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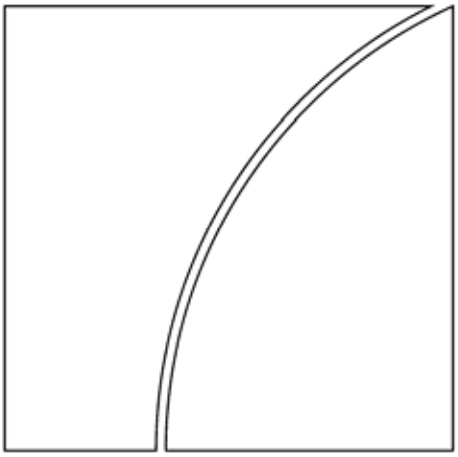

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Understanding asset prices: an overview

2006 Autumn Meeting of Central Bank Economists

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The views expressed are our own and do not necessarily reflect those of the central banks that were represented at the Autumn Meeting of Central Bank Economists on "Understanding asset prices: determinants and policy implications" or the Bank for International Settlements.

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Abstract

This paper reviews analytical work carried out by central banks that participated at the Autumn Meeting of Central Bank Economists on "Understanding asset prices: determinants and policy implications", which the BIS hosted on 30–31 October 2006. The paper first discusses some general properties of asset prices, focusing on volatilities and co-movements. It then reviews studies that look at determinants of asset prices and that attempt to estimate a fair value of assets. The next part of the paper focuses on research that aims at measuring the impact of changes in asset wealth on the real economy. It then goes on to discuss how central banks use information from asset prices to develop indicators of market expectations that are useful for monetary policy purposes. Finally, the paper reviews central banks' views on whether monetary policy should react in a direct way to asset price developments.

Contents

Introduction[1]

In the wake of financial liberalisation and innovation, asset prices have become more important factors in driving economic fluctuations, allocating resources across sectors and time and influencing the strength of the financial system. Moreover, asset prices play various related roles in the monetary policy/financial stability frameworks. These roles include acting as sources of information concerning market expectations and markets' risk attitudes, acting as leading indicators of output, inflation and financial distress, and acting as indicators of the shocks that hit the economy. In recent years, policymakers have been confronted with sometimes unusual developments in asset prices, including strong booms and busts, the exceptional strength and breadth in the upswing in residential property prices, historically low long-term interest rates, and low volatility and very narrow credit spreads. As a result, it has become more important to understand what determines asset price movements, to interpret the message they contain about the future and to incorporate them into policy decisions.

In this context, some of the questions that seem particularly relevant include the following. How have the low- and high-frequency statistical properties of asset price behaviour changed, if at all, over time? What have we learnt in recent years about the determinants of asset prices? How useful are various techniques for assessing whether asset prices are evolving broadly in line with economic fundamentals or exhibiting "bubble"-like behaviour? Have central banks made advances in estimating time-varying risk premia and understanding their determinants? Has there been any progress in examining the role of "liquidity conditions" as a determinant of asset prices? How significant are the various roles played by asset prices in monetary policy and financial stability frameworks? Has their use changed over time, and if so, how and why? Is there a case for a more pre-emptive policy with respect to asset price misalignments, or is it always best to allow the potential imbalance to unwind before responding?

This paper reviews analytical work carried out on these and related issues by central banks that participated at the Autumn Meeting of Central Bank Economists on "Understanding asset prices: determinants and policy implications", which the BIS hosted on 30–31 October 2006. The first part of the paper briefly discusses some general properties of asset prices and takes a first look at the data. The second part looks at determinants of asset prices and attempts to estimate a fair value of assets, while the third section focuses on the impact of changes in asset wealth on the real economy. The final section discusses how information from asset prices can be used to develop indicators of market expectations and how such indicators can be employed for monetary policy purposes. This section also discusses if and how monetary policy should react in a more direct way to asset price developments.

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1. Properties of asset prices

The most general asset pricing model states that today's price of an asset, p_t, should equal the expected value of the product of a stochastic discount factor m_{t+1} and the payoff of the asset one period ahead, x_{t+1} (see eg Cochrane (2005)):

$$p_t = \mathrm{E}_t\left[m_{t+1}x_{t+1}\right]. \quad (1)$$

This pricing equation is general in at least two senses. First, it holds for any asset, including stocks, bonds, real estate property, etc. Second, it does not depend on any specific assumptions about the properties of asset prices, and therefore does not rely on any particular asset pricing model. Nonetheless, specific models, such as the traditional CAPM, or some multifactor model, can be accommodated within (1), simply by choosing a specific functional form for the stochastic discount factor m_{t+1}. In a consumption CAPM setup, for example, the stochastic discount factor would be a function of marginal utility of consumption, and asset prices would then depend on the covariances between their payoffs and consumption.

While the generality of asset pricing equation (1) is very appealing in its simplicity, the main drawback is that it is too general to give us meaningful guidance when confronted with observed asset prices, unless more structure is imposed and additional assumptions are made. The main problem in this regard is that pricing equation (1) contains many unobservable elements, such as future payoffs and risk premia demanded by investors, which are hard to disentangle. Imposing structure so as to make (1) operational requires making choices on various issues, such as the type of preferences consumers have, which often are not obvious. Moreover, when attempting to estimate asset pricing models using observed data, additional assumptions, such as specific distributional properties of asset prices, are often required.

In addition to these practical complications, real-life asset prices sometimes tend to exhibit features that seem hard to reconcile with equation (1). Examples include the very low levels of long-term bond yields observed recently (the "conundrum"), high international co-movement of asset prices, and very sharp price rises and subsequent collapses in some markets, suggestive of bubble-like behaviour. It is not always clear, however, whether such violations or puzzles are due to a choice of overly limiting assumptions in the implementation of specific asset pricing models or whether they are the result of market failures and other factors that lie outside traditional asset pricing frameworks. Another potentially important issue that may be hard to reconcile within the framework discussed here relates to liquidity constraints, which can play a key role for some assets and markets.

While most papers discussed at the 2006 Autumn Central Bank Economists' Meeting explicitly or implicitly make use of the basic pricing formula in (1), the value added of individual papers often lies in how they address the specific issues that pin down the pricing relation and the way apparent violations or puzzles are taken into account.

A look at the data: volatility and co-movements

In order to understand the behaviour of asset prices and the forces that shape them, it is useful to have a look at the data. The first moment of asset prices and returns is discussed in the next section, which focuses on the determinants of asset prices. Meanwhile, this section reviews recent work conducted in central banks concerning the second moment of asset returns, ie volatilities and co-movements.

Volatility

One issue of particular relevance is measurement of volatility – which inherently is an unobservable variable. Chaboud et al (Federal Reserve Board, 2006) focus on the issue of

measuring realised volatility as precisely as possible using intraday data, an issue also addressed by eg Andersen et al (2001, 2003). The authors argue that while, in principle, volatility estimates should become more precise the higher the sampling frequency (see Andersen et al (2001)), market microstructure effects at very high frequencies tend to create important complications. Hence, there is an optimal trade-off between higher frequency of sampling and microstructure noise that should result in the best possible estimate of realised volatility. Results reported by Chaboud et al suggest that for large, well developed, liquid markets, the optimal sampling frequency can be substantially shorter than what has been suggested in the literature. While the application in the paper is on foreign exchange returns, the analysis has general implications for other asset classes.

The properties of volatility is a topic that has received a great deal of attention in the literature; examples include Schwert (1989b); Campbell et al (2001); Gerlach et al (2006); Wei and Zhang (2006). In a Bundesbank study, Stapf and Werner (2003) study the properties of volatility on the German DAX equity index and find that volatility is significantly higher and much more persistent after 1997 than before. A decomposition of overall volatility into market- and firm-specific volatility suggests – in line with the results of Campbell et al – that the idiosyncratic component has increased more than the market component. The authors argue that this structural break cannot be attributed entirely to international factors: potential additional factors include the growing number of institutional investors and the increase in the volatility of long-term interest rates.

Taking a longer-term perspective, and looking at a broader class of assets and markets, recent joint research work of the Bank of Italy, the Bank for International Settlements, the Federal Reserve Board and the Swiss National Bank finds instead that the current level of volatility is relatively low (BIS (2006c)). A distinguishing feature documented in this study is that volatility has been low for a prolonged period simultaneously across different asset classes and markets. The paper builds three different measures of global financial market volatility: (i) the volatility of an equally weighted international bond-equity portfolio, (ii) a simple average of individual market volatility indexes, and (iii) the sum of quartile indexes of individual market volatility indexes. The paper confirms earlier findings in the literature that financial volatility is countercyclical (see eg Schwert (1989a,b) and Brandt and Kang (2004)), and concludes the recent decline in volatility is partly explained by the sustained expansion of the world economy. At the microeconomic level, the paper argues that the decline in volatility reflects the reduction of leverage and increase in profitability experienced by listed companies since 2003. Another factor which seems to have helped to keep global volatility low is monetary policy: increased gradualism in policy action, greater transparency and improved communication about policy intentions have translated into more stable money market rates.

Co-movements

The issue of international co-movements or spillovers of asset prices is an important one when considering the use of asset prices as indicators of the state of the domestic economy. Obviously, if asset prices move as a result of price movements abroad that are unrelated to domestic fundamentals, their informational content is diluted. If, instead, they move as a result of common or foreign shocks which are expected to have consequences for the domestic real economy, then this should provide policymakers with useful information. Similarly, asset prices can move because of changing risk premia, which also may depend on local or global factors. For example, as markets become more and more financially integrated, it seems likely that changes in investors' risk appetite should have an impact on asset prices globally rather than locally. There is evidence that the pattern of international co-movements in asset prices has changed over the years, for example as a result of deepening financial integration (Bekaert and Harvey (1997)).

Equity markets provide a fruitful field in which to study the effects of financial integration (see eg Chen and Knez (1995); Bekaert and Harvey (1995, 1997); Stulz and Karolyi (2001);

Baele (2005)). Research at the Bank of France, as described by Clerc (2006), suggests that the influence of US data on European equity markets is very important; similar results have been found by eg Ehrmann et al (2005). Avouyi-Dovi and Matheron (2006), in a framework that isolates the long-term and cyclical components of productivity growth and stock returns in the United States and the euro area, find not only a correlation of stock returns and productivity in both, but also that the cyclical components of stock returns co-vary in the United States and the euro area, which they argue is a possible sign of contagion effects. Avouyi-Dovi and Neto (2004) also study interdependence between the European and US stock markets by examining the conditional correlations defined by Engle (2001), using daily data from 1993 to 2002. In phases of high volatility, the estimated correlation across markets tends to rise – a common finding in the empirical literature, which to some extent is due to a statistical link between sampling volatilities and correlations (see eg Forbes and Rigobon (2002) and Loretan and English (2000)). More recently, Idier (2006) estimates the impact of risk transmission using a multivariate GARCH model for data from 1994 to 2006. Again, the dynamics of stock prices in Europe are found to be largely influenced by US stock market developments. Though this influence seemed to weaken from 2000 to 2003, in line with what might have been expected from monetary union, the tendency for European indices to follow US markets strengthened again after that.

The contribution from the Bank of Chile (Echeverría and García (2006)) also focuses on the effects of financial market integration on the dynamics of equity returns, but with an emphasis on emerging markets. Simple measures of correlation show a high degree of co-movement between equity prices in emerging and mature markets. Moreover, this kind of correlation seems to have been generally increasing over the past 15 years. This result is in line with the findings of Chuah (2004), who finds evidence suggesting that the increase in correlation is due to greater financial integration. Echeverría and García also estimate a factor model for daily emerging market equity returns, which reveals that mature stock market returns and exchange rates seem to be important determinants. When including regional emerging market equity index returns in the model, however, the importance of these two factors seem to decline. The author interprets this as an indication of common factors driving equity returns in both emerging and developed markets – possibly due to variations in risk appetite or financial conditions more generally.

In bond markets, a number of studies have documented international co-movements and spillovers, in particular showing a strong influence of the US market on other markets; see eg Sutton (2000); Ehrmann and Fratzscher (2005); Goldberg and Leonard (2003); Andersen et al (2005). Empirical work on Australian yields has also emphasised their strong relationship with US yields. Kortian and O'Regan (1996), for example, show that pronounced spillovers from US bond yields to Australian yields are common. As a result, studies that examine the response of domestic bond yields to various types of information find that it is important to condition on US yields. Campbell and Lewis (1998) document that Australian yields respond more to US news than domestic news, though shorter-term bill yields respond more to domestic news. More recently, Coppel and Connolly (2003) have confirmed that only the medium and longer end of the Australian yield curve is significantly related to US interest rates. Work done at the Bank of France by Idier et al (2006), confirming the findings of the papers mentioned above, find that euro area long-term rates are heavily influenced by US rates. They argue that this influence may have been an important factor in explaining the low level of long-term rates observed in the euro area recently.

2. Determinants of asset prices

Any attempt to understand what determines asset prices essentially involves pinning down the specific form of the stochastic discount factor and of the future payoffs in pricing equation (1). In some cases, such as government bonds, the payoffs are known in advance, while in

the majority of cases they are uncertain and therefore need to be modelled. The stochastic discount factor is, of course, never directly observable, and therefore has to be inferred from the data. This involves implicitly or explicitly making statements about the preferences of investors and taking a stand on the relevant state variables that determine them.

The pricing of fixed income instruments

Research on the term structure of interest rates has made significant advances in recent years by developing models that are very flexible in terms of specification of the stochastic discount factor and the underlying state variables. Dynamic no-arbitrage models, such as the affine class of models[2] proposed by Duffie and Kan (1996) and generalised by Dai and Singleton (2000), have been quite successful in modelling the dynamics and interrelations of bond yields across the term structure. Developments in the way risk premia are modelled have resulted in specifications where term premia are capable of resolving the "expectations puzzle" of Campbell and Shiller (1987), ie the empirical observation that long-term yields are not unbiased estimators of average future interest rates (Duffee (2002); Dai and Singleton (2002)). All of these models have relied on unobservable "latent" factors as the underlying forces driving bond yields. While this approach results in highly flexible models, it does not provide a straightforward way to interpret movements in bond yields and term premia in terms of macroeconomic fundamentals, which central banks often have an interest in doing. In the past few years, improvements have been made on this front, and a number of papers that combine macroeconomic information and modelling with finance-based no-arbitrage pricing of bonds have appeared, sparked by the work of Ang and Piazzesi (2003). Recent work linking the dynamics of macro factors with the term structure within a no-arbitrage setup include Rudebusch and Wu (2004), Dewachter and Lyrio (2006) and Hördahl et al (2006).

Several papers presented at the meeting describe how central banks develop and use different kinds of no-arbitrage term structure models to try to understand the movements of bond yields. Orphanides (Federal Reserve Board, 2006) reviews the progress that has been made over the past several years in exploring the term structure and its relation to the macroeconomy. The analysis includes an examination of the behaviour of estimates of term premia in the United States obtained from dynamic term structure models, as well as comparisons with survey data. In particular, survey data seem useful in providing a substantial amount of information on actual interest rate expectations, which can be used to disentangle term premia from expectations components in term structure data. An examination of the dispersion of survey expectations for interest rates and inflation shows that estimates of term premia are highly correlated with such measures of dispersion. This result seems to go some way in explaining the observed recent decline in estimated term premia in the United States.

Pericoli and Taboga (2006) at the Bank of Italy pursue term structure modelling along the lines of Ang and Piazzesi (2003), making use of both observable and unobservable state variables. Applying this methodology to German government bond data for the past three decades, the study finds that estimated risk premia display considerable variability over time, are countercyclical, but have no significant relation to inflation. These results confirm the findings of Hördahl et al (2006), who also examine German term structure dynamics, but within a structural macrofinance model that does not require relying on latent state variables. The Bundesbank (2006) has estimated the determinants of the term structure of German interest rates, pre-EMU, in a macrofinance model that combines arbitrage-free models and

[2] In affine term structure models, zero coupon bond prices are exponential-affine functions (exponential of an affine – ie linear plus a constant – function) of a set of factors or state variables, and yields are affine functions of the factors.

monetary macroeconomics. The results show that the explanatory power of inflation and economic activity for interest rate movements tends to decrease with time to maturity. Observable macroeconomic factors seem to do best in capturing persistent fluctuations of short-term interest rates. Other Bundesbank research papers employing the affine macrofinance framework include Fendel (2004) and Lemke and Stapf (2006). The latter study emphasises the development of estimated risk premia, which turn out to exhibit considerable time variation both before and after the launch of the euro. Lemke and Archontajkis (2006) ask whether there are nonlinearities in the dynamics of short-term interest rates. In comparison with a standard linear model, the paper finds empirical evidence in favour of a threshold model. Based on the threshold process of the short rate, arbitrage-free bond yields are derived. The estimates imply that the sensitivity of long-term yields to changes in the short rate declines with the level of the short rate.

Kremer and Rostagno (ECB, 2006) try to identify forces contributing to the recently observed very low bond yields in the euro area. The authors examine the term spread – ie the difference between the yields on long- and short-term bonds – within a DSGE model à la Christiano et al (2006). They also introduce an exogenous process that they label a "term premium shock", which is a residual that explains movements in the term spread unrelated to the macroeconomic fundamentals in the model. It turns out that the fundamental factors in the model are unable to account for the recent decline in the term spread, which instead is captured by the exogenous "term premium shock". However, because this shock is exogenous, the model cannot identify fundamental forces behind the fall in premia. Estimates from an affine two-factor term structure model point to a sharp reduction in estimated term premia in the recent past, suggesting that a reduction in the required compensation for risk may account for part of the low level of bond yields. However, because this model is based on unobservable latent factors, it is silent about the fundamental determinants of declining premia. Simple regressions of estimated term premia on measures of macroeconomic and financial volatility point to statistical significance of these variables, but also show that they are unable to account for the recent downward trend in premia. Nonetheless, the authors do find some similarities between movements in the exogenous "term premium shock" and measures of liquidity (broad monetary aggregates), suggesting that excess liquidity might be part of the story.

Westaway (2006) also examines the underlying causes of the recent bond yield conundrum by studying the behaviour of rate expectations and term premia derived from term structure data. One conclusion is, again, that the risk premium plays an important role. However, because estimated premia often represent the residual component which reconciles asset price changes with movements in observed fundamentals, some caution is warranted in the interpretation of such results. Specifically, he argues that it is important to examine movements in estimated risk premia to judge whether they are consistent with a "reasonable" evolution of premia, given economic theory. In this context, Westaway discusses ongoing research at the Bank of England that uses a DSGE model of a closed production economy to examine how risk premia are determined by the interaction of shocks in the economy, preferences of agents and structural characteristics of the economy. The results so far show that a decline in the volatility of underlying shocks would be consistent with lower output volatility and lower term premia. However, the model does not deliver an overall fall in real yields, and is therefore unable to account for the conundrum.

Apart from fundamental macro factors, bond yields can be influenced by institutional aspects, such as special "demand factors", eg by pension funds and central banks, or more general liquidity considerations. Recent research at the Bundesbank, surveyed by Lemke and Worms (2006), has focused on the role played by demand factors in explaining the low level of interest rates in the United States and the euro area, given the outlook on real activity and inflation. Schich and Weth (2006) provide a measure of the potential excess demand from institutions such as pension funds for high-quality fixed income instruments, based on estimations of cash flow requirements in the distant future. Estimates of scarcity are highest

at the very long end of the yield curve, beyond the 10-year segment, and the results suggest that bond prices are affected when reallocations take place to dissolve "pent-up" institutional demand for long-term bonds. Because such factors cannot easily be captured within a traditional asset pricing framework, such as in (1), it may be important to take them into account separately. Idier et al (2006) at the Bank of France find that several factors such as global liquidity, as measured by the gap between monetary growth and nominal GDP growth, net foreign demand of US long-term bonds and financial market uncertainties as measured by equity prices, have significantly impacted US long-term rates. Their results suggest that net demand for US government bonds was most significant in 2004, while at the beginning of 2005 there is evidence of a greater contribution from excess liquidity.

An additional factor that may affect government bond yields is credit risk. Lemke and Worms (2006) discuss research conducted at the Bundesbank that considers the effects of fiscal policy on long-term yields in Germany and France. Heppke-Falk and Hüfner (2004) find that, during the EMU period, spreads between high-quality private debt and government bond yields for these two countries depend negatively on expected budget deficits. However, the estimated effect is small: a 1 percentage point increase in the budget deficit ratio reduces the swap spread by only 3 to 8 basis points. Other research by Bernoth and Wolff (2006), which compares long-term bond yields of different countries, shows that creative fiscal accounting increases bond spreads and that the risk premium increases with the uncertainty faced by financial markets about the true extent of creative accounting. A current project by Hallerberg and Wolff (2006) finds that countries with "better" institutions are associated with lower sovereign risk premia, and that the impact of budget deficits on risk premia is lower in such countries. Related to this area of research is the issue of the low emerging market credit spreads seen recently. Comparisons of such spreads with credit ratings suggest that both increasing appetite for risk among investors and improving fundamentals may have contributed to the reduction in emerging market spreads (see BIS (2006b)).

Credit risk is also discussed in the Bank of Italy contribution, which highlights research on the determinants of corporate credit instruments. Guazzarotti (2004) investigates the determinants of changes in credit spreads of non-financial European corporate bonds during 1999–2003. Regressing monthly changes in spreads on factors that economic theory indicates as being relevant in determining both default and non-default risk, he finds that default risk factors account for less than 20% of the total variation in credit spreads, and that liquidity and aggregate market risk factors explain only an additional 10%. Paralleling the result of Collin-Dufresne et al (2001) for US bonds, he finds that a large part of the variation in spreads remains unexplained (ie the "credit spread puzzle"; see also Amato and Remolona (2003)). Another paper by Di Cesare and Guazzarotti (2005) looks at the determinants of CDS spreads and finds that as much as 60% of spread changes remain unexplained. This paper also documents that the relation between credit risk premia and fundamentals tends to be non-linear.

Recent research at the BIS has tried to shed further light on the issue of credit spread determinants, as well as on the question whether the market measures credit risk well. On the latter issue, Tarashev (2005) evaluates the performance of structural credit risk models (eg Merton (1974)), and finds that structural credit risk models predict default rates well on average. Specifically, model-implied default probabilities explain about 25% of the variability in default rates over time, but an additional 25–50% is explained by observable macroeconomic factors. With respect to determinants of credit spreads, Amato and Luisi (2005) include observable macroeconomic factors as potential determinants and find that these do contribute to explaining the dynamics of the term structure of credit spreads as well as the intertemporal evolution of risk premia on corporate bonds. The paper also estimates the price of non-diversifiable default risk and finds that this price is countercyclical, quite volatile and larger for higher-rated debt. At the micro level, Packer and Zhu (2005) document that contractual terms related to the definition of trigger events and deliverable obligations –

which can have significant implications for both markets and regulatory practice – are priced into CDS spreads.

While Amato and Luisi (2005) find that observable fundamentals contribute to explaining credit spreads, a substantial part is nevertheless still explained by latent factors. In an attempt to avoid relying on latent factors, Zhang et al (2005) add stochastic volatility and jumps in the value of assets to Merton's structural model of credit risk in order to explain CDS spreads. They find that volatility and jump risk explain 54% of the variability in CDS spreads, and that observable borrower-specific and macro factors raise the explanatory power to 77%. Hence their results go some way in accounting for the credit spread puzzle. Amato and Remolona (2005) offer a complementary rationalisation of this puzzle. The paper argues that, contrary to traditional assumptions, idiosyncratic default risk cannot be diversified away in real-world portfolios of corporate bonds and that it therefore is priced. They propose a VaR-based measure of idiosyncratic risk, which seems to largely explain credit risk premia.

Another important issue is the pricing of portfolio credit risk, in which asset return correlations need to be taken into account. In a recent paper, Tarashev and Zhu (2006) attempt to dissect the pricing of portfolio credit risk by examining spreads on CDO tranches with single-name CDS spreads. The authors estimate probabilities of default, specific to each constituent entity and correlation of the constituent entities' asset returns, which are then fed into a standard model of CDO tranche spreads. The resulting synthetic prices compare poorly to observable prices, which is attributed to the ad hoc distributional assumption made in standard models. In fact, by introducing a negatively skewed common factor that determines borrowers' asset returns, the discrepancy disappears. This corresponds to assuming that market participants highly value insurance against states in which a large number of entities default. While such a premium can explain the level of portfolio credit risk prices, it is unable to account for their variability over time, which instead is almost fully explained by default probabilities.

Equity prices – determinants and fair value

As in the case of term structure research, the issue of links between equity returns and macroeconomic fundamentals and monetary policy has received considerable attention in analytical work at central banks. Panetta (2001) at the Bank of Italy undertakes a thorough investigation of the relation between stock returns and a very wide range of macroeconomic variables in Italy over the period 1978–1994, and finds that the relation between stock returns and macroeconomic factors is highly unstable for both individual securities and portfolios. Other research at the Bank of Italy focuses more the role of monetary policy shocks in moving stock markets. Locarno and Massa (2005) account for the negative relation of stock returns and expected inflation as due to markets responding to changes in inflation outcomes that change the outlook for a uncertain monetary policy. Neri (2004) evaluates the effects of monetary policy shocks on stock market indices in the G7 countries and Spain, using structural VARs, whereby a model is estimated for each country. He finds a negative effect in all countries of changes in short-term rates on stock market indices, though the effect tends to be small and short-lived.

Lee et al (2006) model the quarterly stock returns from 1990–2006 of companies in the Singaporean SESALL share index as a function of macroeconomic variables in a single-equation error correction model. Fundamentals such as GDP growth and exchange rate appreciation are statistically significant. In addition, the authors find that short-term interest rate changes do have an impact on fluctuations in returns. Further, the sign for money supply is strongly positive, implying a significant relationship between liquidity conditions and stock prices, at least in the case of Singapore.

Estimation of the impact of macroeconomic developments on financial markets on a high frequency basis often suffers from the fact that macroeconomic data the researcher has are often not those that were available to markets at the time. Empirical studies typically use

ex post data, but Döpke et al (2006a,b) at the Deutsche Bundesbank are able to use the recently compiled Bundesbank real-time macroeconomic data set. The authors find that predictions of stock returns and volatility based on real-time macroeconomic data do not differ much from hypothetical predictions based on final revised data.

In contrast to government bonds, the future payoffs of equities are not known today. This presents researchers with an additional layer of uncertainty that has to be addressed in order to understand the pricing of equities. This aspect becomes particularly relevant when trying to ascertain whether or not equity markets are fairly valued – an active area of investigation at central banks especially since the possibility of "irrational exuberance" in asset markets was aired by then Federal Reserve Chairman Greenspan (1996).

One way of getting at the valuation question is through the estimation of equity risk premia and comparison of these premia with historical averages. At the Bank of Italy, equity risk premia are regularly calculated through a three-stage dividend discount model, whereby expected earnings are proxied by earnings forecasts and long-term GDP forecasts, and expected inflation taken from Consensus Economics.[3] The Bundesbank also uses a three-stage dividend discount model that decomposes price developments into four determinants: earnings expectations, current dividends, real interest rates and implied risk premia (Bundesbank (2003)). According to Bank of Italy calculations for the euro area, the level of risk premia was significantly higher in 2005 than its average since the early 1990s, suggesting the equity market valuations, at least at the time of the study, were not particularly overstretched (Bank of Italy (2005)).

A related issue is the estimation of investors' risk aversion, by utilising methods to disentangle investors' reluctance to take risk ("risk aversion") from the quantity of risk embedded in financial assets ("riskiness"). Pericoli and Sbracia (2006) at the Bank of Italy investigate the theoretical underpinnings of the "Risk Appetite Index" proposed by Kumar and Persaud at the IMF (2001), which is defined as the rank correlation between expected excess returns and the riskiness of a cross section of assets (see also Tsatsaronis (2000)). The authors suggest that this measure distinguishes between risk and risk aversion only under very restrictive assumptions, and that the measure is very similar to an alternative measure of risk aversion derived from CAPM – results similar to those found by Misina (2003). Grande and Pericoli (2004) at the Bank of Italy estimate an stock option-based indicator of risk aversion, following the methodology laid out by Tarashev et al (2003), which compares the probability distribution of the index implied in option prices with the distribution inferred from historical values of the index. Estimating the index for Germany, Italy and the United States, they find a considerable degree of variation of risk aversion through time and a distinct co-movement of the indicators across countries.

Real estate

Like other assets, property price movements are determined by changes in expected cash flows generated by the asset subject to a stochastic discount factor. However, there are a number of features that distinguish property from other assets. For one, property is a highly heterogeneous good, distinguished markedly by idiosyncratic local factors. Real estate markets are also relatively illiquid, with most owners holding on to assets for long periods of time for residential purposes. And purchasers of property tend to be exceptionally reliant on external debt finance, while real estate is usually used as collateral in such financing

[3] The methodology essentially follows Panigirtzoglou and Scammell (2002). The three-stage dividend discount model assumes that projected profit growth initially evolves according to market forecasts, but subsequently converges to a long-run level, which in turn is determined by the long-term real interest rate and a risk premium.

arrangements. In addition, housing directly delivers a stream of consumption services that are more difficult to value than in the case of most other assets.

The past couple of decades have seen price booms in real estate markets in a number of countries, as well as collapses in some cases. A number of the papers presented at the Autumn Meeting discuss research on the determinants of housing and property prices. Many contributions also consider the related issue of estimating equilibrium real estate prices in order to identify possible misalignments.

Measurement issues and geographic considerations

One of the most notable by-products of the lack of liquidity and heterogeneous nature of housing markets is that the measurement of housing prices is often highly problematic. Because of the lack of liquidity, only a limited sample of properties might be available to calculate the relevant price index in any month or quarter. Further, the characteristics of the properties that are sold may change markedly between measurement periods. Thus, the policymaker interested in abstracting from these effects to arrive at a "pure" price change must construct quality-controlled indices. These and other methodological issues in the construction of property price indices have been recently addressed in a volume resulting from a conference on real estate indicators and financial stability organised by the BIS and IMF (BIS (2005)).

One way to adjust for changes in quality is through the calculation of hedonic indices, whereby observed prices are estimated to be a function of quality characteristics, which in turn allows the construction of quality-controlled indices. Hoffmann and Lorenz (2006) of the Bundesbank describe in detail the latest developments of estimation of hedonic property price indices in Germany. Earlier, Kurz and Hoffmann (2004) had estimated hedonic functions for German rents and owner-equivalent rents, and concluded that the true rate of price increase is significantly understated in the official German CPI housing subindex.

While hedonic price indices for real estate can improve markedly upon traditionally calculated ones, they tend to be very resource-intensive in terms of data collection and computation. An open question in the literature is the extent to which the results of hedonic price indices for real estate can be replicated using less data-intensive approaches. A common alternative is to use a repeat-sales index. Hansen (2006) of the Reserve Bank of Australia (RBA) constructs repeat-sales indices for three major Australian cities and finds that they produce less volatile measures than regular median price measures. Alternatively, Prasad and Richards (2006) construct a house price index by grouping suburbs according to their long-run price levels and taking the average of the median of these groups. This latter measure generally replicates movements in hedonic and repeat-sales indices, which supports the empirical method.

Given the local nature of real estate markets, it comes as little surprise that geographic considerations can be a critical determinant of real estate prices. Major cities seem to benefit disproportionately from housing price run-ups, resulting in greater disparities of wealth between the largest cities and outlying regions. For instance, Égert and Mihaljek (2006) document concentration of real estate price appreciation in the capital cities of central and eastern Europe, which are now close to EU 15 levels. Real estate price movements in the capitals also seem to lead prices movements elsewhere. Other conference contributions also document disproportionate gains in capital cities during the latest episodes of rapid property price appreciation, as well as (in some cases) a more marked sensitivity in capital regions to feedback mechanisms such as higher stock prices (Bu (2006), Jung (2006), Kamada (2006)). Another geographic consideration of importance to control for in empirical estimates of the determinants of property prices is spatial correlation, ie the fact that even after controlling for fundamentals, land prices in different regions can be correlated with each other simply because of adjacent location (Kamada (2006)).

Globalisation of international capital appears to have been an important stimulus to housing price appreciation in a number of countries. The contribution from Bu (People's Bank of China, 2006) documents that housing price appreciation has been greatest in those areas where foreign capital has entered China's real estate market. In the past few years, around 5% of total property sales in China were accounted for by foreign capital, but in Shanghai the proportion reached close to 25% in the latter part of 2004.

Measuring the importance of factors underlying property price appreciation can be further complicated when the price observations from some periods do not represent market clearing prices. For example, much of the rapid house price appreciation in the countries of central and eastern Europe was an adjustment from overly low levels earlier, due to the distortion of relative prices inherited from the planned economy regimes (Égert and Mihaljek (2006)).

The role of credit

As with other asset prices, rising property prices in many countries have been encouraged by low and falling real interest rates. Lower interest rates can operate to loosen credit constraints: Ellis (2005) at the RBA finds that the reduction in the interest rate burden for households was very important for the rapid rise in property prices in Australia in the late 1990s and early 2000s, when the ratio of housing prices to household disposable income doubled. The contribution from Coleman (Reserve Bank of New Zealand, 2006) develops an overlapping generations model of the housing market in New Zealand, where low interest rates also contributed greatly to the amounts that a typical borrower can borrow. Interestingly, the estimated model finds that the relaxation of mortgage credit constraints does not account for the large increase in housing prices in New Zealand, since older unconstrained households easily offset changes in demand from (younger) constrained households. Rather, the price of rental property has been highly sensitive to the decline in real interest rates. In this case, the transmission from lower real interest rates to higher housing prices appears to have been more through the lower discount rate applied to expected cash flows than through the relaxation of liquidity or cash flow constraints.

Other central bank research has been supportive of an independent role for credit in property price determination, given the importance of external finance and credit constraints in many markets. Using an error correction model, the Bank of Korea's Jung (2006) finds Korean housing prices to be significantly influenced by private credit growth as well as GDP, with private sector lending actually being the most significant variable in an economic sense. In addition, the wide use of real estate as collateral suggests a possible feedback from real estate valuations to mortgage credit availability. The linkage between property prices and bank credit has been recently confirmed in a wide variety of empirical studies based on VAR analysis (Hofmann (2001), Davis and Zhu (2004), Zhu (2003)).

Some of the research described in the meeting contributions documents the significance of credit by controlling separately for interest rates in empirical estimation procedures. In a cross-sectional analysis of land prices in different Japanese prefectures, Kamada (2006) finds bank lending to have a significance apart from lending rates, one which has continued after the end of the bubble era. Lecat and Mesonnier (2005) from the Bank of France use dynamic panel data techniques along the lines of Arellano and Bond (1991) to investigate housing price developments in 18 countries. They find that three financial variables – the short-term rate, the term spread and real credit growth – are highly significant. The paper thus suggests that over the past six years, with varying consequences across countries, monetary policy easing associated with completion of the disinflation process has increased housing prices.

Research has shown that the importance of credit conditions on real estate prices can vary widely across countries. The Égert and Mihaljek study (2006) uses the panel dynamic OLS (DOLS) estimator – separating central and eastern European (CEE) countries from panels of other European economies – and documents that private credit growth is more important in

driving real estate prices in the CEE economies. Tsatsaronis and Zhu (2004) show that for a group of countries in which mortgage equity extraction is never used, and banks' lending practices – as measured by low loan-to-value ratios and the use of historical property valuations – are relatively conservative, the link between bank credit and housing prices is relatively weak, whereas in a group where equity extraction is common and banks' lending practices are more aggressive, the impact of bank lending on real estate valuation is much greater.

Systems moving towards more deregulated housing finance markets often show an increased sensitivity of housing prices to credit conditions. Many countries now exhibit more flexible mortgage financing terms, an increased availability of home equity, high loan-to-value and interest-only loans. In Australia, the increased availability of credit due to financial innovation probably put upward pressure on property prices (RBA (2003b, 2005)). In France, where financial deregulation in the mortgage market also contributed significantly to reducing borrowing constraints on households, property price increases have been accompanied by a marked increase in household indebtedness. New measures which modernised the mortgage market have probably increased household vulnerabilities to income and asset price fluctuations as well (Messonier (2004)).

Some studies look at real estate prices jointly with equity prices to examine the question of whether credit growth – and other variables reflecting liquidity conditions – results in asset price "booms". Examples of this line of research include Detken and Smets (2004), Borio and McGuire (2004) and the conference contribution of Bruggeman (National Bank of Belgium, 2006). Bruggeman defines excess liquidity in terms of cumulative deviations from trend of growth in money-to-GDP exceeding a specific threshold level. Using this identification scheme, the author finds that, in her data set of 18 industrialised countries since 1970, around one third of the periods of sustained excess liquidity have been followed by an asset price boom. Logit model estimations indicate that an asset price boom is more likely to materialise when the driving factors behind the build-up of liquidity include low interest rates, when credit growth is also strong and when asset price inflation is already well advanced. By contrast, using French data, researchers from the Bank of France (Gouteron and Szpiro (2005)) test for Granger causality in a VAR framework and find no clear signs of causality going from excess liquidity measures (such as the deviation from their long-term trends of money supply over nominal GDP, excess credit to nominal GDP and interest rate relative to natural rate) to asset prices.

Rapid credit growth, in part due to its association with property prices, also tends to result in banking and/or currency crises (eg Borio and Lowe (2002b)). The contribution of Kiss et al (Central Bank of Hungary, 2006) focuses on the characteristics of generally rapid credit growth in CEE countries, to disentangle the extent to which credit growth may be due to equilibrium convergence or to unsustainable credit booms. The authors use an error-correction model to estimate the long-run equilibrium level of credit-to-GDP based on fundamental macro variables, and apply the method to euro area countries in order to obtain a benchmark level against which emerging countries can be compared. With the exception of a few smaller countries, the results suggest that credit-to-GDP growth in CEE countries has been consistent with economic fundamentals or with convergence to the long-run equilibrium.

Estimating equilibrium prices and detecting misalignments

As discussed above, one characteristic of housing markets is that supply is localised and can only respond with a considerable lag to demand developments. This, along with a lack of transparency in property markets, the stickiness of rents, an inability to short-sell and the widespread use of real estate as collateral in loans, has resulted in a tendency for property prices to be more likely than other asset prices to deviate from their long-term fundamentals in the short run (Zhu (2003)). In addition, property prices can deviate from fundamentals independently from changes in risk premia in other markets. Researchers have documented

booms in real estate markets based on “myopic” or “rule of thumb” extrapolation of recent values and trends (Hendershott (1994) and Herring and Wachter (1999)).

Because of this, and the risks to the financial system when a real estate bubble bursts, central banks regularly utilise a variety of techniques to assess whether real estate prices are evolving broadly in line with economic fundamentals or instead deviating from them. Finicelli (2006) at the Bank of Italy analyses the pros and cons of inferring house price misalignments from the price-income ratio, the price-rent ratio, affordability indices and the user cost of housing ownership. The paper argues that price-income and price-rent ratios can give only an incomplete view of equilibrium asset prices, and that the index of affordability is difficult to interpret. Hence, it concludes that the best way to infer house price misalignments is the user cost approach, based on a comparison between the choice of owning and renting. Finicelli’s calculations for US property prices indicate that the increase in house prices between 1997 and 2003 (and in the actual price-rent ratio) is largely explained by a fall in the user cost. However, the continued appreciation over the period 2004–05 appears to have resulted in a certain degree of overvaluation.

In Korea, where housing prices have risen by far more than the income levels since the late 1990s, a variety of housing price models suggest the possibility that real-estate prices have overshot fundamentals. Lee (2006) of the Bank of Korea finds that housing prices rose about 8% over their long-term equilibrium level from 2001, using a long-term equilibrium model of supply and demand of Meen (2001). Secondly, on the basis of a current value model based on Campbell and Shiller (1987), Lee documents the lack of a cointegration relation between nationwide apartment prices and rental income, consistent with the existence of bubbles. Finally, Lee estimates a dynamic asset pricing model based on the theoretical model of Ayuso and Restoy (2006a,b), and in this setting finds apartment prices to be 4% over their equilibrium price, and nearly 8% in the most exclusive district of Seoul.

Lee et al (2006) of the Monetary Authority of Singapore (MAS) describe the ongoing development of an MAS error correction model for property prices. The model aims to assess the adjustment dynamics of the housing market in both the short and the long run, and provide the basis for a long-run equilibrium private property price index. It is based on a system of four equations, including private house prices and inventory, resale market prices and special government funds withdrawn for housing purchases. The econometric analyses indicate that the variables affecting long-run private property prices are real GDP, cumulative excess supply, rental and resale price indices. The authors estimate the peaks of property overvaluation in Singapore (relative to long-run equilibrium) to be 16–20% in 1994–95 and about 18% in early 2000.

In France, the evidence on misalignments of real estate prices from fundamentals is mixed. Villetelle (2005) examined housing price projections in France, regressing changes in residential property changes across a range of real and financial variables. The analysis shows that actual prices have diverged substantially from their past and usual determinants since 2002. On the other hand, Moëc (2004) looked at several indicators measuring potential housing price misalignments but could not find evidence supportive of the existence of a housing bubble. Indices of housing affordability regularly compiled and updated by Moëc (2004, 2006) still remain slightly above 1991 levels, though they have undergone a downward trend from 1998.

Ayuso, Blanco and Restoy (Bank of Spain, 2006), in an analysis of Spanish real estate prices, note that the application of simple valuation model – the Gordon dividend discount model – implies that the fall in ex post real interest rates, as proxied by the difference between nominal rates and actual inflation, can fully explain the boom in house prices since 1997 in Spain. However, the simple model does not take into account frictions, assumes constant real rent growth and risk premia and ignores the effects of taxes on the relationship between rents and prices. Specifying a more general intertemporal asset pricing model which distinguishes between observed values of house prices and a long-run equilibrium, and allows for a time-varying risk premium, they estimate the overvaluation of house prices relative to rents at the end of the sample period (2004) to be around 30%. Although this

implies that housing prices are well above their long-term fundamental equilibrium, the model also estimates the latest deviations from the estimated short-term adjustment path to equilibrium are small and thus not suggestive of a disorderly short-term adjustment. The authors posit that the discrepancy between their estimates of long-term overvaluation and the one generated by the simple model is largely due to the fact that changes in ex post real rates have been poor proxies for changes in ex ante real rates (the relevant ones in standard asset pricing models). This is particularly the case in Spain, where there were sharp drops in inflation expectations and the inflation risk premium ahead of monetary union.

3. Asset prices and consumer expenditure

The previous section has highlighted some evidence suggestive of asset price misalignments and bubble-like behaviour. An important reason why policymakers should be concerned about such misalignments is obviously that they are associated with severe risks to the real economy. In trying to gauge such risks, it is important to understand how changes in asset wealth impact consumption.

In the past few decades, the sensitivity of consumption to fluctuations in asset wealth seems to have changed. For example, while the 1970s stock market decline was associated with a sharp drop in consumption, the pattern following the 2000–2002 drop in equity prices was completely different, with consumption remaining stable. Potter (Fed New York, 2006) examines possible reasons for this shift in the reaction of consumption to falling stock market wealth, and also asks whether recent increases in equity prices have fuelled unsustainably high consumer spending. Empirical estimates of the propensity to consume from net worth have tended to be relatively unstable. Recognising this, Potter notes that recent research has modified the wealth effect of Modigliani's life cycle hypothesis to allow consumers to take into account the possibility that observed asset values may be inconsistent with long-run fundamentals. In this setup, consumers would change their consumption behaviour not in response to shifts in asset value that they perceive to be transitory, but only in response to perceived permanent shifts. Estimates of the transitory and permanent components of asset value show that it is highly likely that the build-up of equity market value that took place in the late 1990s contained a sizeable transitory component (the estimate is around US$ 4 trillion). By contrast, estimates for the most recent past do not suggest that the increase in stock market wealth is due to a transitory component, or that consumption would be unsustainably high. Finally, an examination of the response of consumption to housing wealth suggests that, although the estimates are imprecise, consumption is around twice as sensitive to shocks to real estate wealth as to fluctuations in stock market wealth.

Ongoing research at the Bundesbank is examining the extent to which housing wealth affects consumption. The first results of an empirical study suggest that while there is a significant link between consumption and housing wealth in the German data, it is much less pronounced than in the United States. A similar study by Hamburg et al (2005), based on data from 1980 to 2003, finds that a cointegration relation exists between variables of German consumption, asset wealth and income. The authors find that deviations from this relationship have predictive power for changes in income. This contrasts with studies such as Lettau and Ludvigson (2004), who find that such departures instead forecast changes in asset prices.

As Australia has a relatively large share of housing assets (60% of total wealth), estimates of the property wealth effect on consumption are even more important than in other industrialised countries. Estimates by Dvornak and Kohler (2003) suggest that a $1 increase in real estate wealth increases consumption by 3 cents, which is less than the 6 to 9 cents recorded for stock market wealth. However, since housing wealth is three times as large, a given percentage increase will have as great or greater an impact on consumption than the same percentage increase in stock market wealth. In terms of the precise mechanism, the Reserve Bank of Australia's examination of home equity withdrawal, which is discussed in its

well known survey of households (RBA (2005) and Schwartz et al (2006)), suggests that this is not the main source of rapid consumption growth. Property transactions (or trading up), rather than refinancing, are the main source of equity withdrawal, and less than one fifth of all equity withdrawn is used for consumption.

Instead of looking at the effect of asset wealth fluctuations on the average consumer, Calvet et al (Sveriges Riksbank, 2006) focus on segments of households which may be particularly vulnerable to swings in asset values. In particular, using micro data, they measure the financial fragility of the marginal buyer in the Swedish housing market, which they hypothesise will be a segment of the household population that is likely to contain those individual households that are especially vulnerable to idiosyncratic shocks as well as abrupt and sharp adjustments of house prices.

In research conducted at the Netherlands Bank, Berben et al (2006) also focus on the micro level in their analysis and explore the possibility of asymmetric wealth effects on consumption. Using a household panel to analyse the relationship between wealth gains and losses on actual and planned savings, they find that positive asset returns have a significant negative effect on household savings, while capital losses result in increasing savings. However, the effect is asymmetric, with the impact of a capital loss being about three times larger than that of a capital gain. Moreover, they find that the magnitude of this asymmetry increases with age. The authors argue that their results are in line with those of the loss aversion literature (Knetsch (1989)) of behavioural economics. Berben et al conclude that failing to take into account such asymmetries may seriously bias the estimates of the marginal propensity to consume out of wealth.

4. Asset prices and monetary policy

Monetary policymakers face at least two general sets of questions when working with asset prices. First, what is their information content? How accurately can they can be used to infer information about market expectations, as well as to generate predictions for the aggregate macroeconomic aggregates of interest to monetary policymakers? Looking again at asset pricing equation (1), it is clear why asset prices should be informative about market expectations as well as future economic fundamentals. The price of an asset today depends on the expectation of the future payoff of the asset, which is linked to future developments in the economy, and the way this payoff interacts with the stochastic discount factor, which itself will be related to agents' preferences and the state of the economy. The problem, of course, is to reliably extract the information from a consellation of asset prices – an exercise that, in principle, requires disentangling risk premia from expectations components, identifying relevant state variables that go into the pricing of assets and determining the functional form of the pricing relationship. An alternative empirical approach, also frequently pursued in the literature, is to directly analyse asset prices along with fundamentals in reduced-form relationships. Second, given the information content of asset prices, how should policymakers respond to movements in these markets? For instance, if a high likelihood of sharp misalignment has been identified in a particular market, should policy rates be changed as a result? The rationale for taking such action could be financial stability concerns per se or, more indirectly, concerns about the possible impact of a disorderly reversal of misalignment on output, inflation and other economic fundamentals.

Extracting information from asset prices about expectations

As noted above, asset prices can be analysed to provide information to policymakers about market expectations as such, eg for future interest rates, exchange rates, etc. In particular, central banks can use short-term interest rates and derivative financial instruments to infer market expectations about the monetary policy outlook. When extracting short-term

expectations of money market interest rates, the Bundesbank employs the term structure of EONIA swap rates. In addition, implied risk-neutral densities are derived from options on three-month Euribor futures, which provide information about the uncertainty that surrounds an expected course of policy action. Research at the Bank of Italy undertaken by Ferrero and Nobili (2005) examines the value of interest rates implied from future contracts in the euro area and United States in the period 1992–2004 as predictors of future short-term rates. The authors document that futures tend to over-predict interest rates, because they incorporate term premia. The bias tends to be larger for US dollar than euro futures, and tends to be countercyclical for dollar futures and procyclical for euro futures implied rates. Adjusting for the bias is important if using futures to predict spot rates: at all forecast horizons adjusted futures rates tend to predict short-term interest rates better than unadjusted futures rates, econometric models or consensus expectations.

Westaway (2006) highlights the importance of these issues for monetary policy in the context of the macroeconomic forecast framework employed by the Bank of England. The framework is a forward-looking general equilibrium model, in which the conditioning assumptions are consistent with market expectations for various asset prices, including policy interest rates. In principle, this would require disentangling expected future short-term interest rates from term premia in the observed yield curve. Currently, however, "raw" forward rates are taken as reflecting market expectations of future policy rates, although ongoing research is focused on identifying and understanding the term premia embedded in such forward rates.

Another important financial indicator increasingly used by central banks is the implied risk-neutral density of the return or price of an asset. Such densities are typically extracted from prices of options and other derivative instruments, by relying on the principles of "risk-neutral pricing". This amounts to setting the discount factor in equation (1) equal to the risk-free interest rate, and using an adjusted ("risk-neutral") probability measure when taking the expected value of future payoffs instead of the actual real-world ("objective") probabilities. Given a set of derivative prices, this approach makes it possible to infer the risk-neutral density function of the underlying security's price or return. This tool is useful because it provides a measure of the entire distribution of the future price/return, as perceived by investors, instead of just the mean or variance. The main caveat, however, is of course that such densities do not generally reflect the actual probabilities of investors unless they are, in fact, risk-neutral. Hence, risk premia matter for the interpretation of implied densities. A Bundesbank study by Craig et al (2003) examines the extent to which implied risk-neutral densities "anticipate" extreme price changes in the DAX. The authors document a strong negative skewness in the densities which suggests that the markets attach a higher probability to a large loss than to a comparable gain. Moreover, they find evidence for significant differences between actual and risk-neutral densities, which they interpret as suggesting that market participants were often surprised by the extent of rising equity prices in the 1990s and of the subsequent fall in prices.

Tabak (Central Bank of Brazil, 2006) also looks at density forecasting and argues that implied densities are of relevance for policymakers and financial regulators. For example, exchange rate forecasts and scenarios play an important role in macro projections at the Central Bank of Brazil. Using options data on the Brazilian real/USD exchange rate, the paper shows that estimated implied one-month risk-neutral densities do a reasonably good job in terms of capturing the actual one-month-ahead distribution. Moreover, assuming a specific type of utility function, the coefficient of relative risk aversion can be estimated. The results reported in the paper suggest that the measure of risk aversion estimated in this way has been falling since 2000, reaching zero in recent years. Due to liquidity considerations, option-implied densities cannot be estimated for horizons beyond one month. Instead, for longer horizons the author uses an assumed time series model to obtain density forecasts through a simulation procedure. This approach seems to produce density forecasts superior to those obtained from survey data.

Asset prices as macroeconomic indicators

An alternative approach, which may be highly useful, is to directly compare asset prices with subsequent economic fundamentals to try to identify leading indicator properties of asset prices (Stock and Watson (2003) provide a useful overview of the literature on this topic). In contrast to the use of asset prices to extract market expectations, which largely relies on the basic structural model of asset prices to break prices down into estimable components, this use of asset prices generally relies on estimating reduced-form relationships, and the reason for the predictive content of asset prices can be subject to considerable debate. Asset prices can be argued to be associated with changes in fundamentals not only because of their forward-looking nature, but also because they might directly cause changes in fundamentals, or reflect a common response to shocks.

Several papers presented at the conference point to mixed evidence on the usefulness of asset prices as leading indicators. The contribution of the Bank of Italy cites work by Nobili (2006), who, using a Bayesian VAR model with time-varying coefficients, finds that standard financial indicators in the euro area such as the slope of the yield curve and credit risk premia have no or negligible marginal predictive content for either inflation or output. A couple of papers at the Reserve Bank of Australia have focused on the information content of the slope of the term structure in predicting economic activity. While Lowe (1992), in an early study using data from 1972 to 1991, finds that the slope of the term structure predicts growth in various measures of real activity over one to two years, later research finds that the predictive power has appeared to dissipate more recently, as Australian bond yields have become more highly correlated with US yields. For example, Nimark (2006) estimates New Keynesian models on Australian data and shows that the Australian term structure contains little reliable information about shocks for the central bank. This is in contrast to the evidence in much of the literature, which has pointed to the yield curve's strong predictive ability with respect to future economic growth and inflation; see eg Harvey (1988); Estrella and Hardouvelis (1991); Estrella and Mishkin (1997); Bernard and Gerlach (1998); Estrella (2005); Ang et al (2006).

The finding by Kremer and Rostagno (2006) that declining bond market risk premia largely explain the low level of long-term interest rates prompts them to ask whether this has had an impact on the way term structure indicators and break-even inflation rates should be used for policy purposes. Specifically, they discuss the extent to which the unusual behaviour of risk premia has been "distorting" the information content of the yield curve and break-even rates as indicators of future growth and inflation, respectively. On the one hand, they conclude that it remains crucial to take into account developments in risk premia in order to assess the predictive content of the yield curve for future economic activity. On the other hand, the authors cite evidence suggesting that inflation risk premia have remained broadly unchanged over the recent past (Kim and Wright (2005), Hördahl and Tristani (2006)), indicating that changing compensation for inflation uncertainty did not seem to contribute to the conundrum. Hence, the information content of break-even inflation rates in terms of perceived inflationary pressures and central bank credibility would therefore have been little affected.

Westaway (2006) discusses other distortions that are increasingly compromising the ability of conventional asset price measures to provide reliable indicators of economic activity. In particular, he points out that the effects of "demand-supply imbalances" on government securities markets, due to asset-liability management by pension funds or the build-up of dollar reserves by Asian central banks, may be non-negligible in this regard (as discussed in the earlier section on the determinants of interest rates). Such effects represent a departure from the standard asset pricing framework, and hence complicate the interpretation.

The Bank of France summary paper discusses research by Clerc (2003) in which the predictive content of a broader range of asset prices is assessed with respect to euro area output and inflation. He finds that in some cases asset prices and financial variables have predictive power for real output growth and inflation, but that the statistical significance is

marginal. Moreover, such indicators are often found to be outperformed by monetary aggregates and other variables such as oil prices. However, by combining forecasts of various financial indicators, as in Stock and Watson (2003), the reliability of the forecasts is sometimes improved. A related point is made by Borio and Lowe (2004), who note that it is important to recognise the non-linear nature of the information content of asset prices, and to take into account information from asset prices and credit jointly when extracting information.

Kannan (Reserve Bank of India, 2006) reports results testing for the predictive content of equity prices for inflation and economic activity in India. Interestingly, he reports that stock prices seem to be a leading indicator of inflation, but that they seem to lack predictive power for the output gap. Altissimo et al (2003) examine the forecast performance of bank interest rates with respect to Italian economic activity by analysing whether interest rates help to improve the forecasts of the Bank of Italy's macroeconometric model of the Italian economy. They show that interest rates have strong information content, while the role played by monetary aggregates is limited. The authors conclude that financial prices and quantities can play an important role as indicators of the future state of the economy.

A general caveat about this line of research is that the stability and reliability of the predictive content of asset prices reflects to a considerable extent the nature of the underlying "shocks" that hit the economy, for which asset price movements may be a proxy. Hence there is a distinct possibility of instability in the reduced-form "forecasting" regressions.

Asset price misalignments and monetary policy

A hotly debated topic among academics as well as policymakers is whether monetary policy should try to respond to asset price misalignments, and if so, what the preferred approach should be. At the risk of some oversimplification, it is possible to distinguish two views in this regard. One view argues that to ensure price and macrostability it is sufficient to focus on the pursuit of low and stable inflation over horizons of one to two years. Given identification and policy calibration difficulties, the best way of addressing potential asset price misalignments is to use monetary policy to cushion the blow of their reversal, if and when it materialises. This view, or versions thereof, has been presented by eg Bernanke and Gertler (1999, 2001), Schwartz (1995, 2002), Bordo et al (2002, 2003) and Bordo and Wheelock (2004). The alternative view is that central banks should respond more directly to the perceived asset price misalignment even if inflation is forecast to be on target over the relevant horizon. Variants of this view range in terms of specific rationale and the degree to which proactiveness is recommended, and include Smets (1997), Cecchetti et al (2000, 2002), Filardo (2000, 2004, 2005), Bordo and Jeanne (2002a,b), Detken and Smets (2003) and Roubini (2006). For example, one variant argues that it is desirable for monetary policy frameworks to retain the option to lean against signs of the build-up of financial imbalances, characterised by a joint excessive expansion in credit and asset prices, even if near-term inflation remains subdued, so as to limit the risk of unwelcome disinflation, economic weakness and possibly financial strains further down the road (Borio and Lowe (2002), Borio and White (2004), Borio (2006).

Some of the conference contributions are not very supportive of a proactive monetary policy in response to perceived asset price bubbles. Savioz and Bengui (Swiss National Bank, 2006) focus on two very concrete episodes of apparent misalignment – the Swiss housing market bubble of the 1980s and the more recent dotcom bubble (from a Swiss perspective). The authors find that in both cases, the collapse of the bubbles did have severe adverse consequences in terms of real economic activity. Nonetheless, for both housing and stock markets, the authors view monetary policy as an ineffective instrument to forestall bubbles. In the case of real estate market bubbles, because of the lags in the transmission of monetary policy, Savioz and Bengui argue that interest rate increases are unlikely to be very successful, and may in fact reinforce a recession after the bubble has burst. Instead, the authors favour special regulatory measures aimed at reining in the excesses. In the case of

equity market bubbles, they argue that domestic interest rates are unlikely to have an impact in a timely fashion, owing to the integration of global financial markets and the reliance of listed firms on international demand conditions. Here, the authors recommend focusing on the aftermath of the bursting of the equity market bubble, adopting a loose policy stance in order to limit the damage to the domestic economy.

Euro area central bank economists express a range of views in their contributions. Lemke and Worms (2006) note that the link from asset prices to inflationary developments is not fully understood or measurable. Further, they argue that the challenge of determining the existence of a bubble is quite severe, especially at the early stages. Moreover, it is also not clear that the short-term interest rate is a particularly effective instrument to control bubbles. Grande (Bank of Italy, 2006) argues that targeting of asset prices through monetary policy (ie the inclusion of asset prices into the intermediate or final objective of monetary policy) has a number of drawbacks: it is difficult to assess the fair value of assets, and asset price targeting could lead to undesired fluctuation in output and inflation. Instead, the Bank of Italy closely monitors asset prices, as well as monetary and credit aggregates, as indicators of financial stability and economic conditions. When concerns about valuation of assets arise, the Bank of Italy has generally made public such concerns in official statements. However, ongoing theoretical work at the Bank of France by Epaulard et al (2006) is more supportive of an active role for central banks in responding to perceived asset price bubbles, as a central bank can send a credible signal that it fears possible non-fundamental price dynamics. In the parameters of their model, a rate hike may be sufficient to curb the cascade by forcing markets to reassess their views about the productivity of a new technology. Loisel (2006) argues that monetary policy may have more leverage on asset prices (and hence might curb asset price bubbles without aggressive interest rate hikes) by reacting to current private expectations of future asset prices rather than to current asset prices. Lemke and Worms also acknowledge that by taking the liquidity situation explicitly into account in its policymaking decisions (as the ECB does), a central bank may, in a sense, be countering bubble tendencies related to liquidity.

Park (Bank of Korea, 2006) also recommends a monetary policy which actively considers leaning against asset bubbles. The view is that price stability itself cannot guarantee sustainable and stable growth. Furthermore, collapsing real estate bubbles are likely to generate various problems, such as recessions and financial instability, which are likely to result in substantial economic costs. Of course, macroeconomic considerations may override: during the latest rapid rise in Korean real estate prices, more stringent monetary policy was not considered an option since the economy was stagnant.

A large number of the contributions address the importance of the policymaker's time horizon when considering optimal policies in response to asset price bubbles. Sriphayak and Vongsinsirikul (Bank of Thailand, 2006) ask whether asset price misalignments, because of their potential impact on financial stability, should be explicitly incorporated into the reaction function of a central bank aiming at price stability and long-term output growth. The authors conclude that the answer depends on the time horizon of policymakers' objectives. Because it is difficult to define financial stability in a precise way, and because of the long and variable time lags between asset price imbalances and inflation, monetary policy that focuses on one- to two-year-ahead inflation is unlikely to respond in a timely fashion to the risks posed by asset price build-ups. Indicators of financial imbalances can provide the central bank with a picture of the full range of risks that may affect inflation in the medium to long run. By systematically incorporating such information into its macroeconomic models, the central bank can lower the probability that financial instability can cause medium-term inflation to breach its target.

Similarly, Selody and Wilkins (Bank of Canada, 2006) discuss whether an inflation targeting central bank should incorporate flexibility in its monetary policy framework in order to respond to asset price misalignments. The authors conclude that the aim of the central bank should be to maintain low and stable inflation, as this provides the best contribution to

economic and financial stability. Nevertheless, they argue that some flexibility in the target horizon may be warranted to allow monetary policy to respond appropriately to asset price bubbles, because such misalignments can have particularly persistent effects on output and inflation. Hence, by leaning against a bubble, policy may be more effective in maintaining low and stable inflation, even though it might result in inflation deviating longer than usual from its target, compared to conventional policy horizons. At the same time, Selody and Wilkins note that this would require that policymakers can reasonably infer a bubble and that they know a priori that it is likely to have significant real economic effects – requirements which are unlikely to be satisfied very often. Moreover, they argue that too much flexibility in the monetary policy framework may be harmful because it can result in lower credibility with respect to the central bank's inflation target.

The Australian contribution also describes research that weighs the importance of differing time horizons for the policymaker. Kent and Lowe (1997), for example, argue that if financial system regulation and supervision are unable to reduce the adverse effects of asset price bubbles, if only for financial stability reasons, central banks should be concerned with them. Rather than advocating a prescribed response, they suggest that central banks should be concerned with outcomes beyond the period of the normal transmission lag of monetary policy, particularly in a low-inflation environment – ie a recommendation in line with that described earlier of Selody and Wilkins (2006). However, Gruen et al (2003) argue that in the absence of detailed information on the properties of the bubble, the gains from responding to asset price developments might be limited. Robinson and Stone (2005) extend the theoretical framework and conclude that even with perfect knowledge of the bubble's properties, whether optimal monetary policy should tighten in the presence of an asset price bubble may depend on different bubbles and periods.

Countries whose monetary policy is centred on management of the exchange rate face particular challenges in responding to perceived excesses in asset markets. Even when the monetary authority believes that asset prices are overextended, it cannot raise interest rates to curb the rise without abandoning its exchange rate instrument. And as discussed in the review of the Singaporean experience by Lee et al (2006), allowing the currency to appreciate to bring about a cooling in financial conditions would be a very indirect and risky path, for exchange rates are an even blunter tool than interest rates. Rather, the government in Singapore has generally used other tools such as administrative controls and taxes to cool down overheated residential property markets.

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