also made in preparing these forecasts, notably that nominal government spending and the nominal exchange rate are constant.

[70] Of course, if the consumption function in the model contains an error correction term of the form (C/W), where C is consumption and W is wealth, then one might argue that it already incorporates his concerns.

Obviously these estimates should be viewed as purely illustrative as they assume that other things remain equal (they rarely do), and, like all point estimates, considerable uncertainty must reside around them.

Nevertheless, they suggest that changes in asset prices can have a significant impact on the inflation forecast – for example, if the exchange rate were to move exogenously by 10%, it would lead to an increase of around 1.4 percentage points on RPIX inflation, which is rather large in the context of an inflation target of 2.5%. It is also interesting to note that changes in housing prices have a much larger effect on inflation than corresponding changes in equity prices, a result that we have already noted in Chapter 6.

Comparing the responses in the UK with those reported in the Table 7.1 for the United States reveal that while the inflationary consequences of equity prices are similar in the two countries, GDP appears to be substantially more sensitive to such changes in the US.

7.4.3. A multi-country simulation.

The OECD recently carried out a simulation of a global stock market correction (US equity prices were assumed to fall by 30%, while prices elsewhere in the OECD area fell by 15%) in the context of their multi-country INTERLINK model. (See OECD Economic Outlook, December 1999).

Table 7.3 shows what, hypothetically, would happen to output in the case where there were no response from the monetary authorities. In the model, the effects on GDP are through wealth and confidence effects on consumption and investment behaviour.

Even allowing for the smaller underlying equity price shock in the Euro area, the effect on GDP is much smaller there than in the US (a cumulative effect on the level of GDP of 0.9 percentage points, as compared to 2.4 percentage points in the US). This might be because equities are a more significant fraction of household portfolios in the US as compared to the Euro area. By contrast, the cumulative effect on GDP in Japan and the US is broadly comparable (once one allows for the fact that Japanese equity prices were assumed to fall by less than in the US in this simulation).

Table 7.3: Effect on GDP Growth of a Stock Market Correction

	2000	2001	2002
United States	-0.8	-1.2	-0.4
Euro Area	-0.3	-0.5	-0.1
Japan	-0.7	-0.6	0

Source: OECD Economic Outlook, Dec. 1999

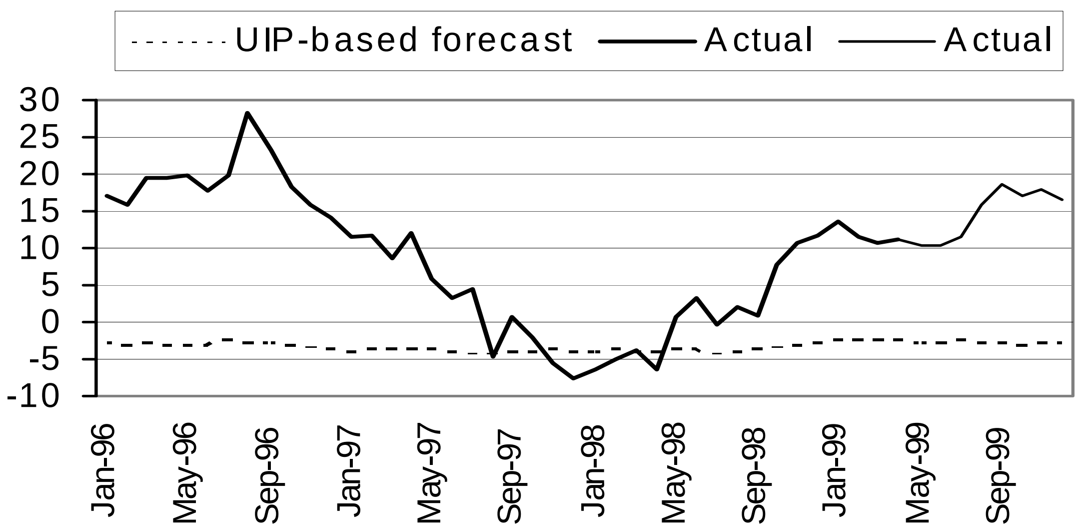
7.5. The Potential Importance of Forecasting Asset Prices.

It was noted above that asset price changes can have a significant effect on inflation forecasts. Hence, this would suggest that forecasting asset prices would be a rather important part of the toolkit for central bankers.

However, a number of central banks and international agencies typically 'forecast' asset prices on the basis simple conventions instead of econometric models. For example, at the Bank of England, the exchange rate has (until November 1999) been forecast using the assumption of the textbook uncovered interest parity hypothesis whereby the exchange rate is assumed to move in line with existing interest rate differentials. The BoE is by no means alone in adopting this forecasting convention – several other central banks, finance ministries and international organisations use the same assumption.

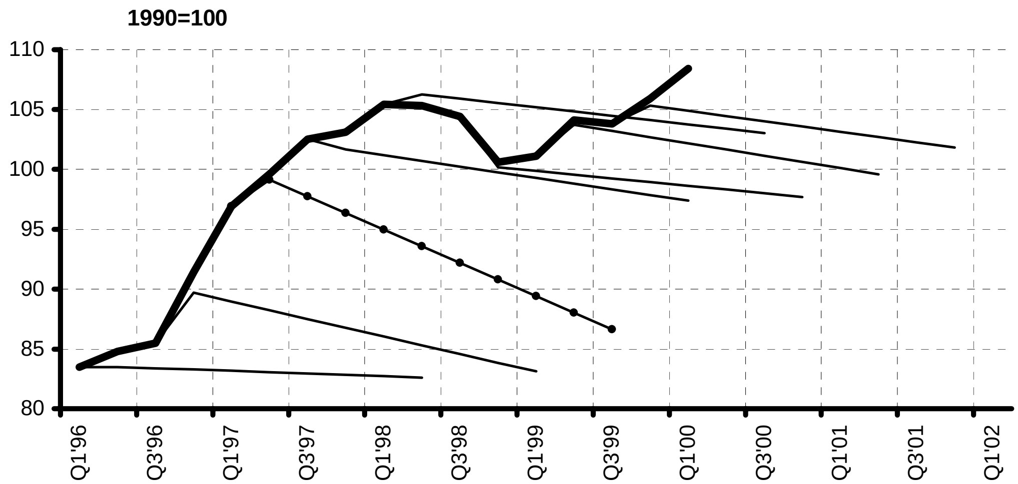
Yet it has been known for some time that uncovered interest parity performs poorly. For example, Froot and Thaler (1990) pointed out that a very large literature (some 75 studies) had found that it had been reliably rejected. More recently, the hypothesis has continued to work poorly for UK policymakers, e.g. Figure 7.1 reminds us that with UK short-term interest rates above those in Germany, a uncovered interest parity-based projection has, since 1996, always looked for sterling to fall against the DM. Yet, for much of this period, sterling has tended to rise (defined over 12-month horizons) over this period, and often by significant amounts (e.g. by over 25% in the 12 months to mid-1997). Note that during a period where the effective exchange rate has moved from around 83 during the first quarter of 1996, to about 109 in February 2000, at each stage during this near 30% appreciation of the currency, the BoE has tended to predict a depreciation (see Figure 7.2). A corollary of this exchange rate forecasting error is that, other things being equal, the BoE's inflation forecast has been persistently higher than it might have been under perfect foresight of the exchange rate and, therefore, there is a risk that interest rates have been set too high.

Figure 7.1 DEM/GBP – Forecasts and Actual Outturns



Note: Forecasts are based on the 12-month interest rate differential at time t. The actual outturn is equal to 100*ln(E(t+12)/E(t)) until April 1999. From May 1999 it is equal to the annualised realised change in E from month t until April 2000.

Figure 7.2: Inflation Report Effective Exchange Rate Index forecast relative to outturn.



Note: We have interpolated linearly between the starting point and the published two-year-ahead projections.

To get some crude indication of how much difference the exchange rate can make to the appropriate level of interest rates, recall (from Table 7.2) that a difference in the exchange rate level of 10% changes the forecast as much as 1.4 percentage points, and note also that the MPC has previously reported simulations (see MPC (1999)) suggesting that a temporary increase in the three month interest rate of 1 percentage point might, under certain assumptions, be associated with a fall in inflation of between 0.2 and 0.4 percentage points after nine quarters.

The evidence presented in Froot-Thaler (1990) has been updated using more recent data (see, e.g. Meredith-Chinn (1998), Wadhwani (1999)), and for a variety of different exchange rates in developed economies, and it continues to reject the uncovered interest parity hypothesis.

There are those who have argued that (see e.g. McCallum (1994)) the conventional econometric testing of the this hypothesis is flawed because the interest differential itself depends on exchange rate expectations (giving rise to an endogeneity bias). However, using more appropriate econometric techniques (e.g. instrumental variable estimates, as in Wadhwani (1999)) makes very little difference.

Of course, the economics profession has long known that a random walk model – i.e. a naive convention of an unchanged exchange rate - outperforms many existing models of the exchange rate, including uncovered interest parity, in terms of out-of-sample performance (see e.g. Meese and Rogoff (1983)). The evidence presented in Wadhwani (1999) suggests that the random walk hypothesis has retained its edge over the uncovered interest parity hypothesis in recent years.

Moreover, there has been considerable progress in our understanding of real exchange rates (see e.g. MacDonald (1998)), and many Wall Street firms now routinely publish their estimates of the medium-term equilibrium exchange rate, and even central banks occasionally do so (see, e.g. Deutsche Bundesbank (1995)). Wadhwani (1999) presents some evidence suggesting that a model (for sterling) of this kind would have, in terms of out-of-sample testing, outperformed either the uncovered interest parity or the random walk alternatives.

In general, we feel that central banks should be less diffident about attempting to forecast exchange rates – especially as current conventions appear to be misleading for policy purposes.

Note that the use of forecasting conventions is not just confined to the exchange rate, but also often applies to other asset prices. For example, in recent years, the BoE has typically assumed that nominal stock prices rise in time with nominal GDP, a convention that , once again, has also been used by a variety of other organisations.

At a visceral level the reluctance to attempt to forecast asset prices appears to be grounded in a belief in a variant of the efficient market hypothesis that asserts that returns on financial assets are essentially unpredictable. Yet, in his recent review of the Finance literature, Cochrane (1999) asserts that:

> "The last 15 years have seen a revolution in the way financial economists understand the world around us. We once thought that stock and bond returns were essentially unpredictable. Now we recognise that stock and bond returns have a substantial predictable component….. We once thought that long-term

> interest rates reflected expectations of future short-term rates and that interest rate differential across countries reflected expectations of exchange rate depreciation. Now, we see time-varying risk premia in bond and foreign exchange markets as well…..”

Consequently, we wonder if it might make sense for central banks to be less diffident about attempting to forecast asset prices in the hope of improving their inflation forecasts. We do not want to pretend that it is easy to forecast asset prices – it certainly is not. Recall that most of the academic studies relating to the predictability of asset returns tends to find low explanatory power. However, our best judgement is that it might be better to use forecasting models (modified by judgement) rather than existing ad hoc conventions. Moreover, it is important to recall that central bankers do possess a significant informational advantage over the average model participant – which is that they have a much better idea of their own reaction function and where interest rates are headed (on unchanged information). Therefore, it does seem to be a pity that they do not, in general, exploit this informational advantage in preparing their asset price forecasts.

7.6. Using Asset Prices to Help Form Judgement.

Asset prices can, sometimes, contain information about the likely evolution of key macroeconomic variables <u>before</u> this is reflected in a conventional forecast from a macroeconometric model. Hence, looking at asset prices and trying to discern whether any message can be gleaned from them can be an important part of forming judgements for policy-making.

To take a recent example, consider the buoyant performance of US equities during the 1990s. It is difficult to explain the rise in the market without appealing to some rise in the underlying growth rate of productivity of the US economy. In the past year or so, some academic studies of productivity growth in the US have begun to acknowledge that there may, indeed, have been an upsurge in the trend rate (see e.g. Oliner and Sichel (2000)). However, no conventional macro-econometric model of the US economy predicted this rise in the underlying rate. Yet, trying to rationalise the rise in US equity prices could have (and arguably did) help policymakers proceed on the basis that productivity growth had in fact risen.

In the current conjuncture, it is notable that there is not, as yet, any formal evidence suggesting that the underlying rate of productivity growth has speeded up in any of the other G5 countries. Therefore, none of the other G5 central banks have increased their estimate of prospective productivity growth. One wonders whether the current level of equity prices should be used as a justification for basing policy on and estimate of higher productivity growth. Alternatively, if the central bank believes that the markets have an inflated view of likely productivity growth, the presumption must be that policy should be based on and assumption that equity prices will fall back.

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