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Monetary policy and asset prices: the investment channel

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Abstract

The role of monetary policy during periods of asset price volatility has been the subject of discussion among economists and policymakers at least since the 1920s and the Great Depression that followed. In this paper we survey the recent and rapidly growing literature on this topic, with an emphasis on the investment channel. We present a detailed discussion of the hypotheses that have been used to justify, or criticise, a response to asset prices. These hypotheses concern imperfections in financial markets, bubbles in asset prices, and the information on which firm managers and central banks base their decisions.

JEL Classification: E22, E30, E52, E58.

Keywords: Investment; Asset Prices; Inflation Targeting; Monetary Policy; Fundamentals.

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1 Introduction

The recent experience with booms and busts in asset prices, especially in Japan and the USA, originated a heated debate on the relation between stock prices and monetary policy. Naturally, the events surrounding the Great Depression had already led to a discussion of this issue, but systematic study of it became topical only in the late 1990s — see, e.g., White (2004a). It is also the case that in recent years monetary policy has been often represented by a "simple interest rate rule", i.e., an equation that relates the nominal interest rate (the policy instrument) to a small number of variables thought to be the ones policymakers look at when taking decisions. These would normally include the output gap and inflation (actual or expected). It has been found in several papers that simple rules may approximate optimal rules, though the result is obviously not general — e.g., see the discussion in Taylor (1999). The main question addressed by those studying the relation between asset prices and monetary policy has therefore been: Should monetary policy react to movements in (real) asset prices in a way that goes beyond their actual or foreseen impact on output and, especially, inflation? That is, are simple rules that exclude asset prices enough to take into account the importance of asset prices to economic management?

In this paper we survey the current state of this relatively new, but fast-growing, body of literature. We focus our attention on that part of the literature that has highlighted the link between equity prices and real economic activity that is provided by the "investment channel." That is to say, we shall discuss whether and how fluctuations in asset prices may trigger fluctuations in investment, and what consequences these may have for the economy. Two main issues have been addressed. One is the possibility that, through a "financial accelerator" effect, asset price movements may contribute to significantly magnify fluctuations in investment and output.[1] The other is that a change in investment caused by non-fundamental movements in asset prices represents an inefficient allocation, i.e., a deviation from a frictionless benchmark model. The goal of the literature is then to assess whether this channel justifies a special monetary policy response to movements in asset prices.

We narrow the focus to the investment channel primarily to limit the scope, and thus the size, of the survey. Nevertheless, though the earlier papers in the literature on monetary policy and asset prices focused on the "wealth effect" of asset prices on consumption, it is a common view that it is not clear that the wealth effect is really that important.[2] In fact, the more recent research has instead emphasised the importance of equity prices to investment and the effects of an "over-accumulation" of capital, and this is the research that we survey.

The literature is divided between those who believe the correct answer to the question above to be "yes" — e.g., Cecchetti, Genberg, Lipsky, and Wadhwani (2000) — and those who answer "no" — e.g. Bernanke and Gertler (1999). The main problem when dealing with asset prices is that there may be a significant non-fundamental component in them. Crucially, this component is non-observable. In general, the "yes" side of the debate will attach little relevance to the difficulties posed by the non-observability of the non-fundamental component, while the "no" side will do just the opposite. Indeed, the consequences for investment and the estimation of the non-fundamental component of asset prices have been two of the main issues in the debate. Concerning the consequences, the literature surveyed in section 2 reports mixed results: some studies find that investment is significantly affected by non-fundamental movements in asset prices, whereas others find at most a limited effect of asset prices on investment. As for estimation of misalignments, Cecchetti et al. (2000) argue that it is no more difficult than estimating other policy variables such as the output gap. Cogley (1999) takes the opposite view and goes as far as to suggest that reacting to (inaccurately) estimated misalignments might even be destabilising. Closely related to this difficulty is another important problem with including asset prices in the policy rule: it could lead to indeterminacy — see Bullard and Schaling (2002). If asset prices respond to monetary policy actions, and monetary policy reacts to asset prices, then there is no anchor and the result is indeterminacy. In fact, another strand of the literature has emphasised the impact of monetary policy on asset prices, and what reacting to asset prices might imply for asset markets. Though there is evidence that equity prices react to monetary policy — see, e.g., Bernanke and Kuttner (2004) and the references therein — the magnitude and timing of that reaction are uncertain. This would advise policymakers to be cautious when attempting to influence equity prices, or not to try it at all. Besides, the psychology of investors is still ill understood. Thus, the way market participants would respond to actual or expected steps taken by monetary policy to steer equity prices is unpredictable and might endanger market stability — see, e.g., the discussion of communication problems of the central bank in Filardo (2004).

There are actually three views in this debate: those who believe monetary policy should react to asset prices themselves (e.g., Bordo and Jeanne, 2002); those who believe monetary policy should react only to misalignments in asset prices (e.g., Dupor, 2002); and those who believe monetary policy should just not react to asset price fluctuations in any special way (e.g., Gilchrist and Leahy, 2002). If asset prices reflect only fundamentals, then the second and third groups will advocate no reaction. The first group stress the non-linear effects that asset price movements may have. In particular, asset prices may be important for determining the collateral available for borrowing. If asset prices collapse, possibly because of weak fundamentals, the economy may be caught in a credit-crunch situation, with potentially very damaging consequences for the economy as a whole. Therefore, according to this group, monetary policy should be preemptive, i.e., it should also aim at preventing excessive fluctuations in asset prices. Members of the second group will typically either not model these effects, or attach little quantitative importance to them. On the other hand, members of the third group tend to believe that an "inflation targeting" framework — in a sense to be clarified in section 3 — is the adequate regime for monetary policy. Monetary policy should then focus on inflation forecasts alone. Asset prices (and, for that matter, any other variable) will be relevant if, and only if, they help forecast inflation. Attempting to moderate asset price movements will be, to this group, beyond the remit of monetary policy.

In this paper we discuss these arguments by means of a sticky-price model with endogenous investment, possibly driven by non-fundamental movements in asset prices. We discuss the potential benefits, in terms of output and inflation stabilisation, of employing a monetary policy rule that reacts to asset prices. At some point we will assume that equity prices may be contaminated by sentiment — i.e., deviations from rationality or mistaken expectations — and that this distorts firms' investment decisions: managers cannot disentangle sentiment and information about fundamentals, leading to "wrong" investment decisions. If there is a bubble in stock prices, this may result in excessive capital accumulation relatively to the frictionless benchmark.

In section 2 we discuss, through the presentation of theories and evidence on the relationship between stock prices and investment, what role asset prices play in the explanation of investment fluctuations and whether the existence of some form of irrational exuberance in the stock market may induce firms to invest beyond what fundamentals suggest. In fact, there is by now enough evidence that stock returns predict investment — see, e.g., Morck, Shleifer, and Vishny (1990) — but the channels that make that correlation hold are not so evident. The most cited channels between stock prices and investment are Tobin's q, the active informant hypothesis and the balance sheet channel provided by imperfections in financial markets.

Section 3 discusses the policy evaluation approaches used in the literature, which fit well in what Taylor (2000) has named the "new normative macroeconomics" method. In section 4 we describe a sticky-price model with endogenous investment and adjustment costs where asset prices may be driven by a non-fundamental shock. This model will serve as a guide to the literature under survey. Issues will be discussed taking the model as reference. Section 5 presents conclusions and directions for future work.

2 Stock prices, investment and the real economy

Although there are several channels through which asset prices may impinge on the real economy, in this paper we focus on the effects that go through the investment channel. The opposite views of Bosworth (1975) and Fischer and Merton (1984) illustrate the divergence in the literature on the effects of market valuations on investment. On one side, Bosworth argues that although stock market and firms' investment are closely related, since the stock market will try to evaluate the value generated by firms' investments, managers should ignore the information coming from the market and base their investment decisions on their own valuation of fundamentals. In this case the stock market would be a sideshow with no effect on investment decisions.

On the other side, Fischer and Merton (1984) argue that managers should simply consider the stock market valuation and use investor sentiment to the advantage of their company. In the authors' opinion, whether or not they coincide with their own assessment of fundamentals, firms should react to stock-price changes when taking their investment decisions: firms should follow investor exuberance. In this case non-fundamental movements in asset prices affect investment and, therefore, the real economy, providing a possible justification for the intervention of monetary policy. The main elements relating asset price movements to fluctuations in investment are Tobin's q, the active informant hypothesis and the balance sheet channel. This section describes these.

2.1 The credit view

Traditionally, theories of the monetary transmission mechanism have stressed the direct effects of interest rates and exchange rates on output components, and then, indirectly, on inflation. In particular, changes in the real interest rate would cause investment to adjust to react to the changing cost of capital. However, an old tradition in macroeconomics that focused on the importance of financial markets in the transmission of monetary policy and other shocks has recently been recovered. The recent survey by Trautwein (2000) provides an historical appraisal of this "credit view" in macroeconomics, contrasting it with the once dominant "money view." This renewed interest arises essentially from the belief of policymakers and theorists that the structure of financial markets may amplify the effects of shocks and, therefore, output fluctuations.

The basic insight is that financial markets are plagued by problems related to information asymmetries and incentive compatibility. These problems are of relevance to the conduct of monetary policy for they also provide a channel — the credit channel — through which monetary policy may have larger real effects. In addition, this credit view stresses the asymmetries that result from financial constraints, which may depend on movements in asset prices.

The link between stock prices and investment provided by the balance sheet channel is studied, for example, in Kiyotaki and Moore (1997) and Bernanke et al. (1999). In this case, the link between stock prices and investment works through their effects on the financial structure of firms. In a world where capital markets are characterised by imperfect information and incentive and enforcement problems, the cost of borrowing depends on the financial position of agents and, therefore, a increase (decrease) in asset prices increases (decreases) the market value of borrowers' collateral and their ability to borrow and invest. These effects may be highly damaging for the economy in the special case when a bubble in asset prices bursts, as the experiences of the Great Depression and of Japan in the 1990s seem to suggest.

How much of investment fluctuations are explained by "fundamental" shocks alone and by the amplification provided by the structure of financial markets is what Gilchrist and Himmelberg (1998) study. They find that, for the average firm in their sample, financial factors raise the impact of a shock on investment by 25% relative to a benchmark situation with no frictions in financial markets. Hubbard (1998) surveys earlier empirical work, also concluding that financial frictions appear to matter.

2.2 Investment, fundamentals and financial frictions

The standard theory for Tobin's q is presented in Tobin (1969), where q stands for the ratio of the market's valuation of capital to its replacement cost. According to this theory an increase in stock prices increases the value of capital relative to the cost of acquiring new capital and thus increases investment demand by firms. However, several studies (see, for example, Barro, 1990; Blanchard, Rhee, and Summers, 1993; Chirinko, 1993) have shown that Tobin's q is not a good predictor of investment, at least when compared to other variables.

A first problem in the empirical literature on investment is that fundamentals are unobservable by the econometrician and therefore a proxy has to be chosen — sales and cash flow in Morck et al. (1990) and profits (or its expected present discounted value) as in Blanchard et al. (1993) — and the results are not independent of the choice. Another problem is the choice of the variable to represent market valuation, that is, Tobin's q or the stock price.

The use of q can easily result in measurement-error problems, given the problems involved in the computation of q. On one side, there are the difficulties in computing a series for capital at replacement cost. On the other side, the relevant variable for investment, in theory, is marginal q, which is very hard to measure because of the difficulties in determining the market value of a marginal unit of capital. To circumvent this problem, average q is used instead, which is based on the total value of capital. Two recent papers, Bond, Cummins, Eberly, and Shiller (2000) and Bond and Cummins (2001), mention noise in equity prices as an explanation for the empirical failure of the q model.

At least since the seminal work of Shiller (1981), theoretical and empirical work suggest that fashions and fads, and not only fundamentals, affect asset prices. In a series of papers, most of them collected in Shiller (1989), Shiller and others looked for evidence on the relative importance to asset price movements of changes in economic fundamentals and changes in opinion or psychology. Although the answer to this question is still not well established owing to statistical difficulties, there is a broad consensus today that stock prices exhibit more volatility than is justified by fundamentals. Given these findings, several authors (e.g., Robert Shiller, Andrei Shleifer, James Poterba, Lawrence Summers, among others) have been proposing behavioural theories, models of contagion of opinion and behaviour, fads and bubbles, to provide an explanation for the empirical findings that have raised doubts about the efficient markets hypothesis, and therefore to justify marked and prolonged deviations of asset prices from fundamentals.

The study of the relationship between stock prices and investment is of great interest during periods of marked deviations of stock prices from fundamentals. If there is some irrational exuberance in the stock market driving prices up because investors believe in a New Era economy, as described in Shiller (2000), then firms may be "forced" to follow that enthusiasm and invest beyond what would be warranted by fundamentals.

The 1920s and the Great Depression that followed and the crash of 1987, have been studied as periods during which asset prices deviated markedly from fundamentals. The examination of both periods by Barro (1990) led this author to conclude that managers do not follow the market valuation closely in their investment decisions. Firms invested less during the 1920s than implied by market valuation; and after the 1929 crash, investment fell more than the fall in the stock market would suggest. In the case of the 1987 crash, the author concludes that, when investing, firms must have considered information other than market valuation. The overall conclusion is that stock prices outperform a standard q-variable in explaining investment and that stock prices are an important determinant of US investment, especially for long-term samples, and even when controlling for cash flow variables.

Two other periods of marked deviations from the fundamentals are the second half of the 1980s in Japan and the 1990s in the American economy. The Japanese stock price index Nikkei 225 climbed from 11 543 in January 1985 to 38 916 in January 1990 — an increase of 237% or an average annual growth rate of 27.5%. The S&P 500 stock price index for the American economy climbed from 459 in January 1995 to 1521 in September 2000 — an increase of 231% or an average annual growth rate of 23.5%. During these periods, fixed capital investment increased at an average annual real growth rate of 9%.[3] Looking at the Japanese economy in the 1980s, Chirinko and Schaller (2001) used different types of evidence to conclude that there was a bubble in the equity markets and that it affected business fixed investment. The authors first confirm that the stock market boom of the late 1980s coincided with high levels of business fixed investment and that, at the peak in 1989, the funds raised from securities issues covered almost 90% of the expenditures on business fixed investment by the principal Japanese enterprises, when usually it covers only 30%. Using a non-structural forecasting equation and controlling for other macroeconomic factors that might have affected investment, the authors concluded that the investment/capital ratio was about 20% higher than predicted by these factors in the late 1980s, but lower than predicted after the crash. This evidence is reinforced by the use of orthogonality tests and parametric estimates; from these they concluded that the bubble increased fixed investment by something like 6 to 9% in the period 1987-89. The boom in stock prices and in fixed investment in the American economy in the 1990s is certainly worthy of further research.

These studies by Barro (1990), Chirinko and Schaller (2001), and more recently Baker, Stein, and Wurgler (2002), find an important role for non-fundamental movements in asset prices in explaining investment. But there is also contradicting evidence.

Morck et al. (1990) when revising the different channels from stock prices to investment, emphasise the one that stresses the fact that managers, when making investment decisions, have in the stock market a source of information that may or may not correctly describe future fundamentals. According to this view, the *active informant hypothesis*, stock prices predict investment because they convey relevant information to managers when deciding on investment. It is arguable that the market does inform firms' managers, which have to take investment decisions, about, for example, the future state of the economy, namely, future aggregate or individual demand. However, information contained in stock prices may accurately, or inaccurately, predict fundamentals. It can inaccurately predict fundamentals because of their inherent unpredictability "or because stock prices are contaminated by sentiment that managers cannot separate from information about fundamentals" (Morck et al. 1990, p. 164). In this case, sentiment — that is, the component of stock prices that is not explained by fundamentals — may distort investment decisions through the false signals it transmits to the managers. According to these authors' terminology, in that case, the stock market will be a *faulty active informant*.

Morck et al. (1990) regress investment growth on stock returns and the growth in fundamental variables in order to see how important the stock market is, after controlling for fundamentals — the growth rates of sales and cash flow. They try to answer the following question: If managers knew future fundamentals, would orthogonal movements in share price still help predict their investment decisions? Although they concluded that they could never reject the null hypothesis that investor sentiment does not affect investment through the stock market, their results suggest that it is not the most important factor in explaining investment. For firm-level data they conclude that investor sentiment has a very small explanatory power for investment and that the stock market is neither a complete sideshow, nor one of the most important elements in explaining investment behaviour. The same results were achieved using aggregate data.

Additional evidence is provided in the important paper on the effects of stock prices on investment by Blanchard et al. (1993). These authors analyse whether investment moves more with the stock market or with fundamentals, using time series for the period 1900-1990. For fundamentals they employ two proxies: first, the expected present discounted value of the profit rate, conditional on information available as of the time of investment; second, the profit rate. When controlling for fundamentals, and especially when they use profits as a proxy, they conclude that market valuation has a limited effect in explaining investment behaviour over the period of analysis and that the evidence goes strongly against the hypothesis that managers simply follow the market valuation. However, they conclude that stock prices matter. According to their estimates, a non-fundamental increase of 1% in the market valuation leads to an increase in investment of 0.45%.

2.3 Summary

The overall conclusion from these empirical studies is that market valuation, when one proxies fundamentals by cash flow and profits, has a role, although a limited one, in the determination of investment decisions. That is, the stock market is not a sideshow; it affects real economic activity through its effect on investment. Therefore, in the next sections we describe a model with endogenous investment where the asset price is affected by a non-fundamental shock, that will allow us to discuss the potential benefits from monetary policy reacting to asset prices, in terms of inflation and output stabilisation. As an introduction, we begin by discussing the policy evaluation approach.

3 The approach to policy evaluation

It is standard nowadays in monetary policy models to assume that monetary policy is implemented through simple (or optimal) rules for the nominal interest rate, the central bank's instrument. Two main approaches have been used to study the potential benefits from monetary policy moderating the impact of movements in asset prices. In the first approach, one evaluates the effects of letting the policy instrument react to asset prices over and beyond the reaction to deviations of expected inflation from the target. In the second approach, assuming the central bank has perfect information, one determines the optimal policy rule and assesses the importance of its reaction to non-fundamental shocks. As discussed below, these approaches reflect different ways of viewing and modelling an "inflation-targeting" central bank.

The policy evaluation approach is usually based on the computation of an expected loss for alternative policy rules that do or do not include some reaction to asset prices. One can then compare the ability of those different policy rules to stabilise inflation, output and the other variables of the system, when the economy is hit by asset-market disturbances. The stability of the variables is usually evaluated in terms of their variance. However, comparisons of the performance of different policy rules in the context of an otherwise unchanged model always bring to mind the "Lucas critique." When the model employed is interpreted as "structural", as is common with the forward-looking IS and Phillips curve equations that we will include in our benchmark model, the modeler has some justification for arguing that the Lucas critique is ineffective. However, some authors — see, for example, Sims (2001) and Estrella and Fuhrer (2002) — have been suggesting that, even in that case, a model may still be affected by policy changes.

In the context that interests us here, it could be the case that bubbles or firm managers (non-rational) expectations are endogenous, i.e., responsive to monetary policy. Introducing this in the model would, in the most interesting formulations, render it non-linear and bring in the difficulties mentioned in section 4.4. This is an issue that has been under discussion and certainly deserves attention. One of the arguments employed by those that favour a reaction to asset prices is that this will also prevent non-fundamental movements in asset prices from developing. Critics of this view argue that, given the information limitations of the central bank, the impact of monetary policy actions on expectations and asset prices is hard to predict and might actually be destabilising.

3.1 Policy rules

All monetary policy rules considered in our analysis are interest rate rules. The exclusive use of interest rate rules for policy rests on the evidence that virtually all industrialised countries' central banks use some short-term (nominal) interest rate as their policy instrument — see Walsh (1998). Simple rules have been widely discussed among academics and in wider discussions about monetary policy. Of course, because simple rules do not use all the information available they will not in general be optimal.[4]

Much of the discussion on whether monetary policy should react to asset prices has been conducted in the context of an "inflation targeting" regime.[5] However, different representations of it have been made, leading to different approaches of the issue. It is therefore convenient to briefly distinguish these different views.

A narrow definition of inflation targeting is as a regime in which the interest rate is set so as to achieve the target value for the forecast of the inflation rate at an appropriate horizon. Rudebusch and Svensson (1999) view inflation targeting as a regime in which central bankers can be modelled as setting interest rates using all available information so as to optimize a welfare function that penalizes deviations from the inflation target alone (strict inflation targeting), or also conceding some weight to the output gap (flexible inflation targeting). This view of inflation targeting has been used in papers that assess the role of non-fundamental shocks to asset prices in the optimal policy rule — see, e.g, Bean (2003).

However, the seminal studies by Bernanke and Gertler (1999) and Cecchetti, Genberg, Lipsky, and Wadhwani (2000) view inflation targeting in a looser way. This looser definition of inflation targeting, following McCallum and Nelson (1999) and others, is as a regime in which the policy instrument reacts to deviations of expected inflation from target, for a given horizon. On this looser definition, a policy would approximate more closely that under the narrower definition (strict inflation targeting) the greater the strength of the response of the interest rate to the deviation of inflation from the target. It is argued that such forecast-based forward-looking rules provide good approximations to the behaviour of inflation targeting central banks — see, for example, Svensson (1997).

We are now ready to briefly describe the interest rate rules discussed in this paper. The symbols used in the following equations are defined as follows: i_t is the nominal interest rate; π_t is the inflation rate; $\tilde{y}_t$ is the output gap; q_t is the asset price; ψ_{xt} is the non-fundamental shock in the investment equation. All are measured as log-deviations from steady-state values.

In the looser view inflation targeting corresponds to the use of a rule that sets the nominal interest rate as a function of the deviations of the inflation forecast, for a defined horizon, from the target. In log-deviation form, the target is zero for inflation (and also for the output gap, when it enters the policy rule). The policy rule is usually written as:

$$i_t = \gamma E_t \pi_{t+1} \tag{1}$$

where i is the policy instrument, γ is the feedback parameter, and $E_t \pi_{t+1}$ is the expected next period inflation, conditional on all the information available at time t.

One possible alternative monetary policy is then one in which the monetary policy rule reacts not only to deviations of inflation from the target but also to the current asset price:

$$i_t = \gamma_1 E_t \pi_{t+1} + \gamma_2 q_t \tag{2}$$

However, the optimal policy would call for a response to shocks rather than expected inflation or asset prices themselves, as the papers that adopt the stricter view of “inflation targeting” unsurprisingly conclude. But the optimal rule is not feasible; it is just a benchmark. Assuming the central bank can correctly identify the non-fundamental shock, a preferable alternative to the previous simple rules would be an inflation-forecast targeting policy rule in which the policy instrument, instead of reacting to the asset price, reacts to the non-fundamental shock itself:

$$i_t = \gamma_1 E_t \pi_{t+1} + \gamma_3 \psi_t \tag{3}$$

In this rule it is assumed that central banks can identify misalignments in asset prices, while at the same time firms either cannot identify them, or will base their decisions on them anyway — recall the discussion in section 2 and Fischer and Merton (1984)'s view of the subject. Whether such an assumption is tenable is the subject of great controversy. Estimating misalignments in asset prices is a difficult task and highly dependent on the assumed model and the dataset — see Alessandri (2004) for a recent study of the issue. In fact, this estimation problem is the main source of divergence between Bernanke and Gertler (1999) and Cecchetti, Genberg, Lipsky, and Wadhwani (2000): to the former, adjusting the simple rule's parameters is sufficient to stabilise the economy without incurring the dangers of wrongly estimating misalignments; to the latter, there are significant gains in supplementing the simple rule's elements with misalignments in asset prices, which are no more difficult to estimate than, say, the output gap.

The Taylor rule is another simple rule frequently used in policy analyses. A simple version of it is:

$$i_t = \gamma_4 \pi_t + \gamma_5 \tilde{y}_t \tag{4}$$

i.e., the interest rate is set in response to deviations of actual inflation and the output gap from the target. Starting from this baseline version, one might study the impact of adding the same terms added above to the inflation targeting policy rule.

After assigning values to the parameters in them, the alternative policy rules are compared by computing the values of a, sometimes implicit, welfare loss function. The loss function is what we discuss next.

3.2 Central banks' loss function

In what concerns the welfare loss function, we should also mention that although the focus of analysis is the question of whether or not monetary policy should react to asset prices over and above deviations of inflation from the target, we are not addressing the question of whether or not monetary policy should target asset prices in the sense that they belong in the objective function. The dominant view is that monetary policy should concentrate on goods and services inflation and that monetary policy should not aim at asset price stability. Therefore, the discussion of whether or not central bankers should stabilise asset prices around fundamentals, should be understood as a means to stabilise output and inflation. Or, as Cecchetti, Genberg, and Wadhwani (2003) make clear, the concern is how the central bank can most effectively fulfill its objectives. Reacting to asset prices in order to stabilise the economy and aiming to stabilise the financial markets are two different things.

The welfare loss function usually considered in theoretical discussions has the following form:

$$L = (1-\theta) \sum_{t=0}^{\infty} \theta^t \left(\pi_t^2 + \chi \tilde{y}_t^2 \right) \tag{5}$$

where θ is the discount factor and χ is the weight assigned to output stabilisation. When θ tends to 1, the loss function approaches the "asymptotic loss function":

$$AL = V(\pi_t) + \chi V(\tilde{y}_t) \tag{6}$$

Sometimes — in the context of the optimal response to asset prices, an example is Filardo (2001) — a modified version is used, where the volatility of the policy instrument is included:

$$AL_i = V(\pi_t) + \chi V(\tilde{y}_t) + \chi_i V(i_t - i_{t-1}) \tag{7}$$

The inclusion of output and inflation in the central bank's loss function reflects the wide agreement that they represent the most important concerns of policymakers — even inflation targeters as the Bank of England claim that they are not "inflation nutters", in King (1997)'s terminology. A similar loss can be derived from a microfounded general equilibrium model without endogenous investment, as shown in Rotemberg and Woodford (1999), as a second-order approximation to the utility function of the representative agent. The inclusion of an interest rate smoothing term in the expected loss reduces volatility of the policy instrument and is justified, among other reasons, because policymakers are concerned about financial stability — see Mishkin (1999); alternative possibilities are discussed in Woodford (1999). On the same grounds, Gruen, Plumb, and Stone (2003) consider including the variance of the shock to an asset-price bubble in the welfare loss function. It is also important to note that implicit in the use of the asymptotic loss is a disregard for issues related to time-inconsistency. Groth (2003) explicitly takes into consideration the commitment problem in the context of the debate on monetary policy and asset prices.

Nevertheless, to our knowledge, the sort of loss function presented above has not yet been given proper microfoundations in a model with endogenous investment. To overcome this difficulty, Gilchrist and Leahy (2002) use an apparently different approach to evaluate the performance of policy rules. They first simulate a real business cycle (RBC) version of their model and then simulate New Keynesian and financial accelerator versions of it under inflation targeting rules. Given that a frictionless economy yields maximum welfare, any deviation from it means a reduction in welfare, if we ignore other possible distortions. Thus, Gilchrist and Leahy assess the optimality of the rules by how close the variables' paths are to their paths in the RBC version. This procedure actually amounts to defining the "output gap" as the difference between actual output and the output under the frictionless RBC model. The implicit loss function would then be similar to the sum of squared deviations of inflation and of this redefined output gap from zero. Here, a value of zero corresponds to zero inflation and output being on the same path as in the corresponding RBC model.

One remaining difficulty, which Gilchrist and Leahy do not attempt to solve, is giving a value to parameter χ, the weight of output in the loss function. A commonly used option is $\chi = 1$ (and $\chi_i = 0.5$ — see Rudebusch and Svensson, 1999). Another difficulty is that in this sort of model it is not obvious why output deviations should be taken as indicative of welfare losses. In principle, all variables relevant to the welfare function would have to be on the same path as in the RBC model for welfare to be at its maximum. The variable that comes to mind as one strong candidate for the job is consumption. Nevertheless, one may ask whether monetary policy should be given the task of addressing all distortions.

Usually the output gap is computed as the difference between actual output and the output under full price flexibility. This is what we do below. However, the existence of imperfections in financial markets should also be taken into account, which would require defining a "parallel" frictionless model — the RBC model in Gilchrist and Leahy (2002). The benchmark model that we shall discuss next does not have financial market imperfections, only price stickiness. For our purposes, we do not need to define the frictionless model. We would need to do so if we intended to extend the analysis, for instance, to include numerical simulations.

4 A model-based discussion

Because of its high volatility and weight in aggregate demand, investment is seen, at least since John Maynard Keynes, as a major determinant of the business cycle. Therefore, with central banks aiming at stabilising inflation and output, and given the evidence presented above, we ask if there is something monetary policy can do to improve things in periods of enthusiasm or optimism about the future, with stock prices booming and firms induced to invest beyond what fundamentals would imply or, on the other hand, during a wave of pessimism, a crash in stock prices and delays in the implementation of investment projects. That is, do the effects of asset price movements on investment provide an argument for a reaction of monetary policy to asset prices, in order to stabilise output and inflation?

Bernanke and Gertler (1999) analyse the benefits of monetary policy reacting to asset prices in a small-scale dynamic New Keynesian model extended to allow for financial accelerator effects — as developed in Bernanke et al. (1999) — and for exogenous bubbles in asset prices, which affect investment, and therefore the real economy, via the financial accelerator. In this model firms' capital is financed through internally generated funds and by borrowing. As described above, because there are credit-market frictions, stock price movements, through their impact on firms' net worth, affect the collateral firms can offer to banks. This will influence their costs of financing and thus affect investment. Therefore, in this model links between changes in asset prices and the real economy work through the financial accelerator mechanism.

Gilchrist and Leahy (2002) use the framework of Bernanke et al. (1999) to analyse the effect of a non-fundamental shock to the net worth of firms and of a technological shock. Tetlow (2004) uses a version of Bernanke et al. (1999)'s model as modified by Bernanke and Gertler (1999), to study issues raised by the uncertainty regarding the behaviour of the non-fundamental component of asset prices, namely the robustness of simple rules. Both these papers share Bernanke and Gertler's "no-reaction" view. Groth (2003) employs another simplified version of Bernanke and Gertler's model to investigate optimal monetary policy under inflation targeting. Groth concludes that the discretionary solution is similar to an inflation-targeting rule and that credibly promising to be tough on bubbles will reduce their impact.

Without allowing for financial accelerator effects, Dupor (2002) develops a sticky price-imperfect competition model with endogenous capital accumulation and investment adjustment costs. As expected, in Dupor's model a non-fundamental increase in equity prices leads to inefficient physical investment. Dupor then concludes that the optimal monetary policy will react to non-fundamental movements in asset prices.

In our analysis we use the dynamic New Keynesian model with endogenous investment and adjustment costs developed by Casares and McCallum (2000). The model assumes monopolistic competition and nominal price rigidities to allow for non-neutral effects of monetary policy. We chose to use this model, which has not previously been used to this end, because it is representative of the type of model currently in use in macroeconomics. One advantage is that it has a simpler structure than that of Bernanke et al. (1999), and this will greatly simplify the discussion. Naturally, being simpler it lacks some of the required ingredients for our discussion. Therefore, to the basic model we will have to add some terms. These additions will make clear the issues being debated and the sources of disagreement in the literature.

4.1 The benchmark model

The original Casares and McCallum's model may be described by the following equations, which are log-linearised around the steady state:

$$\begin{aligned}
y_t &= w_1 c_t + w_2 x_t && (8)\\
c_t &= E_t c_{t+1} - \beta(i_t - \pi_t) + \varepsilon_{ct} && (9)\\
k_{t+1} &= (1-\delta)\, k_t + \delta x_t && (10)\\
f_{2t} &= \zeta(y_t - k_t) && (11)\\
a_t &= \rho_a a_{t-1} + \varepsilon_{at} && (12)\\
\bar{y}_t &= (1-\alpha) a_t + \alpha k_t && (13)\\
\tilde{y}_t &= y_t - \bar{y}_t && (14)\\
\pi_t &= \phi_0 E_t \pi_{t+1} + (1-\phi_0)\pi_{t-1} + \phi_1 \tilde{y}_t + \varepsilon_{\pi t} && (15)\\
x_t &= \frac{1}{1+\delta} E_t x_{t+1} + \Omega\left[\Theta E_t f_{2t+1} - (i_t - E_t \pi_{t+1})\right] + \frac{\delta}{1+\delta} k_t && (16)
\end{aligned}$$

The variables are the following: y is output, c is consumption, x is investment, i is the nominal interest rate (the monetary policy instrument), π is inflation, ε_c is a consumption preference shock, k is the stock of capital, f_{2t} is the return on physical capital, a is technology, ε_a is a technology shock, $\bar{y}$ is "natural" output, $\tilde{y}$ is the output gap, ε_π is a "supply" shock. We refer the reader to Casares and McCallum (2000) for details on the derivations, which are similar to those encountered in many other recent papers.

All variables represent log-percent deviations around the steady state. Equation (8) is the overall resource constraint with w_1 and w_2 giving the steady-state shares of consumption and investment, respectively, in total output. Equation (9) is the Euler equation for consumption, which depends positively on its own expected next period value and negatively on the real interest rate, $r_t = i_t - E_t\pi_{t+1}$. Additionally, consumption depends on a preference shock, ε_{ct}, that may, for instance, be assumed to follow an AR(1) process.

Equation (10) is the log-linearised form of the capital accumulation equation. Equation (11) is the log-linear approximation to the marginal product of capital for a Cobb-Douglas production form. Equation (12) describes the process followed by the labour augmenting technology. Equation (13) gives "natural" output, $\bar{y}$, that is, the output that would prevail if there was no deviation from full price flexibility. Equation (14) defines the output gap, $\tilde{y}$, as the deviation of output from its natural level. As discussed in section 3, welfare maximisation would have this gap as close to zero as possible.

Equation (15) — the Phillips curve — depicts the price-adjustment process in the economy. This specification differs from the New Keynesian Phillips curve as it includes a backward-looking term for inflation that is believed to match the data more closely. An equation similar to this hybrid Phillips curve was derived by, e.g., Galí and Gertler (1999). The backward-looking term reflects the existence of a fraction of firms that employ a "rule of thumb" procedure to set their prices. This equation implies the absence of full price flexibility. There is thus a distortion that monetary policy may wish to reduce. But it is this very equation that provides a role to monetary policy in this model: if prices are sticky, changes in the nominal interest rate will affect the real interest rate and thus have effects on consumption, investment and output. Thus, monetary policy must balance its impacts on inflation and output.

4.2 Investment

Equation (16) is an "expectational investment equation" as investment, x_t, depends on its own expected next period value. Investment also depends on the difference between the expected return on physical capital, $E_t f_{2t+1}$, and the return on the financial asset, r_t, which Casares and McCallum refer to as the real asset premium. The coefficient of this term, Ω, should be read as the semi-elasticity of investment relative to the real asset's premium. It depends on the adopted adjustment cost specification and parameterisation. The inclusion of costs in installing capital — besides its theoretical justification — results from the fact that, in its absence, capital, the marginal product of capital, and the marginal product of labour are more volatile than observed in the data.

Among the different adjustment cost specification considered in Casares and McCallum (2000) we chose that which makes, as shown in Hayashi (1982), the average value of Tobin's q equal to its marginal value: that is, total adjustment cost depends not only on the amount of new capital invested but also on the stock of capital, implying constant returns to scale for the production function net of adjustment costs. This specification is of interest to us because, in this case, the marginal value of Tobin's q, which, in the original Casares and McCallum model, is a sufficient statistic to determine the level of investment by firms, is equal to the market value of capital, q_t, which is defined below.

The market value of capital, q_t, is derived from the optimality condition for investment decisions and implies that, in equilibrium, the cost of acquiring one additional unit of capital is equal to the expected present value of next period net return. In the benchmark version of the model it is given by:

$$q_t = \eta \left\{ \frac{1}{1+\delta} E_t x_{t+1} + \Omega \left[\Theta E_t f_{2t+1} - (i_t - E_t \pi_{t+1}) \right] - \frac{1}{1+\delta} k_t \right\} \tag{17}$$

For future reference, notice that, in equilibrium,

$$q_t = \eta \left(x_t - k_t \right) \tag{18}$$

or, alternatively,

$$x_t = \eta^{-1} q_t + k_t \tag{19}$$

i.e., q_t is a sufficient statistic for investment, given the capital stock.

4.3 Perfect financial markets, asset prices and forecasting

The first thing to notice is that this q variable is irrelevant in the benchmark model: equation (17) merely states a definition; nothing in the model depends on this q variable. This is a reflection of the fact that, with perfect financial markets, the stock market is truly just a "sideshow." This is not the same as saying that the stock market would definitely be of no importance to policymaking in this context.

Ideally, the policymaker would employ the "optimal" policy rule. This would entail reacting to the shocks that rock the economy.[6] However, it is clear that identifying these shocks *as they occur*, and accurately assessing their impact and the optimal countervailing action, is beyond what actual policymakers are able to do. In fact, one point on which there seems to be some consensus is that movements in asset prices may carry information that policymakers should try to interpret, in connection with other economic developments, in order to better forecast the evolution of the economy, especially as it concerns output and inflation. That is to say, looking at the evolution of a set of variables that include asset prices may help policymakers identify the type of shock that has occurred.

This is surely what every central bank does, and this is what economists advise — see, e.g., Gertler, Goodfriend, Issing, and Spaventa (1998), who lean against including asset prices in the policy rule. The disagreement is on the weight to be assigned to asset prices. Given that they tend to be very volatile, the direction of movements in asset prices, especially equity prices, cannot be taken for granted: they may be reversed within a few hours or days. A cautious approach thus requires little weight to be attached to them. Perhaps because of their volatility, the empirical evidence is not supportive of giving an important role to asset prices when forecasting economic variables — see, e.g., Filardo (2000) and Stock and Watson (2003). The contrary view is presented in, e.g., Cecchetti et al. (2000) and Goodhart and Hofmann (2000), but it should be mentioned that the results for what interests us most here, equity prices, tend to be disappointing. It is housing prices that appear to have a greater informational content, and are perhaps a more interesting topic for monetary policy — see, e.g., Selody and Wilkins (2004).

4.4 Imperfections in financial markets and non-linearities

We have already highlighted the recent trend in macroeconomics that emphasises the role of financial markets in the transmission mechanism, thus recovering an old tradition that goes back at least to the debt-deflation analysis of the Great Depression by Fisher (1933). Borio and Lowe (2004) talk of a "comeback from the wilderness."

The main focus has been on the financial accelerator that relates changes in borrowers' net worth to credit conditions. How would this link change our benchmark model? The simplest way to represent the financial accelerator in our model would be to modify the investment equation to

$$x_t = \frac{1}{1+\delta} E_t x_{t+1} + \Omega \left[\Theta E_t f_{2t+1} - (i_t - E_t \pi_{t+1}) \right] + \frac{\delta}{1+\delta} k_t + g\left(q_t\right) \qquad (20)$$

All we have done is to introduce a linear function g of current equity prices. This modification is a simple way to make investment depend on equity prices, which act here as a proxy for borrowers' net worth. Increases in asset prices increase the value of collateral borrowers can offer, thus increasing credit availability, which is translated here into more investment.

Given equation (18), it would require only simple algebra to eliminate q_t and transform (20) back into an equation with the same appearance as equation (16). The only differences would be in the coefficients. What the financial accelerator theory tells us is that the new coefficients would be larger than in the benchmark model, i.e., the effect of any shock to the economy that impacted on investment would now be magnified.

Viewed in this light, it would appear that nothing substantial has been brought to the discussion by the financial accelerator model, just a different amplitude of fluctuations. However, there are two aspects one must take into consideration here. The first is that these amplified oscillations are due to distortions in financial markets. Given that a frictionless model (including full price flexibility) will correspond to welfare maximisation, it follows that these oscillations are welfare reducing. Therefore, monetary policy should at least consider the possibility of acting to moderate them — recall section 3. This is what several papers have studied employing the framework developed by Bernanke and Gertler (1999) — for example, Gilchrist and Leahy (2002). The usual conclusion has been that responding to asset prices yields little gains. Since responding to asset prices could create other problems, to be mentioned below, the overall conclusion is that these financial-market imperfections are not sufficient to justify a monetary policy response to movements in asset prices.

The second aspect is that this framework actually fails to capture one of the main features of the literature on financial markets' imperfections. The reason is that this framework is linear, while theorists of financial markets' imperfections often stress the non-linearities involved. These non-linearities would imply a larger and longer impact of a fall in asset prices than predicted by linear models. Therefore, it is no wonder that proponents of "leaning against the wind" of movements in asset prices should often resort to non-linear models to illustrate their views. Three such models are presented in Kent and Lowe (1997), Gruen et al. (2003) and Bordo and Jeanne (2002). Note that the first two papers assume there is a bubble in asset prices, whereas the third does not. The third is thus the one that best represents the issues discussed in this section.

The non-linear nature of a model limits its tractability and demands additional assumptions. One such assumption is the horizon of the model, typically defined to encompass little more than a cycle of boom and bust in asset prices. This is required to allow some tractability, namely solving for rational expectations. The models are thus geared towards something like a "case-based study": what should monetary policy do if there is a positive probability that asset prices are to increase by a certain amount, for a certain number of periods, and then collapse? Additionally, the increase in asset prices is endogenous: monetary policy may influence its pace. The conclusion reached is that, optimally, monetary policy should use its influence to moderate the rise in asset prices and thus reduce the magnitude of the later fall. This will reduce the impact of the fall on credit conditions and possibly prevent a credit crunch. It will also make pre-bust output and inflation lower than otherwise on account of the more restrictive policy, i.e., there is a trade-off between asset price inflation stabilisation. If the horizon for nominal price stability is short, then it will be hard to convince central banks to raise interest rates when no change in inflation is foreseen. Proponents of a response to asset prices thus argue for a longer-term view in monetary policymaking. This would lead current decisions to take into account the possibility and consequences of future financial crises. Thus, current decisions would have to balance the near-term and the longer-term stability goals, and this would entail responding to movements in asset prices.

Notice that quantifying these models is difficult, given the simplifying assumptions employed. In fact, critics will point out that in practice the central bank does not know whether, when and how much asset prices will fall. Changing the policy stance when no problem with inflation or output is observed would be hard to explain by the central bank. The central bank also does not know what will the right degree of monetary tightening be. In addition, there is the possibility that investors may overreact and that it is monetary policy that actually triggers the collapse in asset prices. Besides, equity prices are highly volatile, and reacting to them will make the interest rate also more volatile. This may even lead to indeterminacy.[7]

Moreover, given that asset prices may be contaminated by bubbles or mistaken expectations, and are very volatile, perhaps they are not the best source of information for monetary policymaking. Borio and Lowe (2004) suggest that policymakers should attempt to identify financial imbalances in a timely fashion by looking at credit indicators — see also Borio, Kennedy, and Prowse (1994), Borio and Lowe (2002) and Posen (2003). This sort of indicators will give a better insight into the evolution of credit conditions and the likelihood of future financial crises. It is to these indicators that monetary policy may wish to respond, not to asset prices. This is one direction future research is bound to explore.

4.5 Bubbles

The most prominent issue in the debate concerns "bubbles" in asset prices. By "bubble" we mean any non-fundamental component in asset prices. In the context of our model, this could be represented by including an extra term, ψ_{qt}, in the equation for q_t:

$$q_t = \eta \left\{ \frac{1}{1+\delta} E_t x_{t+1} + \Omega \left[\Theta E_t f_{2t+1} - (i_t - E_t \pi_{t+1}) \right] - \frac{1}{1+\delta} k_t \right\} + \psi_{qt} \qquad (21)$$

If we consider the benchmark model, without the financial-market imperfections discussed previously, then the stock market continues to be just a sideshow. The variable q_t would continue to be irrelevant in the model, and so would the bubble. In this case, and contrary to the situation envisaged in the previous section, moderating asset price movements would actually be welfare reducing.[8]

If we assume that firm managers base their investment decisions on equity prices, then we would replace equation (16) for investment with equation (19). In such a model, the non-fundamental shock, when positive, will stimulate investment beyond what fundamentals suggest. We would thus be assuming the stock market to be a "faulty active informant" in the terminology of Morck et al. (1990) — i.e., the information about fundamentals in stock prices may be inaccurate and may therefore distort investment decisions through false signals to managers.

When this is the case, again there would be reasons to consider whether monetary policy might be used to counteract the distortions caused by the bubble in asset prices. Blanchard (2000) argues that "inflation targeting" — i.e., keeping inflation, over a certain horizon, on target — would not be the adequate monetary policy action. With booming equity prices stimulating investment and output, raising interest rates only to keep inflation under control would contract consumption, while moderating the rise in investment. This is to say, the composition of output would be changed in favour of investment. In the end, the economy would have an over-accumulation of capital, which could lead to a painful adjustment of the economy, through a prolonged recession. Blanchard thus concludes that monetary policy should respond to movements in asset prices in order to prevent bubbles from developing and having these undesirable consequences. A similar argument was put forward by Poole (2001) who asserted that "distorted price signals from the stock market permitted the industry to raise capital easily and cheaply, which certainly contributed to the overexpansion" of the US economy in the 1990s.

Though in their model investment decisions are based on fundamentals, with bubbles affecting investment only through the balance-sheet channel, Bernanke and Gertler (1999) disagree with this view. According to them (and restated in Bernanke and Gertler, 2001) it only takes a tougher inflation targeting strategy to deal with such misalignments. These bubbles will act like demand shocks, increasing investment demand and causing inflation. Inflation targeting will obviously counteract such tendency. Strong inflation targeting — stronger interest rate movements in response to deviations from the inflation target — will discourage it.

Gruen et al. (2003) present a simple macroeconomic model with a non-linear bubble element that affects output. The interesting thing about their analysis is that in their model a forward-looking policymaker faced with a bubble situation may actually want to loosen policy, rather than tightening it. The reason is that, given the "long and variable" lags deemed to affect monetary policy, a policymaker that expects the bubble to collapse in the near-future may find it advisable to prepare the economy for the landing, and start gearing policy towards making it a soft one. In other words, if the bubble is going to burst and that will contract the economy, the optimal stabilising action is to loosen monetary policy in advance. In terms of the model, the stochastic process for the non-fundamental term, ψ_{qt}, should depend on the stance of monetary policy, besides other elements such as the length of the boom in asset prices. These would be essentially non-linear features, and thus would not fit well into the usual linear framework.

If a restraining policy discourages bubbles, then one must admit the possibility that an expansionary monetary policy might actually encourage the continuation of the bubble. This sort of effect has been studied by Miller, Weller, and Zhang (2002). This paper argues that expectations of a stabilising intervention by the Federal Reserve in the 1990s, in case equity prices were to fall, may help explain the run up in asset prices. Stock market investors felt insured against a downfall risk in equity prices, and thus a "moral hazard" problem developed. It thus seems central banks are in a difficult position: increasing interest rates to moderate the rise in asset prices might prick the bubble; not raising interest rates, but preparing for the worst, might help the bubble go on. Sellin (2001) provides a survey of work on the impact of monetary policy on equity prices. The conclusion of this literature seems to be that monetary policy does influence equity prices. Therefore, if monetary policy is to react to equity prices, it must be careful with feedback effects.

4.6 Mistaken expectations

Another deviation from fundamentals might arise from mistaken expectations of firm managers regarding future productivity, such as in Bordo and Jeanne (2002) and Dupor (2002). In this case, we would add a non-fundamental component, ψ_{xt}, to the equation determining investment:

$$x_t = \frac{1}{1+\delta} E_t x_{t+1} + \Omega \left[\Theta E_t f_{2t+1} - (i_t - E_t \pi_{t+1}) + \psi_{xt} \right] + \frac{\delta}{1+\delta} k_t \qquad (22)$$

Again, the additional term, ψ_{xt}, should be seen as a non-fundamental shock. The introduction of this non-fundamental shock might be seen as representing the fact that firms will sometimes wrongly estimate the gap between the expected return on capital and the real interest rate, leading a distortion in investment decisions. The non-fundamental shock will therefore affect investment and, in case stock market investors believe the firm managers assessments, asset prices. This is similar to Dupor (2002), where there is a deviation from rational expectations in that firms may be over- or under-optimistic about the future return to current capital accumulation. The non-fundamental shock leads to inefficient investment. Reacting to this shock depresses consumption and nominal prices. There is a trade-off between asset price and nominal price stabilisation when the non-fundamental shock occurs.

Assuming the market follows the firm managers views, q_t will, in our model, be determined by equation (18). Thus q_t will carry information about the non-fundamental element driving investment. This suggests giving asset prices a role in monetary policy. Dupor argues that optimal monetary policy, which reacts to the non-fundamental shock, will in his model yield significant welfare gains. However, this is not a very clear result to us. What appears to be demonstrated by Dupor is that the optimal policy manages to eliminate a significant part of the welfare loss caused by the non-fundamental shock, not that the loss itself was significant.

4.7 Summary of model-based discussion

The previous sections demonstrate that there is still a big divide in the literature. The central banker looking for a definite prescription on the role of asset prices in monetary policy will not find it. The most we can do is follow Gruen et al. (2003) and say that the adequate monetary policy strategy is a matter for judgement. At times, central banks will feel some restraint is appropriate to prevent bubbles from developing. Other times, they will feel asset price movements are likely to be sustainable and thus no reaction required. The literature surveyed can only point to issues that should be taken into consideration. One such issue is that what is likely to matter most are credit conditions, not asset prices. Either way, asset prices by themselves would not be enough to inform policy. They reflect a variety of shocks which have different implications for policy. In fact, Mishkin and White (2002) stress that crashes in asset prices are important only to the extent that they are associated with episodes of financial instability.

4.8 Central banks and asset prices in practice

But have central banks actually responded to asset price movements? The evidence is mixed. Some empirical studies — such as Cecchetti (2003), Rigobon and Sack (2003) and Dupor and Conley (2004) — find that central banks, namely the Federal Reserve, have responded to asset price fluctuations. Others — such as Fuhrer and Tootell (2004) and Hayford and Malliaris (2004) for the Federal Reserve, Bohl, Siklos, and Werner (2003) for the Bundesbank — contend that they have not. Probably, the correct view is that of Chadha, Sarno, and Valente (2004), who conclude that central banks in the United States, the United Kingdom and Japan have probably reacted only occasionally to movements in asset prices, namely to those perceived to be more dangerous. Borio and Lowe (2004) lean towards the same conclusion, and add that the reaction has possibly been asymmetric: loosening policy more than usual when asset prices fall, but not tightening more than usual when asset prices rise. This asymmetry reminds us of Miller et al. (2002) argument concerning the danger of a "Greenspan Put" option.

5 Conclusion

High investment rates are of great importance for long term growth. Nevertheless, if, when taking investment decisions, firms are responding to distorted signals from the stock market, the economy may end up with too much capital. The recent asset price bubbles in the stock and in the housing markets in the Japanese and in the US economies, and their burst, have raised a wide discussion on what monetary policy can and cannot do to avoid the damaging effects of financial crises to the real economy.

In this paper we have surveyed the recent literature on this topic, with an emphasis on investment. We used a sticky-price model with endogenous investment and adjustment costs in order to discuss the potential benefits of monetary policy reacting to asset prices. The aspects considered were: the usefulness of asset prices for forecasting, the role of imperfections in financial markets and possible non-linearities associated to them, the distortions created by "bubbles" and mistaken expectations that have an impact on investment.

The issues tackled in the literature go beyond the mere definition of an interest rate rule. They reflect different views of how monetary policy is to be evaluated, which is related to the goals assigned to monetary policy, and how to model the economy. Different approaches yield conflicting policy recommendations. Those who support a reaction to asset prices tend to use non-linear models, or stress the fact that the optimal policy does react to non-fundamental shocks. The opponents tend to use linear models or attach little weight to the welfare gains from switching from a simple rule to the optimal rule. They add the remark that reacting to asset prices could actually be destabilising and therefore not compensate the small welfare gain of reacting to asset prices. It appears then that calibrating a "financial accelerator" effect does not give much of a role to asset prices in monetary policy, though the non-linear models might suggest otherwise. Empirical research is needed to elucidate this matter.

The origin of the shock matters for the decision of whether reacting to asset prices.

Monetary policy should lean against the wind of significant asset price movements if these disturbances originate in the asset markets themselves. Therefore, more efforts are needed to improve identification of the fundamental value of asset prices, to make it possible to have good estimates of misalignments, and to improve implementation of monetary policy. Research has also been putting emphasis on credit market conditions. What these can tell us in connection with designing better policy rules to avoid financial crises appears to be a promising topic for future research.

Benefits from reacting to a non-fundamental shock that affects investment derive from a more stable output gap, which is the consequence of a more stable investment. However, when some form of irrationality affects the value of asset prices, an inflation targeting regime may result in a misallocation of the economy's resources, with too much investment at the cost of low consumption. The correction of this imbalance may be costly. However, asset prices and inflation may become more stable if the policy instrument reacts to asset prices in addition to deviations of the expected inflation from the target when the economy is hit by a non-fundamental shock. This would support the argument set forth in Cecchetti et al. (2000) that central bankers that pursue price stability will more easily reach that target by reacting to asset prices. However, according to Gruen et al. (2003), the appropriate monetary policy reaction to a bubble may be loosening rather than tightening. The relation between monetary policy and asset prices, and the endogeneity of the non-fundamental component, is also the subject of intense research.

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Notes

[1]The main references on the topic of the "financial accelerator," or financial constraints and economic activity in general, are Bernanke, Gertler, and Gilchrist (1996), Kiyotaki and Moore (1997) and Bernanke, Gertler, and Gilchrist (1999). Modified versions of the model developed by Bernanke et al. (1999) have been frequently used in this literature. However, Gomes, Yaron, and Zhang (2003) cast doubt on the empirical adequacy of this type of model. Holt (2003) brings together financial constraints and investment irreversibility, and argues that existing empirical work on investment may be deficient due to failing to take both aspects into consideration.

[2]See Gilchrist and Leahy (2002) for a discussion of the problems with interpreting wealth effect estimates. See Lettau and Ludvigson (2004) for a recent empirical study.

[3]The data came from Datastream.

[4]There is a debate as to the descriptive realism of simple rules. On one hand, Taylor (1993) has argued that a simple rule — the Taylor rule — was a good description of the Federal Reserve's interest rate policy, and Clarida, Galí, and Gertler (1998) have argued that the Bundesbank can be represented as having set German interest rates in response to a few key variables. On the other hand, no central bank will admit to using a simple rule: actual central banking requires art besides science — recall Blinder (1997).

[5]For a description of this monetary policy regime see, e.g., Bernanke, Laubach, Mishkin, and Posen (1999).

[6]In a more general way, the optimal policy could be cast in terms of the state variables of the model: exogenous variables such as shocks, and predetermined endogenous variables. Given that the stock price is neither of these, it would not enter the optimal policy rule in the benchmark model. No one would advocate responding to asset prices in the benchmark model: there are no non-fundamental fluctuations, nor financial accelerator effects to endanger financial and macroeconomic stability. The only disagreement might be on the definition of the price index to be targeted. Following Alchian and Klein (1973), Goodhart (2000) contends that ideally the price index should include asset prices, though recognising that is very hard to put in practice.

[7]A better alternative to reacting to asset prices, some will argue, is to have adequate regulatory and supervision frameworks — see, e.g, Schwartz (2002). However, White (2004b) argues that the moral-hazard problem raised by government intervention to limit the impact of financial crises is significant.

[8]Naturally, one might again argue that in practice a central bank should also look to asset prices in order to identify the type of shock that is driving the economy, and this might even justify giving asset prices a role in the simple policy rule used. However, the existence of a (totally uninformative) bubble in asset prices would tend to reduce the usefulness of such a policy rule — this is an argument

similar to the one presented in Alexandre and Bação (2005) concerning measurement errors and the response of monetary policy to asset prices.

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