Asset Prices
and the Conduct of Monetary Policy

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ABSTRACT

In simple backward-looking structural models of the economy the optimal monetary policy rule is given by a Taylor-type interest rate rule, with the interest rate being a function of current and lagged inflation rates and the current and lagged output gap. Such a rule is optimal because current and past inflation rates and output gaps are sufficient statistics for future inflation and demand conditions, which are targeted by the central bank. We show that future demand conditions and CPI inflation in the G7 countries are also determined by the exchange rate and property and share prices. Taking the UK as an example we discuss the implications of this finding for the conduct of monetary policy and show that disregarding asset price movements leads to a sub-optimal outcome for the economy in terms of inflation and output gap variability. This result not only obtains because the information contained in asset prices about future demand conditions is ignored, but also because their omission from the model introduces considerable biases, so that monetary policy would be based on a mis-specified model of the economy. We also show how a Financial Conditions Index (FCI), a weighted average of the short-term real interest rate, the real exchange rate, real property and real share prices can be derived based on the estimated models. The derived FCI appears to be a useful predictor of future CPI inflation.

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1. Introduction

Since the seminal work by Taylor (1993), the analysis of monetary policy rules has received considerable attention in the theoretical and empirical literature. In simple backward-looking structural models of the economy (see e.g. Svenssson, 1997, Rudebusch and Svensson, 1998), the optimal interest rate rule relates the policy rate to current and past inflation rates and current and past output gaps. Such a policy rule is optimal, because current and lagged inflation rates and output gaps are sufficient statistics for future inflation rates and output gaps, which are targeted by the central bank.

Recently there has been an increasing interest in the role of asset prices for the conduct of monetary policy. The consensus view at the moment seems to be that central banks should only respond to asset price movements if they are expected to affect future CPI inflation and the output gap (Bernanke and Gertler, 1999). Besides the interest rate, the exchange rate is usually considered to be the most important determinant of aggregate demand and channel of monetary policy transmission in open economies. Several central banks adopted a Monetary Conditions Index (MCI), a weighted average of the short-term interest rate and the exchange rate as an operating target (Bank of Canada, Reserve Bank of New Zealand) or an indicator (Swedish Riksbank, Bank of Norway, Bank of Finland, Bank of Iceland) for monetary policy in the early-mid 1990s[1].

A more recent development is the interest in the role of housing and equity prices for the design of monetary policy. Housing and equity prices may affect demand via direct and indirect wealth effects. A change in property and equity prices affects consumer wealth, which may induce consumers to change their consumption plans (Modigliani, 1971). Recent evidence reported in Case, Quigley and Shiller (2001) suggests that property prices have a stronger effect on household consumption than equity prices. A more indirect wealth effect of asset price movements operates via households' and firms' balance-sheets. Households and firms may be borrowing constrained due to asymmetric information in the credit market,

[1] Formal treatments of the theoretical underpinnings of MCIs can be found in Gerlach and Smets (1998), Ball, (1998) and Svensson (2000). A discussion of the problems entailed with constructing and interpreting MCIs can be found in Eika, Ericsson and Nymoen (1996).

which gives rise to adverse selection and moral hazard problems[2]. As a result, households and firms can only borrow when they offer collateral, so that their borrowing capacity is a function of their net worth, which in turn depends on asset valuations. Share prices may provide a proxy for the net worth of listed companies. However, the balance sheet position of listed companies can, but does not necessarily have to be closely correlated with the balance sheet position of non-listed companies and of households. Property prices are likely to be a more useful indicator for the borrowing capacity of the private sector, since a large part of private sector credit is secured by real estate collateral[3].

Thus, from a theoretical point of view there seems to be a strong case also to consider property and share prices as determinants of aggregate demand, which would imply a direct reaction of monetary policy to movements in these asset prices. This issue has proven to be highly controversial. Cecchetti, Genberg, Lipsky and Wadwhani (2000) and Goodhart (2001) argue in favour of a direct response of monetary policy to asset price movements which are not in line with perceived fundamentals, while Bernanke and Gertler (1999) and Gertler, Goodfriend, Issing and Spaventa (1998) are more sceptical. The consequences of a direct response of monetary policy to asset prices is usually analysed based on calibrated models (see e.g. Bernanke and Gertler, 1999). Here we adopt a different approach and assess the role of asset prices in the G7 countries based on estimated small structural models in the spirit of Rudebusch and Svensson (1998). The model consists of a backward-looking Phillips Curve, relating CPI inflation to its own lags and the lagged output gap, and a backward looking IS Curve, relating the output gap to its own lags and lags of the real interest rate, the real exchange rate, real property prices and real share prices. This framework is certainly too simple to derive any firm recommendations for the conduct of monetary policy. Our aim is rather to show that asset prices contain useful information about future demand conditions and that ignoring asset prices not only means loss of this information but may also give rise to considerable biases in empirical models used for the analysis of monetary policy.

The plan of the paper is as follows: In the next section we present estimates of this simple model. In Section 3 we discuss the implications of the results presented in Section 2 for the

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[2] Basic references for this literature are Bernanke and Gertler (1989) and Kiyotaki and Moore (1997). For a survey see Bernanke, Gertler and Gilchrist (1998).

conduct of monetary. Taking the UK as an example we explicitly calculate the optimal policy rule and show what happens if the effect of property and share prices on aggregate demand is ignored. In Section 4 we show how a Financial Conditions Index (FCI), a weighted average of the interest rate, the exchange rate, property prices and share prices, can be derived based on the estimated models. Such an index can be used as a summary indicator for aggregate demand conditions. The derived FCI is in fact found to be a useful predictor of future CPI inflation. Section 5 concludes.

2. Asset Prices in a Simple Backward Looking Model of the Economy

In order to assess the potential role of asset prices for the conduct of monetary policy, we estimate an extended version of the simple structural model proposed by Rudebusch and Svensson (1998), which is an empirical application of the Svensson (1997) model, for the G7 countries over the sample period 1972-1998 using quarterly data[4]. In this framework the economy is modelled by a backward-looking supply or Phillips Curve and a backward-looking demand or IS curve. The Phillips Curve relates inflation to lagged inflation rates, lagged output gaps and the current and lagged changes in the world price of oil as a proxy for supply shocks[5]. The development of the output gap is explained by the IS Curve. We model the output gap as a function of its own lags and lags of the real interest rate, the real effective exchange rate, real house prices, real share prices and of external demand conditions proxied by the OECD output gap:

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[3] In fact, credit aggregates are closely correlated with property prices (Borio, Kennedy and Prowse, 1994, IMF, 2000, BIS, 2001). See Hofmann (2001) for a survey on this issue and formal evidence.
[4] In Goodhart and Hofmann (2000) we do a similar exercise for a larger sample of industrialised countries.
[5] The change in the world price of oil was at first also included in the IS equation. But since it was always insignificant and did also not help with outliers we eliminated it from the IS equations. We also tried to include asset prices in the Phillips Curve, since especially exchange rates and house prices could well have a direct effect on consumer prices, but we were unable to detect any significant direct effect of asset prices on CPI inflation.

Phillips Curve

$$(1)\quad p_t = \sum_{i=1}^{n_1} b_{1i} p_{t-i} + \sum_{j=1}^{n_2} b_{2j} y_{t-j} + \sum_{k=0}^{n_3} b_{3k} dpo_{t-k} + e_t$$

IS Curve

$$(2)\quad y_t = \sum_{i=1}^{m_1} g_i y_{t-i} + \sum_{j=1}^{m_2} l_{1j} rir_{t-j} + \sum_{k=1}^{m_3} l_{3k} rex_{t-k} + \sum_{k=1}^{m_4} l_{4k} rhp_{t-k} + \sum_{k=1}^{m_5} l_{5k} rsp_{t-k} + \sum_{q=1}^{m_6} l_{1q} y_{t-q}^{oecd} + h_t$$

p is quarterly inflation in the consumer price index, measured as the quarter-to-quarter percent change in the CPI, *y* is the percent gap between real GDP and potential real GDP, where potential real GDP is calculated using a Hodrick-Prescott filter with a smoothing parameter of 1600. *dpo* is the quarter-to-quarter percent change in the world price of oil. This variable acts as a proxy for supply shocks and helped to eliminate heteroskedasticity. *Rir, rex*, *rhp* and *rsp* are respectively the percent gap between the ex-post real short-term interest rate, measured as the short-term money market rate less quarterly inflation, the real effective exchange rate[6], real residential property prices and real share prices and their respective long-run trend levels, calculated using a Hodrick-Prescott filter with a smoothing parameter of 1600. In order to control for external demand effects we also include lags of the OECD-output gap (y^{oecd}). A detailed description of the data and their sources is provided in the data-appendix.

The modelling approach adopted here entails several points which call for some deeper discussion before we present the estimation results. The use of the Hodrick-Prescott filter as a trend filter is fairly standard for real GDP, but not for interest rates and asset prices. Real interest rates are usually assumed to be mean reverting, so that the long-run level of the real interest rate is constant. However, real interest rates are on average much higher since the 1980s than they were in the 1970s, a development which is usually explained by rising government debt, the liberalisation of capital markets and disinflationary monetary policy (Group of Ten, 1995). As a result, mean reversion of real interest rates is often rejected by standard unit root tests.

[6] The exchange rate is measured as units of home currency per unit of foreign currency, so that an increase in the real exchange rate is a real depreciation.

Unit root tests usually also suggest that real exchange rates, real house prices and real share prices are not mean reverting. Non-constant long-run levels of the real exchange rate may obtain because the real exchange is a function of other real variables. For example, the Balassa-Samuelson effect implies that the equilibrium level of the real exchange rate of a country depends on the productivity growth in its tradable goods sector relative to the productivity growth in the tradable goods sector of its trading partners. Alternative equilibrium concepts suggest that equilibrium real exchange rates are determined by relative real activity, net foreign asset positions or real interest rate differentials[7]. The long-run level of real house prices is explained by changes in construction costs, real income, real financing costs and demographic factors (Mankiw and Weil, 1989, Poterba, 1991). The long-run level of real equity prices depends, according to standard asset pricing formulae (Gordon, 1962), on the expected long-run growth rate of dividends and the discount rate. All these variables are non-constant, which implies a time-variable long-run level of real house prices and real equity prices.

Thus, there are many factors potentially determining the long-run levels of interest rates, exchange rates and house and equity prices. An explicit modelling of real interest rates and real asset prices is clearly beyond the scope of this paper, and it is also not clear whether such an attempt would have proven to be successful. For this reason we decided to filter out the long-run trend movements of the interest rate and asset prices by using the same variable trend filter that was applied to real GDP[8].

Other problems may arise from the simple specification of our model. Smets (1997) shows that the optimal interest rate response to asset price movements depends on whether asset prices are driven by supply (fundamental) or demand (non-fundamental) factors. If asset prices are mainly driven by supply factors, then their effect on aggregate demand helps to equilibrate output demand and supply, so that no policy response is needed. If demand factors are the main driving force of asset prices, then asset price movements tend to cause disequilibria in the goods market and should therefore be neutralised by interest rate

[7] MacDonald (2000) provides a comprehensive survey of all the concepts for equilibrium real exchange rates.

reactions. How to interpret movements of an asset price may be tentatively inferred from its past correlation with the output gap. If movements of an asset price mainly contain information about aggregate demand rather than supply conditions, we would expect this to be reflected in a significant positive ex-post correlation between the asset price and the output gap. If the asset price is also driven by supply or fundamental factors, its correlation with the output gap would be expected not to be significantly different from zero or to be even negative.

Adding asset prices to the analysis may also introduce a simultaneity problem. Property and share prices are often characterised as forward looking variables, so that including them as regressors in a backward-looking model in the spirit of Rudebusch and Svensson (1998), as we do here, may introduce a simultaneity bias in the estimating equations. However, similar simultaneity problems may already arise from including interest rates and exchange rates in the analysis. The central bank may raise interest rates and exchange rates may appreciate in anticipation of future output gaps. Thus, including property and share prices in the analysis does not introduce a problem that has not potentially been there before. In the literature on monetary policy transmission and monetary policy rules it is always assumed that the information set of the central bank can be characterised by lags of endogenous and exogenous variables, so that no simultaneity problem arises. But why should asset markets have information about future output and inflation that is superior to that of the central bank? There is no reason why this should be the case, even if stock market investors are always fully rational.

All these potential problems should certainly be kept in mind, but we believe that they are not so severe to render our estimates invalid. Estimates of the model are presented in Table 1. The equations were estimated separately by OLS[9]. In order to obtain well behaved residuals a number of impulse dummies, which are mainly related to the oil price shocks, have also been included. The lag orders were chosen by a general-to-specific modelling strategy, eliminating all variables which were not significant at least at the 10% level. Underneath the coefficient estimates we report t-statistics in parentheses. For each equation we also report the adjusted

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[8] We also estimated a specification using the level of the real interest rate and first differences of the real exchange rate, real house prices and real equity prices. The results are qualitatively not very different from the ones reported below and are available upon request.

R^2, White's (1982) test for heteroskedasticity (H) and a Lagrange-Multiplier test for serial correlation up to order five (LM). The diagnostics suggest that there is no evidence of misspecification in the estimated equations. The exception is the Italian Phillips Curve, where there is some evidence of heteroskedasticity. Recursive Chow breakpoint tests, which we do not report, did not indicate sub-sample instability in any of the estimated equations.

For the Phillips Curves we find that the output gap is significant at least at the 5% level in all countries. The coefficient estimates suggest that an increase in the output gap by one percentage point leads to an increase of the inflation rate of between 0.23 percentage points (Germany) and 0.51 percentage points (UK) in the following quarter. Except for Japan, the change in the world price of oil significantly affects consumer price inflation, either immediately or with a lag. The effect is particularly strong in Italy, where the coefficients of the current and lagged change in the oil price sum to 0.19. In the other countries the sum of the oil price coefficients never exceeds 0.06.

The results for the IS Curve suggest that the real interest rate, the real exchange rate, real house prices and real equity prices all have a significant effect on the output gap, although the timing of the impact sometimes differs considerably. The estimated coefficients for the real interest rate are smaller than the usual estimates of above -0.1 and vary between –0.1 (Germany) and –0.05 (UK). The real exchange rate has a particularly strong effect on output gaps in Germany and Italy (0.06). In the other countries the exchange rate coefficient varies between 0.02 and 0.03. The estimated coefficient for real share prices in the US and the UK are three times larger than the coefficients estimated for the other countries (0.01). This finding may reflect the higher share of equity in private sector wealth in these two countries (OECD, 2000). The effect of house prices on the output gap is larger than the effect of share prices and in most cases also larger than the effect of the exchange rate. The estimated house price coefficient ranges between 0.06 (France) and 0.03 (Italy and UK). Except for Japan and the UK we also find a significant effect of external demand condition, proxied by the OECD output gap.

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[9] SUR estimates gave almost identical results.

Table 1: Regression Results

USA	$p_t = 0.45p_{t-1} - 0.20p_{t-2} + 0.43p_{t-3} - 0.12p_{t-4} + 0.23p_{t-5} + 0.41y_{t-1} + 0.04DPO_t + 0.02DPO_{t-1} + 0.01DPO_{t-2} + 0.02DPO_{t-3}$ (4.47) (-1.91) (4.40) (-1.18) (2.62) (4.09) (5.53) (2.62) (1.48) (2.42) $\bar{R}^2 = 0.83$ *H* = 24.27 (0.23) *LM*= 8.63 (0.12)
	$y_t = 0.87y_{t-1} - 0.15y_{t-2} - 0.11y_{t-8} - 0.07RIR_{t-1} + 0.03REX_{t-8} + 0.05RHP_{t-1} + 0.04RSP_{t-1} + 2.88D782 - 2.36D802$ (9.98) (-1.93) (-2.89) (-1.86) (1.80) (2.12) (5.19) (4.70) (-3.73) $\bar{R}^2 = 0.88$ *H* = 23.71 (23.71) *LM* = 0.2.22 (0.82)
Japan	$p_t = 0.25p_{t-1} + 0.27p_{t-2} + 0.20p_{t-3} + 0.55y_{t-1} + 8.24D732 + 20.68D741$ (3.84) (4.14) (3.14) (3.77) (3.83) (9.48) $\bar{R}^2 = 0.85$ *H* = 14.61 (0.15) *LM* = 0.13 (0.69)
	$y_t = 0.83y_{t-1} - 0.32p_{t-5} - 0.07RIR_{t-5} + 0.02REXG_{t-4} + 0.04RHP_{t-1} + 0.01RSP_{t-1}$ (12.24) (-5.26) (-2.52) (1.64) (1.64) (1.84) $\bar{R}^2 = 0.79$ *H* = 13.01 (0.37) *LM* = 1.50 (0.22)
Germany	$p_t = 0.46p_{t-1} + 0.20p_{t-3} + 0.18p_{t-5} + 0.29y_{t-1} + 0.02DPO_t$ (5.62) (2.29) (2.10) (2.68) (2.15) $\bar{R}^2 = 0.63$ *H* = 10.75 (0.38) *LM* = 2.28 (0.81)
	$y_t = 0.32y_{t-1} - 0.10RIR_{t-3} + 0.06REX_{t-1} + 0.05RHP_{t-1} + 0.03RSP_{t-3} + 0.14y^{oecd}_{t-1}$ (3.05) (-2.09) (2.20) (2.76) (3.63) (3.49) $\bar{R}^2 =0.67$ *H* = 15.58 (0.21) *LM* = 2.67 (0.75)
France	$p_t = 0.53p_{t-1} + 0.40p_{t-4} + 0.32y_{t-1} + 0.04DPO_t + 0.02DPO_{t-1}$ (7.11) (5.33) (2.05) (4.02) (1.78) $\bar{R}^2 = 0.85$ *H* = 17.73 (0.06) *LM* = 7.51 (0.19)
	$y_t = 0.90y_{t-1} - 0.29y_{t-3} - 0.07RIR_{t-2} + 0.03REX_{t-1} + 0.06RHP_{t-5} + 0.01RSP_{t-1} + 0.12y^{oecd}_{t-2}$ (12.53) (-4.28) (-2.01) (1.65) (2.49) (1.64) (1.69) $\bar{R}^2 =0.77$ *H* = 14.43 (0.42) *LM* = 4.28 (0.51)
Italy	$p_t = 0.37p_{t-1} + 0.26p_{t-2} + 0.21p_{t-3} + 0.37y_{t-1} + 0.06DPO_t + 0.04DPO_{t-1} + 0.04DPO_{t-2} + 0.05DPO_{t-3} + 9.99D762$ (4.39) (3.29) (3.76) (2.00) (4.75) (2.98) (2.84) (3.43) (4.14) $\bar{R}^2 = 0.86$ *H* = 33.31 (0.01) *LM* = 11.62 (0.07)
	$y_t = 0.56y_{t-1} - 0.13y_{t-5} - 0.06RIR_{t-1} + 0.06REX_{t-8} + 0.03RHP_{t-6} + 0.01RSP_{t-1} + 0.19y^{oecd}_{t-1} - 2.03D744$ (8.43) (-3.14) (-2.45) (4.29) (2.77) (4.05) (4.92) (-3.39) $\bar{R}^2 =0.86$ *H* = 16.26 (0.36) *LM* = 10.15 (0.12)
UK	$p_t = 0.38p_{t-1} + 0.26p_{t-2} + 0.15p_{t-5} + 0.51y_{t-1} + 0.05DPO_{t-4} + 12.86D752 + 18.13D793$ (5.29) (3.68) (2.50) (2.95) (2.92) (4.41) (6.22) $\bar{R}^2 = 0.79$ *H* = 17.54 (0.13) *LM* = 5.46 (0.36)
	$y_t = 0.66y_{t-1} + 0.17y_{t-3} - 0.22y_{t-4} - 0.05RIR_{t-1} + 0.03REX_{t-1} + 0.03RHP_{t-1} + 0.03RSP_{t-1} - 2.91D741 - 1.79D752 + 3.61D792$ (9.43) (1.92) (-2.80) (-2.35) (2.31) (2.18) (4.29) (-3.69) (-2.31) (4.87) $\bar{R}^2 = 0.82$ *H* = 27.16 (0.06) *LM* = 5.43 (0.37)
Canada	$p_t = 0.58p_{t-1} + 0.20p_{t-3} - 0.13p_{t-4} + 0.26p_{t-5} + 0.42y_{t-1} + 0.02DPO_{t-1}$ (7.49) (2.11) (-1.22) (2.85) (3.57) (2.49) $\bar{R}^2 = 0.79$ *H* = 20.20 (0.06) *LM* = 8.37 (0.14)
	$y_t = 0.62y_{t-1} - 0.08y_{t-4} - 0.06RIR_{t-2} + 0.03REX_{t-4} + 0.04RHP_{t-1} + 0.01RSP_{t-1} + 0.41y^{oecd}_{t-1} - 0.20y^{oecd}_{t-2}$ (7.36) (-1.59) (-1.93) (1.65) (2.57) (1.67) (4.75) (-2.40) $\bar{R}^2 = 0.84$ *H* = 22.49 (0.13) *LM* = 6.02 (0.30)

Note: The table reports the results of estimating equations (1) and (2). Coefficient estimates are reported with t-statistics in parentheses. $\bar{R}^2$ is the adjusted coefficient of determination, H is White's (1982) test for heteroskedasticity and LM is a Lagrange-Multiplier test for serial correlation up to order five. In parentheses we report probability values for the diagnostic tests.

3. Implications for the Conduct of Monetary Policy

The results presented in the previous section suggest that asset prices significantly affect future demand conditions. What does this finding imply for the conduct of monetary policy? In the following we will only consider the case of the UK. Let us assume that the central bank cares about both inflation and output variability, so that the intertemporal loss of the central bank is given by

$$(3)\quad \mathrm{L} = E_t \sum_{t=0}^{\infty} d^{t} (p_{t+t}^{2} + y_{t+t}^{2}),$$

where d is the central bank's discount rate. For simplicity we have assumed that the inflation target rate is zero and that the central bank gives equal weight to inflation and output stabilisation. Furthermore, we do not consider any additional interest rate smoothing objective[10].

Following Rudebusch and Svensson (1998) we consider the limiting case $d = 1$. The intertemporal loss function of the central bank is then given by the sum of the unconditional sum of the variances of the goal variables[11]. The optimal interest rate rule for the UK which minimises this loss function is given by:

$$(4)\quad \begin{aligned} i_t = r_t^{*} &+ 2.78p_{t} + 0.44p_{t-1} + 0.65p_{t-3} + 0.24p_{t-4} + 2.34y_t + 0.51y_{t-1} - 0.66y_{t-3} \\ &+ 0.31rex_t + 0.31rhp_t + 0.23rsp_t + 0.22dpo_{t-2} + 0.08dpo_{t-3} \end{aligned}$$

The interest rate responds to current and lagged values of CPI inflation and the output gap, but also to the real exchange rate, real house prices, real share prices and the change in the world oil price. The question is now what would happen if the central bank would ignore the

[10] An objective of the central bank to smooth short-term interest rates may be motivated by concerns about financial market stability (Goodfriend, 1989), uncertainty about the economic environment (Blinder, 1998) or the aim to influence long-term interest rates (Goodfriend, 1991). Introducing an additional interest rate smoothing objective helps to obtain smaller and thus more realistic reaction coefficients for the optimal interest rate rule. The qualitative results would, however, not be affected.

effect of property prices and share prices on aggregate demand, and instead assume that output is affected only by the interest rate and the exchange rate, the standard open economy determinants of aggregate demand? Dropping real property and real equity prices from the model and re-estimating the IS Curve yields

$$(5)\ y_t = \underset{(12.68)}{0.816}y_{t-1} + \underset{(1.90)}{0.179}y_{t-3} - \underset{(-2.86)}{0.24}y_{t-4} - \underset{(-1.31)}{0.033}rir_{t-1} + \underset{(1.17)}{0.017}rex_{t-1} - \underset{(-2.59)}{2.19}\mathrm{D741} - \underset{(-2.83)}{2.37}\mathrm{D752} + \underset{(4.87)}{3.87}\mathrm{D792}$$

We see that dropping property and equity prices results in substantially lower estimated coefficients for the interest rate and the exchange rate. This finding is consistent with the results reported in Goodhart and Hofmann (2000). There we estimate backward-looking IS Curves for a sample of 17 industrialised countries and show that the real interest rate coefficient is generally much smaller and insignificant when asset prices are omitted from the model. This finding can be explained by a positive correlation between real interest rates and property and equity prices, which may arise if the central bank reacts to fluctuations in asset prices in order to stabilise the output gap. The interest rate will then proxy the effect of the omitted asset prices on the output gap. Since asset prices are positively correlated with the output gap, the estimated interest rate effect will be biased downwards. The lower estimated coefficient of the exchange rate may also be explained by proxy effects giving rise to a downward bias. Rising equity and property prices may trigger capital inflows, which give rise to an appreciation of the currency. The correlation between equity and property prices and the exchange rate is therefore likely to be negative. Thus, since equity and property are positively correlated with the output gap, their omission will give rise to a downward bias in the estimated exchange rate coefficient.

Dropping property and equity prices from the model also implies a different optimal monetary policy rule. The optimal rule is now given by

[11] See Rudebusch and Svensson (1998), p. 10.

$$
(6) \quad \begin{aligned} i_t = {} & r_t^* + 3.94p_t + 0.72p_{t-1} + 1.06p_{t-3} + 0.41p_{t-4} + 4.56y_t + 0.89y_{t-1} - 1.22y_{t-3} \\ & + 0.26rex_t + 0.32dpo_{t-2} + 0.12dpo_{t-3} \end{aligned}
$$

We see that the optimal rule has changed considerably. Not only is there now no direct response to property and equity prices, but also the response to the other variables has changed. The optimal response of monetary policy to current and lagged inflation rates and output gaps, and also to the change in the oil price is much higher now because of the lower estimated interest rate elasticity.

In order to assess the welfare effects of ignoring the effects of property and equity prices, we assume that the true model of the economy is the one estimated in the previous section, comprising property and equity prices. We simulate the model once using the optimal rule (4) corresponding to the true model and once with the (sub-) optimal rule (6) corresponding to the standard open economy model without property and equity prices. Table 2 displays the derived variances of the goal variables and the corresponding loss given by the unweighted sum of the variances.

Table 2: Results on Volatility and Loss

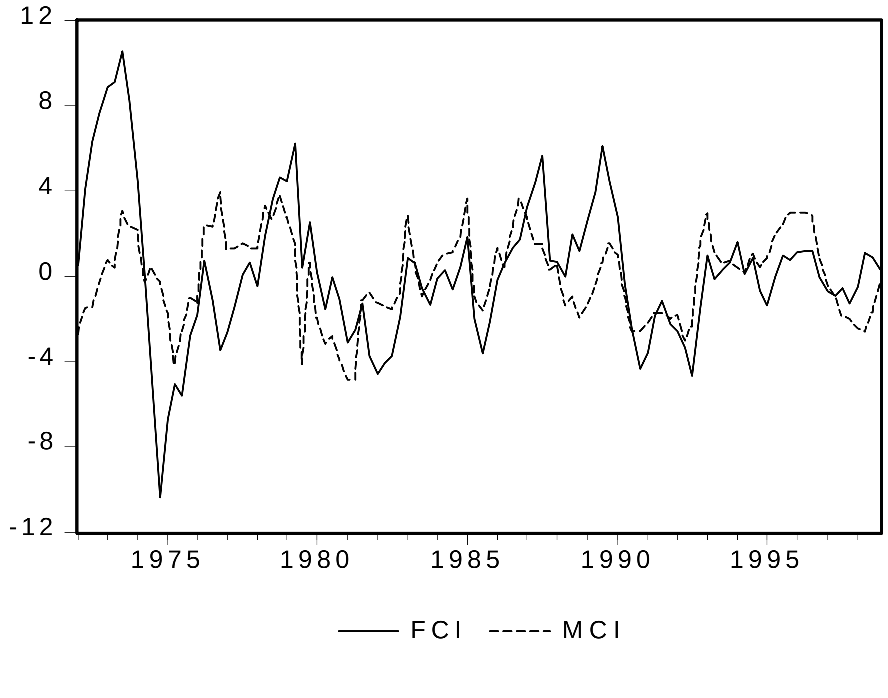
	Variance *p*	Variance *y*	Loss
Optimal Rule	1.21	0.44	1.65
Open Economy Rule	1.53	1.18	2.71

We find that using the rule based on the model without property and equity prices leads to an increase in the loss of more than 60%. This increase in the loss is not only caused by ignoring the effect of property and equity prices on output, but also by using the wrong response parameters for all other variables, which is a result of the biases arising from excluding property and share prices from the model.

4. Monetary and Financial Conditions Indices for the UK

Monetary Conditions Indices (MCIs), weighted averages of the short-term interest rate and the exchange rate, are commonly used by central banks, financial institutions and non-governmental institutions as indicators for aggregate demand conditions[12]. The weights depend on the respective effect of the interest rate and the exchange rate on aggregate demand. Based on the models estimated in the previous section we can obtain an extended MCI, or FCI (Financial Conditions Index) for the UK, comprising in addition to the interest rate and the exchange rate also property and share prices. From the coefficient estimates of the UK IS Curve in Table 1 we obtain a FCI weight of 0.37 for the real interest rate, of 0.23 for the real exchange rate and real property prices and of 0.17 for real share prices. From equation (6) we can derive, for comparison, a standard MCI. The respective weights are 0.66 for the real interest rate and 0.34 for the real exchange rate. Figure 1 shows the derived FCI and the MCI for the UK. The indices are constructed so that a higher level of the index reflects expansionary monetary or financial conditions.

Figure 1: An FCI and an MCI for the UK



[12] For a survey on MCIs for the UK see Batini and Turnbull (2000).

Not surprisingly, we find that the FCI is more volatile than the MCI, and often times the indicators give conflicting signals about future demand conditions[13]. Thus, the FCI would often tell policy makers a different story than the MCI. The question is, which story is more informative and more reliable? In order to assess the information content of the FCI and the MCI we estimate simple forecasting regressions for the CPI inflation rate of the form

$$(7)\quad p_t = a + b_1 p_{t-4} + b_2 I_{t-4} + e_t \ ,$$

where *I* is either the FCI or the MCI. In Table 3 we report the estimated forecasting equations. In parentheses we report t-statistics calculated based on Newey-West heteroskedasticity and autocorrelation consistent standard errors.

Table 3: Forecasting regressions for UK CPI Inflation

$p_t = 0.63 p_{t-4} + 0.70 FCI_{t-4}$ $\bar{R}^2 = 0.45$ (5.25) (5.28)	$p_t = 0.62 p_{t-4} + 0.68 MCI_{t-4}$ $\bar{R}^2 = 0.34$ (4.41) (1.75)

Note: T-statistics are in parentheses and are based on Newey-West heteroskedasticity and autocorrelation consistent standard errors.

The coefficient of the FCI is significant at the 1% level, that of the MCI only at the 10% level. Also, the fit of the FCI forecasting regression is clearly better than the fit of the MCI equation. Thus, the FCI seems to contain valuable information about future inflation four quarters ahead. The MCI also contains information about future inflation, but appears to be less informative than the FCI.

[13] The correlation between the FCI and the MCI is 0.44.

5. Conclusions

In simple backward-looking structural models of the economy optimal monetary policy is given by Taylor-type interest rate rules, with the interest rate being a function of current and lagged inflation rates and the current and lagged output gap. In open economy extensions of these models the central bank additionally reacts to the exchange rate. However, other asset prices, property and share prices, may also affect aggregate demand. In order to control future inflation, the central bank may also have to react to movements of these asset prices if they have a significant effect on output.

Based on an estimated backward-looking structural model of the economy we show that besides the real interest rate and the real exchange rate also property and equity prices have a significant effect on G7 output gaps. This finding implies that monetary policy should also respond to property and equity price movements in order to offset their effect on the output gap. Taking the UK as an example we show that ignoring property and equity prices in fact leads to a sub-optimal outcome for the economy in terms of inflation and output gap variability. This result not only obtains because the information contained in asset prices is ignored, but also because their omission from the model introduces substantial biases, so that monetary policy would be based on a mis-specified model of the economy.

The evidence presented in this paper seems to support an active response of monetary policy to asset price movements. However, we do not want to advocate a mechanical policy response to asset prices. Any policy response to asset price movements must be preceded by a thorough analysis of the causes of these movements and take into account the endogeneity of asset valuations. The chosen framework is certainly much too simple to derive any firm policy conclusions. Our aim is rather to show that asset prices contain useful information about future demand conditions and that ignoring asset prices not only means loss of this information but may also give rise to considerable biases in empirical models used for the analysis of monetary policy.

References

Ball, L. (1998), 'Policy Rules for Open Economies', NBER Working Paper No. 6760

Batini, N. and K. Turnbull (2000), 'Monetary Conditions Indices for the UK: A Survey', External MPC Unit Discussion Paper No. 1, Bank of England

Bernanke, B. and M. Gertler (1989), 'Agency Costs, Collateral and Business Fluctuations', American Economic Review, 79, pp 14-31

Bernanke, B., Gertler, M. and S. Gilchrist (1998), 'The Financial Accelerator in a Quantitative Business Cycle Framework', NBER WP 6455

Bernanke, B. and M. Gertler (1999), 'Monetary Policy and Asset Price Volatility', Federal Reserve Bank of Kansas City Economic Review, Fourth Quarter 1999, pp 17-51

BIS (2001), 71st Annual Report.

Blinder, A. (1998), 'Central Banking in Theory and Practice', MIT Press, Cambridge, MA.

Borio, C., Kennedy, N. and S. Prowse (1994), 'Exploring Aggregate Asset Price Fluctuations across Countries: Measurement, Determinants and Monetary Policy Implications', Bank for International Settlements, BIS Working Paper No. 40

Case, K., Quigley, J. and R. Shiller (2001), 'Comparing Wealth Effects: The Stock Market versus the Housing Market', Cowles Foundation Discussion Paper No. 1335, Yale University

Cecchetti, S., Genberg, H., Lipsky, J. and S. Wadhwani (2000), 'Asset Prices and Central Bank Policy', Geneva Reports on the World Economy 2

Eika, K., Ericsson, N. and R. Nymoen (1996) 'Hazards in Implementing a Monetary Conditions Index', Oxford Bulletin of Economics and Statistics, 58 (4), November, pp 765-90

Gerlach, S. and F. Smets (1996), 'MCIs and Monetary Policy under Floating Rates', unpublished manuscript, Bank for International Settlements

Gertler, M., Goodfriend, M., Issing, O. and L. Spaventa (1998), Asset Prices and Monetary Policy: Four Views, Centre for Economic Policy Research (CEPR) and Bank for International Settlements (BIS), CEPR: London

Goodfriend, M. (1989), 'Interest Rate Smoothing and Price Level Trend-Stationarity', Journal of Monetary Economics, 19, pp 335-48

Goodfriend, M. (1991), 'Interest Rates and the Conduct of Monetary Policy'. Carnegie Rochester Series on Public Policy, 34, pp 7-30

Goodhart, C. (2001), 'What Weight Should be Given to Asset Prices in the Measurement of Inflation?', The Economic Journal, 111, pp 335-56

Goodhart, C. and B. Hofmann (2000), 'Financial Variables and the Conduct of monetary Policy', Sveriges Riksbank Working Paper No. 112

Gordon, M. (1962). 'The Investment, Financing and Valuation of the Corporation', Irwin, Homewood, IL.

Group of Ten (1995). 'Saving, Investment and Real Interest Rates'

Hofmann, B. (2001), 'The Determinants of Private Sector Credit in Industrialised Countries: Do Property Prices Matter?', BIS Working Paper, forthcoming

IMF (2000), World Economic Outlook, May 2000

Kiyotaki, N. and J. Moore (1997), 'Credit Cycles', Journal of Political Economy, 105, pp 211-48

MacDonald, R. (2000), 'Concepts to Calculate Equilibrium Exchange Rates: An Overview', Economic Research Group of the Deutsche Bundesbank Discussion Paper No. 3/00

Mankiw, N. and D. Weil (1989), 'The Baby Boom, the Baby Bust, and the Housing Market', Regional Science and Urban Economics, 19, pp 235-58

Modigliani, F. (1971), 'Monetary Policy and Consumption', in: Federal Reserve Bank of Boston, Consumer Spending and Monetary Policy: the Linkages

OECD (2000), Economic Outlook 68, December 2000

Poterba, J. (1991), 'Housing Price Dynamics: The Role of Tax Policy and Demography', Brooking Papers on Economic Activity, 12 pp 143-203

Rudebusch, G. and L. Svensson (1998), 'Policy Rules for Inflation Targeting', in: J. B. Taylor (ed.), Monetary Policy Rules, University of Chicago Press for NBER

Smets, F. (1997), 'Financial Asset Prices and Monetary Policy: Theory and Evidence', CEPR Discussion Paper No. 1751

Svensson, L. (1997), 'Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets, European Economic Review, 41, pp 1111-46

Svensson, L. (2000), 'Open-Economy Inflation Targeting', Journal of International Economics, 50, pp 155-83

White, H. (1980), 'A Hetroskedasticity-Consistent Covariance Matrix and a Direct Test for Heteroskedasticity', Econometrica, 48, pp 817-38

Data Appendix

Consumer Prices

Consumer Price Index, IMF International Financial Statistics, series code 64; OECD Main Economic Indicators for Germany.

Gross Domestic Product (GDP)

IMF International Financial Statistics, series code 99b.p.; OECD-GDP: OECD Main Economic Indicators

World price index of petroleum

IMF International Financial Statistics

Real Exchange Rates

Effective real exchange rate, OECD Main Economic Indicators.

Short-term interest rates

Overnight money market rates for France, Germany, Italy, Japan and the USA, IMF International Financial Statistics, series code 60b; three months commercial paper rate for Canada (IMF, series code 60bc) and three months interbank rate for the UK (BIS).

Share prices

Share price index, IMF International Financial Statistics, series code 62

Property Prices

Residential property price index from national sources as shown in Appendix-Table 1. Annual data from the first quarter of each year for Germany and semi-annual data for Italy and Japan were converted to quarterly frequency by linear interpolation.

Appendix-Table 1: Residential property prices

	Series	**Source**
United States	Median sales prices of second hand one-family houses	National Association of Realtors
Japan	Nation-wide land price index	Japan Real Estate Institute
Germany	Average sales price of dwellings in Frankfurt, Munich, Hamburg and Berlin	Ring Deutscher Makler
France	Residential house price index	Bank of France
Italy	House price index for the whole country	Bank of Italy/ 'Il consulente immobiliare'
United Kingdom	Nationwide Anglia House Price Index	Datastream
Canada	Multiple listing service price index of existing homes	Bank of Canada