Financial Variables and the Conduct of Monetary Policy[*]

Charles Goodhart[a] and Boris Hofmann[b]

Abstract

This paper analyses the role of financial variables in the conduct of monetary policy. In the baseline model for the analysis of interest rules, the inflation rate depends on the output gap, which is solely determined by its own lags and the lagged short-term real interest rate. However, from a theoretical point of view there are several other financial variables which may affect aggregate demand, and should therefore be taken into account in the estimation of an output gap equation. In order to assess the importance of financial variables such as asset prices and monetary aggregates for aggregate demand, we estimate a small structural model for 17 developed countries using quarterly data spanning 1973 -1998. The results indicate that the effect of other financial variables, especially property and share prices, on the output gap is highly significant. It appears that in almost all of the countries in our data set it is necessary to control for the effect of other financial variables on the output gap in order to find a significant effect for monetary policy.

[*] We wish to thank Jürgen von Hagen, Bernd Hayo and Frank Smets for helpful discussions and comments. All remaining errors are our own.
[a] London School of Economics
[b] Zentrum für Europäische Integrationsforschung, University of Bonn

1. Introduction

What role do asset prices play in the conduct of monetary policy? Assets represent claims on future consumption. A change in a nominal asset price may reflect a change in the expected real future service to be derived from the asset, or a change in the relative price of an unchanged flow of future services. For such reasons, Alchian and Klein (1973) argued that a correct measure of inflation would need to include asset prices, since such an index would also account for the expected cost of future consumption. There have been some practical attempts to incorporate asset prices systematically into a broader index of inflation. Shibuya (1992) and Shiratsukata (1999) tried to derive a broad price index based on wealth statistics, but this did not prove to be very successful. Cecchetti et al. (2000), using a different methodology based on the respective variances of consumer, equity and house prices, find that equity prices contain too much noise to be useful in inflation measurement, while house prices appeared to contain significant information on aggregate price inflation. Nevertheless, movements in asset prices are intrinsically hard to interpret, so that targeting a broader price index is not really an alternative to targeting the consumer price index. The general consensus is therefore that Central Banks should only react to asset price fluctuations in so far as far as they are a threat for consumer price stability (see e.g. Bernanke and Gertler (1999)).

Financial variables may affect future inflation mainly via their effect on aggregate demand. In the baseline model for inflation targeting, future inflationary pressures are determined by the output gap, which is in turn determined by the past short-term interest rate. The analysis can be extended to open economies by also allowing the exchange rate to affect the output gap. There are, however, just as good reasons also to consider other financial variables, real estate and equity prices and real money balances, as determinants of aggregate demand. Property and equity prices affect private sector wealth and thus consumption. Also, according to the credit view, real estate and equity prices determine the borrowing capacity of households and firms, and thus affect consumption and investment demand. Real money balances may have a direct effect on aggregate demand because they affect a wide range of yields and relative prices, which are relevant for aggregate demand, and also via real balance effects. Thus, from both a theoretical and a practical viewpoint, there is a strong case also to consider real estate and equity prices and real money balances, and not only interest rates and exchange rates, as financial indicators for aggregate demand. In fact, in so far as these variables do have a significant impact on the output gap, their omission would lead to biases in the estimated effect of the other variables. If the Central Bank reacts to fluctuations in financial variables in order to stabilise the output gap, then omitting such interaction will tend to bias downwards the estimated effects of monetary policy. For example if the Central Bank raises interest rates to offset the expansionary effects of a housing and property price boom, ignoring the latter lead the interest rate effect to be underestimated.

In Section 2 of our paper we will assess the significance of short-term interest rates, real exchange rates, real property prices, real share prices and real money balances with respect to economic activity. For this purpose we estimate a small structural model for 17 developed countries, in which financial variables enter as determinants of the output gap. The model is estimated over the sample period 1973:1 to 1998:4. Our results show that the output gap is an important determinant of future inflation. The short-term real interest rate is insignificant in all but one country if no other financial variables are allowed to affect the output gap. Thus, it is not possible to analyse monetary policy rules for inflation targeting in this over-simplified framework. If other financial variables are included in the model, we find a significant impact of a monetary policy instrument on the output gap in more than two-thirds of the countries. The change in real equity prices and the change in real property prices are the most important determinants of the output gap. On the other hand, the change in the real exchange rate and real money growth do in general not appear to have a significant effect on the output gap.

2. Inflation, output gaps and financial variables

Instability in the money demand function has made the growth of monetary aggregates an unreliable gauge of the stance of monetary policy and of future inflationary pressures in many countries. Partly as a reaction Central Banks in most countries adopted strategies of direct inflation targeting as opposed to monetary targeting. Simplified models for inflation targeting consist of an aggregate supply or Phillips Curve, relating inflation to past inflation rates and the past output gap, and an aggregate demand or IS curve, relating the output gap to lagged output gaps and the lagged real interest rate. Such models are then used to derive optimal monetary policy reaction functions for inflation targeting (see e.g. Svensson (1997) and Rudebusch and Svensson (1999). The idea is that the Central Bank sets the short-term nominal interest rate, which amounts to setting the short-term real interest rate when prices are sticky. The short-term real rate is thus assumed to summarise the monetary transmission process adequately. Other studies (e.g. Bernanke and Blinder (1992), Fuhrer and Moore (1995)) model the output gap as a function of the short-term nominal interest rate. The assumption behind this approach is that aggregate demand responds to the expected long-term real interest rate, which can be proxied by the short-term nominal rate (see Fuhrer and Moore (1995)).

Ball (1998) and Svensson (2000) extend the baseline closed-economy inflation targeting model to allow for open-economy effects. Since the real exchange rate affects net exports, aggregate demand now depends on the short-term real interest rate and the real exchange rate. Adding the interest rate parity condition to the model yields an additional transmission channel for monetary policy via the real exchange rate. As a result the monetary policy instrument is now a weighted average of the real interest rate and the real exchange rate, a 'Monetary Conditions Index' (MCI). The MCI concept has received considerable attention in the empirical literature and also in the conduct of monetary policy. Sweden, Finland, Iceland and Norway used MCIs as indicators for the stance of monetary policy, the Bank of Canada and the Reserve Bank of New Zealand even as an operating target for monetary policy. The weights for the MCI have been derived from the coefficient estimates of the effect of the real interest rate and the real exchange rate on the output gap or real GDP growth (see e.g. Duguay (1994) for Canada and Hansson and Lindberg (1994) for Sweden).

As has already been stressed by Smets (1997), other financial variables besides the exchange rate may also have an impact on aggregate demand, and may thus need to be taken into account in the conduct of monetary policy. On the one hand, property and equity prices affect private sector wealth and thus consumption demand. Table 1 shows estimates of the ratio of private sector wealth held in equity to private sector wealth held in property for some industrialised countries, based on the estimates shown in Borio, Kennedy and Prowse (1994), Table AI.2, p. 80, for the years 1988-1992 (Sweden 1970-1992, UK 1985-1992).

The share of property in private sector wealth is about double as high as that of equity in Canada, Japan, the UK and the US, about three times as high in Australia and Sweden and about five times as high in Finland and Germany. Given the similarities in the structure of the continental European countries, the ratio of property to equity wealth in France, Italy, Spain and the Benelux countries, for which data are not available, is likely to be similar to that in Germany.

Table 1: Ratio of equity wealth to property wealth (in percent)

	Ratio		Ratio
Australia	27	Finland	18
Canada	43	Germany	18
Japan	45	Sweden	32
USA	45	UK	52

Source: Author's calculations based on Borio, Kennedy and Prowse(1994), Table AI.2, p.80.
Note: Data refer to1988-1992 (Sweden 1970-1992, UK 1985-1992).

The wealth effect of stock-market fluctuations has already become an intensely debated issue, especially in the USA. However, given the much higher share of property in private sector wealth in most countries, property prices should actually be more relevant for the wealth effect than equity prices. In addition, share prices are far more volatile than property prices, so that there should be significantly more uncertainty about the permanent effect of gains/losses in equity wealth as compared to gains/losses in property wealth. This may be an additional reason to expect property prices to have a stronger impact on private sector consumption than equity prices.

In addition, property and share prices may also affect the economy via household's and firm's balance-sheets. The balance-sheet channel arises from the problem of asymmetric information in the credit market. Asymmetric information gives rise to adverse selection and moral hazard problems. The lower the net worth of firms and households, the more severe these problems will be, since there will be less collateral available to secure loans. A rise in asset prices raises the borrowing capacity of firms and households by increasing the value of collateral. The additionally available credit can be used to purchase goods and services and thus stimulates economic activity. The process can be self-reinforcing, since part of the additionally available credit may also be used to purchase assets, pushing up asset prices even further, what will again increase the credit worthiness of borrowers, and so on. The role of credit-market conditions has already been stressed by Fisher (1933) to explain the Great Depression. The interaction of credit and asset prices was re-emphasised amongst others by Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1998). These models show how the interaction between credit and asset prices transmits, amplifies and propagates shocks to the economy. This effect is also referred to as the ''financial accelerator''. Except maybe for the USA, where equity secured borrowing also plays a role, loans are more generally secured by property. Therefore, property prices would be expected to be by far more important for the balance-sheet channel than equity prices. Table 2 shows estimates of the share of loans which are secured by real estate collateral in 1993 (Sweden 1992), taken from Borio (1996), Table 12, p.101.

Table 2: Share of loans secured by real estate collateral (in percent)

	Share		Share
Australia	34	Netherlands	36
Belgium	34	Spain	33
Canada	56	Sweden	>61
France	41	UK	59
Germany	36	USA	66
Italy	40		

Source: Borio(1996), Table 12, p.101.
Note: Data refer to 1993 (Sweden 1992).

As pointed out by Borio(1996), the figures have to be taken with caution, since it is not clear whether the information on which the estimates are based are really comparable across countries due to possible differences in definition and coverage. Bearing this in mind, the figures indicate that the share of loans secured by real estate collateral is around 35-40% in all countries except Sweden, the UK and the US where the share is around, or over, 60%. According to Borio(1996), there are indications suggesting that the share may also be quite high in Japan, but an estimate is not available.

Finally, despite unstable money demand, monetary aggregates need not be completely redundant in an inflation targeting framework since they also affect aggregate demand. As has recently been re-emphasised by Meltzer (1999) and Nelson (2000), monetary policy works by changing many interest rates and relative prices, not only a short-term interest rate, and all these changes may be summarised by the change in real base or narrow money. Real broad money balances may also affect aggregate demand via real balance effects. Therefore, monetary aggregates may have a significant effect on the output gap and may thus be useful information variables for inflation targeting Central Banks, despite unstable money demand.

3. The baseline model for inflation targeting

In order to assess the importance of financial variables in the conduct of monetary policy, we estimate the standard inflation targeting model proposed by Rudebusch and Svensson (1998) We first estimate the model in the original specification of Rudebusch and Svensson (1998) and then extend the model by including other financial variables in addition to the short-term interest rate.

The economy is modelled by a backward-looking supply or Phillips Curve and a backward-looking demand or IS curve:

(1) $$p_{t+1} = \sum_{i=0}^{n} a_i p_{t-i} + b y_t + e_t ,$$

(2) $$y_{t+1} = \sum_{j=0}^{m} g_i y_{t-i} + l_1(\bar{i}_t - \bar{p}_t) + h_t$$

p is quarterly inflation in the consumer price index, measured as the quarter-to-quarter change in the log CPI, y is the percent gap between industrial production and potential industrial production[1], where potential industrial production is calculated using a Hodrick-Prescott-Filter with a smoothing parameter of 1600. $\bar{i}$ is the four-quarter average short-term interest rate and $\bar{p}$ is the four-quarter average CPI inflation. $\bar{i} - \bar{p}$ is therefore an approximate ex-post short-term real interest rate, which in the view of Rudebusch and Svensson (1998) ''appears to be a workable approximation of the(se) various intermediate transmission mechanisms'' of monetary policy (p.5). All variables were de-meaned prior to estimation, so that no constants are included in the regressions.

Rudebusch and Svensson (1998) estimate this model for the US, Peersman and Smets (1999), using a different methodology, for the EURO-area. Both studies find the key parameters, b and l to be significant with the expected sign. Here we estimate this model for 17 industrialised countries over the sample period 1973:1 – 1998:4. Table 3 and 4 present the results of the estimation of the 17 Phillips Curves and IS Curves. All equations were estimated separately by OLS. The lag lengths of the autoregressive terms were determined by using the Akaike information criterion[2], allowing for a maximum of six lags. The tables display the selected autoregressive order of the dependent variable, the sum of the coefficients of the autoregressive terms, with an F-statistic for a test of the hypothesis that the coefficients of the lagged dependent variables sum to one in brackets, and the estimated coefficient of the lagged output gap or real interest rate respectively with absolute t-statistics in brackets. For model diagnostics the tables show the adjusted coefficients of determination, the results of Ljung-Box Q-test for autocorrelation (significance level in brackets) and the supremum F-statistic (with the respective date in brackets) of the test for unknown breakpoint proposed by Andrews (1993).

---

[1] We chose industrial production as our measure of real activity instead of real GDP, since quarterly real GDP was not available for a sufficiently long time period for many of the countries in our sample.

[2] We also tried the Schwarz-Bayes information criterion. In most of the cases the lag length chosen by the Schwarz-Bayes criterion were too short to eliminate autocorrelation of the error term, so that we preferred the Akakaike criterion, where this problem in general did not occur.

Table 3: Estimates of the Phillips Curves

	n	$\sum a_i$	b	$\overline{R}^2$	Q	Stability
Australia	3	0.841** (5.3)	0.306*** (2.80)	0.621	22.478 (0.66)	1.492 (1984:3)
Belgium	3	0.897* (3.43)	0.109* (1.97)	0.728	16.056 (0.93)	5.505 (1980:1)
Canada	6	0.976 (0.22)	0.239*** (4.51)	0.794	24.728 (0.53)	1.03 (1984:2)
Denmark	6	0.927 (0.66)	0.372*** (3.34)	0.511	26.059 (0.46)	4.365 (1976:4)
Finland	3	0.931 (2.21)	0.129** (2.03)	0.811	33.855 (0.14)	4.266 (1976:4)
France	4	0.955 (1.05)	0.211** (2.53)	0.829	36.509* (0.08)	1.936 (1989:2)
Germany	6	0.828* (3.09)	0.14** (2.03)	0.413	25.047 (0.52)	1.426 (1991:1)
Ireland	3	0.907 (2.01)	0.218* (1.83)	0.647	26.559 (0.43)	3.02 (1976:4)
Italy	6	0.956 (0.75)	0.292*** (3.1)	0.80	28.436 (0.34)	3.024 (1977:2)
Japan	3	0.815*** (8.21)	0.263*** (3.34)	0.67	20.985 (0.74)	2.752 (1980:2)
Netherlands	3	0.903** (3.94)	0.122** (2.15)	0.772	10.894 (1.00)	2.995 (1977:3)
New Zealand	4	0.824** (4.53)	0.58*** (3.44)	0.604	18.784 (0.54)	5.447 (1987:3)
Norway	3	0.88* (3.26)	0.022 (0.28)	0.625	32.233 (0.19)	4.308 (1979:3)
Spain	5	0.964 (0.35)	0.118 (0.99)	0.712	14.31 (0.97)	3.246 (1977:4)
Sweden	3	0.635*** (7.59)	0.305* (1.84)	0.265	24.718 (0.54)	4.849 (1977:1)
UK	6	0.938 (0.83)	0.468*** (3.45)	0.68	50.888** (0.01)	2.46 (1978:4)
USA	5	0.878** (5.19)	0.23*** (3.54)	0.772	31.89 (0.20)	2.273 (1983:1)

*Note: ***,**,* denote significance at the 1%, 5% and 10% level respectively. For the estimated coefficients t-statistics are in parantheses. "Q" is a Ljung-Box Q-test for serial correlation (significance level in parantheses)."Stability" is the supremum F-statistic (respective dates in parantheses) of the stability test proposed by Andrews(1993).*

The sample period for the estimation of the Phillips Curves is in general 1973:1 – 1998:4, with the exception of New Zealand, for which the sample period starts in 1979:1, and the sample period for the estimated IS curves is in general again 1973:1 – 1998:4, with the exception of Australia, Spain, Ireland and the UK, for which the sample period starts in 1973:2, 1978:1, 1974:1 and 1973:2 respectively. Inflation persistence is high across all countries, but the hypothesis that the lagged inflation terms sum to one is rejected in more than half of the countries, most notably in the G3-economies Germany, Japan and USA. This finding implies that with the present specification of the Phillips Curve we are unable to reject a long-run output/inflation trade-off in most of the countries in our sample. The lagged output gap is significant in all but two countries: Norway and Spain. In the significant cases, the coefficient of the lagged output gap varies between 0.1 and 0.3. The coefficient is somewhat higher in Denmark, New Zealand and the UK. The stability test results suggest that there is no stability problem over the full sample period in all countries.

Thus, the output gap in general seems to affect inflation significantly, and the central bank could in theory target the inflation rate via the effect of its short-term interest rate on the output gap. But here we come to the major problem of the estimated model. As can be seen from Table 4, the short-term real rate of interest is significant in only one of the seventeen countries, which is Finland. We do in general not find evidence of a significant impact of the monetary policy instrument on the economy. The output gap appears to be a purely autoregressive process. It would, therefore, not be possible to analyse interest rate rules based on this estimated model. Again the stability test results do not suggest any stability problem over the full sample period in all countries, so that the insignificance of the monetary policy instrument does not seem to result from a structural break in the underlying relationship.

Table 4: Estimates of the baseline IS Curves

	l	$\sum g_k$	*rir*	$\overline{R}^2$	*Q*	*Stability*
Australia	3	0.685*** (20.56)	-0.004 (0.10)	0.626	24.073 (0.52)	1.94 (1994:4)
Belgium	1	0.492*** (34.12)	-0.03 (-0.33)	0.233	15.33 (0.95)	7.997 (1980:1)
Canada	6	0.782*** (15.29)	-0.049 (1.01)	0.843	26.99 (0.41)	1.688 (1982:4)
Denmark	3	0.577*** (19.85)	-0.05 (0.63)	0.394	20.767 (0.75)	1.968 (1976:4)
Finland	5	0.648*** (18.35)	-0.124* (1.77)	0.698	22.124 (0.68)	3.546 (1990:4)
France	3	0.682*** (24.53)	-0.038 (0.86)	0.676	28.141 (0.35)	2.05 (1978:1)
Germany	4	0.729*** (16.09)	-0.102 (1.11)	0.706	16.771 (0.92)	1.963 (1977:3)
Ireland	4	0.64*** (19.40)	0.014 (0.31)	0.544	29.449 (0.25)	3.315 (1990:4)
Italy	6	0.537*** (20.30)	-0.059 (1.21)	0.633	30.934 (0.23)	2.527 (1976:4)
Japan	6	0.831*** (9.77)	0.069 (1.49)	0.89	35.76 (0.10)	2.674 (1982:1)
Netherlands	5	0.482*** (23.10)	-0.04 (0.67)	0.44	38.261* (0.06)	4.524 (1980:3)
New Zealand	5	0.668*** (9.92)	0.044 (0.69)	0.576	39.839** (0.01)	3.46 (1984:1)
Norway	1	0.453*** (38.30)	0.022 (0.34)	0.197	32.375 (0.18)	1.734 (1982:4)
Spain	4	0.652*** (23.55)	-0.022 (0.68)	0.695	13.912 (0.87)	5.84 (1992:2)
Sweden	6	0.613*** (20.80)	-0.066 (1.39)	0.605	22.312 (0.67)	1.703 (1980:2)
UK	1	0.784*** (11.92)	0.046 (1.21)	0.639	22.623 (0.60)	2.215 (1976:4)
USA	4	0.787*** (22.48)	-0.035 (0.72)	0.855	23.588 (0.60)	1.458 (1978:1)

*Note: ***,**,* denote significance at the 1%, 5% and 10% level respectively. For the estimated coefficients t-statistics are in parantheses. "Q" is a Ljung-Box Q-test for serial correlation (significance level in parantheses)."Stability" is the supremum F-statistic (respective dates in parantheses) of the stability test proposed by Andrews(1993).*

3. An extended IS curve

This apparent lack of significance of the real interest rate might be due to proxy effects from omitted variables. As we have already pointed out, there are many other financial variables that may effect the output gap. If these variables are taken into account when setting interest rates, then it is quite likely that their omission reduces the (absolute) value of the estimated coefficient of the real rate. On the other hand, it is also possible that the short-term real interest rate is not the policy variable to which the output gap responds. The output gap could instead respond to the short-term nominal interest rate or the change in the monetary base, which are alternative measures of the stance of monetary policy. In order to control for all these alternative hypotheses we estimate an extended version of the baseline Rudebusch and Svensson model, which allows for other financial variables to have an impact on aggregate demand. The additional variables included are the change in the log effective real exchange rate[3], the change in log real house prices, the change in log real share prices and the change in log real money balances[4]. Real house and share prices were calculated by deflating the nominal house and share price index with the CPI. Real money balances were calculated by deflating the monetary aggregate with the CPI. We considered base or reserve money (M0), narrow money (M1) and broad money (M3 for the EMU countries, money + quasi money according to IMF definition for all other countries). We also included a four-quarter average nominal short term interest rate in the extended specification, allowing for the possibility that the output gap responds to the nominal and not the real rate. We thus estimate an output gap equation of the form:

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

[4] One could argue that it is rather the deviation of some long-run equilibrium level and not the change of these variables that affects the output gap. However, it is not clear at all how one would model such equilibrium levels. Moreover, all these variables are often characterised as random walks, so that it appeared reasonable to us to choose the specification with changes.

$$(3) \qquad y_{t+1} = \sum_{j=0}^{m} g_i y_{t-i} + l_1(\bar{i}_t - \bar{p}_t) + l_2 \bar{i}_t + l_3 \overline{\Delta} rex_t + l_4 \overline{\Delta} rhp_t + l_5 \overline{\Delta} rsp_t + l_6 \overline{\Delta} rm0_t + l_7 \overline{\Delta} rm1_t + l_8 \overline{\Delta} rmb_t + h_t$$

$\overline{\Delta} rex$ is the four-quarter average change in the log effective real exchange rate. $\overline{\Delta} rhp$ is the four-quarter average change of log real house prices, $\overline{\Delta} rsp$ is the four-quarter average change in log real share prices. $\overline{\Delta} rm0$, $\overline{\Delta} rm1$ and $\overline{\Delta} rmb$ are the four-quarter changes in the log of the ral monetary base, real M1 and real broad money (real M3 for the EMU-countries, real Money + Quasi-Money for the other countries) respectively. The Data Appendix gives detailed information about the data used in the estimation. All variables were de-meaned before estimation, so that no constant is included in the regression, and all variables except interest rates and share prices are seasonally adjusted.

For each country the extended IS equation was estimated separately by OLS, using the Akaike information criterion for model selection. We calculated the Akaike information criterion for all possible combinations of lagged output gaps, allowing for a maximum of six lags, and explanatory variables, and then chose the specification that gave the lowest value of the criterion. Table 5 presents the results of this model selection procedure. The table reports the selected lag lengths for the lagged output gap terms and the sum of their coefficients with an F-statistic for a test of the hypothesis that the coefficients of the lagged dependent variables sum to one in brackets. Then the estimated coefficients (t-statistics in brackets) of the selected explanatory variables are displayed. Blanks indicate that the variable was not selected to be included in the model by the Akaike criterion. For model diagnostics we show again the adjusted coefficients of determination, the result of a Ljung-Box Q-test for autocorrelation (significance level in brackets) and the supremum F-statistic of an Andrews stability test.

The sample period for the estimation is the same as for the IS-equations of the baseline model. The variables selected by this search procedure generally appear with the expected sign. Exceptions are the change in the real exchange rate in Australia, the short-term nominal interest rate in Spain and the change in real M1 in the Netherlands. In the case of Australia and Spain, the wrongly signed variables could be eliminated without affecting the estimates of the other coefficients. In the case of the Netherlands, eliminating real M1 growth would leave us with a purely autoregressive model for the output gap.

Table 5: Estimates of the extended IS-equation

	m	$\sum g_k$	rir	ir	Δrex	Δrhp	Δrsp	$\Delta rm0$	$\Delta rm1$	Δrmb	$\overline{R}^2$	Q	Stability
Australia	1	0.665***	-0.104***		-0.033*		0.016**			0.172***	0.72	29.491	2.254
		(34.51)	(2.75)		(1.73)		(2.13)			(5.00)		(0.24)	(1988:1
Belgium	1	0.456***			0.113			0.199***			0.301	13.461	4.749
		(42.12)			(1.57)			(2.95)				(0.979)	(1980:1)
Canada	6	0.719***			0.048	0.063***	0.035***				0.871	30.07	3.711
		(23.92)			(1.58)	(2.80)	(3.75)					(0.26)	(1985:1)
Denmark	2	0.668***				0.095***	0.025**				0.492	18.038	4.133
		(17.23)				(3.29)	(2.40)					(0.87)	(1977:4)
Finland	5	0.663***				0.07***		0.021**			0.742	19.129	2.607
		(27.04)				(3.83)		(2.47)				(0.83)	(1978:3)
France	3	0.61***	-0.076*			0.114***	0.016**	0.028*			0.722	29.118	3.411
		(29.65)	(1.80)			(3.27)	(2.54)	(1.82)				(0.31)	(1976:4)
Germany	4	0.61***	-0.14*			0.113***	0.013				0.761	24.437	1.593
		(27.72)	(1.67)			(4.66)	(1.60)					(0.55)	(1976:4)
Ireland	4	0.61***			0.097*	0.069**					0.582	26.197	3.289
		(22.81)			(1.90)	(2.13)						(0.40)	(1989:4)
Italy	6	0.514***	-0.072	-0.11*			0.012*				0.652	28.033	4.758
		(23.14)	(1.45)	(1.91)			(1.78)					(0.36)	(1978:4)

*Note: ***,**,* denote significance at the 1%, 5% and 10% level respectively. For the estimated coefficients t-statistics are in parantheses. "Q" is a Ljung-Box Q-test for serial correlation (significance level in parantheses)."Stability" is the supremum F-statistic (respective dates in parantheses) of the stability test proposed by Andrews(1993).*

Table 5, continued: Estimates of the extended IS-equation

	m	$\sum g_k$	rir	ir	Δrex	Δrhp	Δrsp	$\Delta rm0$	$\Delta rm1$	Δrmb	$\overline{R}^2$	Q	Stability
Japan	6	0.749***			0.03**	0.066*				0.073	0.908	29.094	4.069
		(14.16)			(2.59)	(1.78)				(1.41)		(0.31)	(1983:1)
Nether-lands	5	0.522***		-0.199*					-0.072		0.454	38.261*	4.294
		(18.21)		(1.92)					(1.55)			(0.06)	(1980:3)
New Zealand	5	0.608***				0.057	0.035***	0.047**	0.058**		0.661	23.004	2.638
		(15.77)				(1.46)	(3.83)	(2.24)	(2.05)			(0.29)	(1991:2)
Norway	1	0.291***	-0.131*		0.25***		0.028***				0.319	27.755	1.989
		(62.19)	(1.87)		(3.40)		(2.98)					(0.37)	(1976:4)
Spain	4	0.471***	-0.099***	0.065		0.034			0.085**		0.747	7.638	4.684
		(45.48)	(2.79)	(1.52)		(1.55)			(2.41)			(0.996)	(1981:1)
Sweden	6	0.58***		-0.133*		0.045	0.017**				0.648	33.742	1.857
		(24.97)		(1.87)		(1.43)	(2.06)					(0.14)	(1978:2)
UK	1	0.669***		-0.094	0.036*	0.059***					0.686	19.207	5.515
		(23.95)		(1.55)	(1.94)	(2.93)						(0.79)	(1977:1)
USA	4	0.828***	-0.086*			0.063**	0.03***				0.877	20.714	4.816
		(15.74)	(1.80)			(2.47)	(3.38)					(0.76)	(1977:1)

*Note: ***,**,* denote significance at the 1%, 5% and 10% level respectively. For the estimated coefficients t-statistics are in parantheses. "Q" is a Ljung-Box Q-test for serial correlation (significance level in parantheses)."Stability" is the supremum F-statistic (respective dates in parantheses) of the stability test proposed by Andrews(1993).*

Table 6 summarises the performance of the different variables in the demand equation. The introduction of the other variables obviously helps to reduce the bias in the coefficient of the short term real interest rate, which is selected for inclusion in the extended IS curve in 7 countries by the Akaike model selection criterion. In Italy, the Netherlands, Sweden and the UK we find that it is rather the short-term nominal interest rate that affects aggregate demand. In Belgium, Finland, France and New Zealand we find a significant effect of the change in real base money. Based on our estimated extended model it would be possible to analyse monetary policy rules, either interest rate or base money growth rules, for 13 out of the 17 countries. Previously this was only possible for one country.

Looking at the performance of the other variables we see that house and share prices seem to be common determinants of the output gap on a cross country basis. While share prices seem to be more important in the Anglo-Saxon countries, house prices seem to be more important in the European countries and Japan. The real exchange rate does in general not seem to be an important determinant of the output gap, being strongly significant only in Japan and Norway. Monetary aggregates also do generally not seem to have strong explanatory power for the output gap cross country.

Table 6: Performance of the financial variables in the extended IS equation

rir	ir	Δrex	Δrhp	Δrsp	$\Delta rm0$	$\Delta rm1$	Δrmb
7	5	6	12	11	4	3	2

Note: The table displays the number of times (countries) each variable was selected to be included in the extended IS curve by the Akaike model selection criterion.

4. Conclusions

In this paper we reviewed the Rudebusch/Svensson model, which is widely used for the analysis of monetary policy rules. We showed that the model does not work empirically over a large sample of industrialised countries, since it was not possible in almost all cases to detect any significant effect of the short-term real interest rate on the output gap. It was then shown that the insignificance of the policy instrument can be explained by mis-specification of the underlying model. The mis-specification of the model arises from the fact that the effect of other financial variables, most importantly property and share prices, on the output gap is completely disregarded in the setup of the baseline model. In fact, if other financial variables are included in the estimation, it is possible to detect a significant effect of a monetary policy instrument, either a short-term interest rate, nominal or real, or base money growth, on economic activity.

As another important result we find that property and share prices have significant explanatory power for the output gap in most of the countries in our sample. These asset prices clearly outperform the exchange rate or monetary aggregates. Therefore, more attention should be paid to property and share prices as information variables for monetary policy.

Some caveats are, however, in order. Our simple model can, of course, not control for possible simultaneity problems that may arise from the forward looking character of asset prices and forward looking monetary policy that is not already controled for by the inclusion of additional financial variables in the IS equation. According to standard asset pricing theory, asset prices are equal to the discounted sum of future returns. If future returns are positively correlated with future output, anticipation of higher future output would lead to a rise in asset prices. Thus, the strong positive correlation between the output gap and lagged share and property prices we found could probably overstate the true causal effect of asset prices on the output gap.

Simultaneity problems arising from forward looking behaviour may also affect the coefficient estimates of the monetary policy instruments and the exchange rate. The direction of the bias is here, however, likely to be downwards. If the Central Bank (successfully) tries to control the future output gap based on information that is not fully reflected in the financial variables we added to the IS equation, then the estimated coefficients of the monetary policy instrument is still likely to be biased downwards. This could be the reason why we still did not find a significant effect of monetary policy on the output gap in four of the countries in our sample, and that the significance was generally not very high in the cases where we did. The estimated coefficient of the exchange rate could also be affected by simultaneity bias. If interest rates start to rise in anticipation of an output boom, the exchange rate could start to appreciate. This reaction would bias downwards the estimated demand effect of exchange rate fluctuations.

Resolving these problems is not possible in our simple two-equation framework, much more elaborate structural models would be needed. This raises, of course, the question, if it is at all recommendable to analyse monetary policy rules in such a simple framework. If one wishes to do so, it seems to be possible only if the role of other financial variables, especially property and share prices, is taken into account.

References

Andrews, D., (1993), 'Tests for Parameter Instability and Structural Change with Unknown Change Point', Econometrica, 61(4), pp 821-856

Alchian, A.A. and B. Klein, (1973), 'On a Correct Measure of Inflation', Journal of Money, Credit and Banking, 5 (1), Pt 1 (February), pp 173-191.

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

Bernanke, B. and A. Blinder, (1992), 'The Federal Funds Rate and the Channels of Monetary Policy Transmission', American Economic Review, 82(4), pp 901-921

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

Bernanke, B., M. Gertler 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', Paper presented at the Federal Reserve Board of Kansas City, Jackson Hole Conference, August 1999, forthcoming in Proceedings.

Borio, C., (1996), 'Credit Characteristics and the Monetary Policy Transmission Mechanism in Fourteen Industrial Countries: Facts, Conjectures and Some Econometric Evidence', in: Alders, K., K. Koedijk, C. Kool and C. Winder (eds.), 'Monetary Policy in a Converging Europe', Kluwer Academic Publishers, pp 77-115

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

Cecchetti, S, Genberg, H., Lipsky, J. and S. Wadhwani, (2000), 'Asset Prices and Central Bank Policy', Report prepared for the conference 'Central Banks and asset Prices' organised by the Center for Monetary and Banking Studies and CEPR in Geneva on May 5, 2000

Duguay, P. (1994), 'Empirical Evidence on the Strength of the Monetary Transmission Mechanism in Canada: An Aggregate Approach', Journal of Monetary Economics, 33, pp 39-61

Eika, K.H., Ericsson, N.R. and R. Nymoen, (1996) 'Hazards in Implementing a Monetary Conditions Index', Oxford Bulletin of Economics and Statistics, 58 (4), November, pp 765-790.

Favero; C. and R. Rovelli (1999), 'Modelling and Identifying Central Bank's Preferences', CEPR Discussion Paper No. 2178

Fisher, I., (1933), 'The Debt-Deflation Theory of Great Depressions', Econometrica, 1, pp 337-57.

Fuhrer, J. and G. Moore, (1995), 'Monetary Policy Tradeoffs and the Correlation between Nominal Interest Rates and Real Output', American Economic Review, 85(1), pp 219-239

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), booklet (CEPR: London).

Goodhart, C.A.E., (1999), 'Time, Inflation and Asset Prices', Paper presented at Conference on 'The Measurement of Inflation', organised by the Office of National Statistics (ONS) and Eurostat at the University of Wales, Cardiff, August 30, 1999, forthcoming in Proceedings.

Goodhart, C.A.E. and B. Hofmann (2000), 'Do Asset Prices Help to Predict Consumer Price Inflation?', The Manchester School, 68, Supplement, pp. 122-140

Hansson, B. and Lindberg, H. (1994), 'Monetary Conditions Index – A Monetary Policy Indicator', Quarterly Review (Sveriges Riksbank – Swedish Central Bank), 1994, 12-17

Kiyotaki, N. and J. Moore, (1997), 'Credit Cycles', Journal of Political Economy, 105, pp 211-248.

Meltzer, A., (1999), `The Transmission Process', Paper presented at a Conference organised by the Deutsche Bundesbank on 'The Monetary Transmission Process', Frankfurt, March; forthcoming in Proceedings.

Nelson, E., (2000), 'Direct Effects of Money on Aggregate Demand: Theory and Evidence', mimeo, Bank of England

Peersman G. and F. Smets (1999), 'The Taylor rule: A Useful Monetary Policy Benchmark for the Euro Area?', International Finance, 2(1), pp 85-116

Peeters, M., (1999), 'Measuring Monetary Conditions in Europe: Use and Limitations of the MCI', De Economist, 147 (2), June, pp 183-203.

Rudebusch, G. and L. Svensson, (1999), 'Policy Rules for Inflation Targeting', in: J. B. Taylor (ed.), Monetary Policy Rules, University of Chicago Press for NBER.

Shibuya, H., (1992), 'Dynamic Equilibrium Price Index: Asset Price and Inflation', Bank of Japan Monetary and Economic Studies, Bank of Japan, 10 (1), pp 95-109.

Shiratsukata, S., (1999), 'Asset Price Fluctuation and Price Indices', Institute for Monetary and Economic Studies, Bank of Japan, Discussion Paper No. 99-E-21.

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 1111-1146

Svensson, L. (2000), 'Open-Economy Inflation Targeting', Journal of International Economics, 50, pp 155-183

Tobin, J., (1969), 'A General Equilibrium Approach to Monetary Theory', Journal of Money, Credit and Banking, 1, pp 15-29

Wright, S., (1998), 'Monetary Policy, Nominal Interest Rates, and Long-Horizon Inflation Uncertainty', University of Cambridge, DAE Working Paper No. 9820

Data Appendix

Consumer Prices

Consumer Price Index, IMF International Financial Statistics, series code 64.

Industrial Production

Industrial Production Index, IMF International Financial Statistics, series code 66..c.

Real Exchange Rates

Effective real exchange rate, OECD Main Economic Indicators.

Short-term interest rates

Money market rate, IMF International Financial Statistics, series code 60b. For Australia, Canada, Ireland and the UK we used the treasury bill rate (series code 60c). For New Zealand we used the money market rate from the OECD Main Economic Indicators. For Finland we used the 3 months Helibor provided by the Bank of Finland.

Monetary aggregates

Base Money

Reserve Money, IMF International Financial Statistics, series code 14.

Narrow Money

M1, OECD Main Economic Indicators, Bank of England for the UK. For France, Italy, Belgium and the UK these series started only in 1977:4, 1974:4, 1979:4 and 1988:1 respectively and were backdated using Money from the IMF International Financial Statistics (series code 34).

Broad Money

M3 from the OECD Main Economic Indicators for the EMU countries, Money + Quasi Money from the IMF International Financial Statistics, series codes 34 and 35 for all other countries. For Belgium, Finland, France, Ireland and Italy the M3 series started only in 1979:4, 1974:4, 1977:4, 1980:1 and 1974:4 respectively and were backdated using Money+ Quasi Money from the IMF International Financial Statistics.

Share prices

Share price index, IMF International Financial Statistics, series code 62. For Sweden we took the share price index from the OECD Main Economic Indicators. For Belgium we had to splice the share price index from the IMF international Financial Statistics (which ends in 1996 quarter 2) and the share price index from the OECD Main Economic Indicators (which starts in 1985 quarter 2). This was done by backdating the OECD series with the growth rates of the IMF series.

Property Prices

Residential property price index from national sources as shown in Appendix-Table 1. For France, Germany and Italy we had only annual data sets, which we converted into quarterly frequency by linear interpolation. For Spain we had a quarterly data set for the whole country starting in 1987 quarter 1 and an annual data set for the Madrid area starting in 1976. We used the growth rates of the interpolated annual data to backdate the quarterly data set. For Belgium, Finland, Ireland and Sweden we had quarterly data starting in 1980:1, 1978:1, 1976:1 and 1976:1 respectively. In all cases we had the same series at annual frequency going back to 1970. In order to improve on simple linear interpolation, we regressed in the overlapping time period the quarterly observations on quarterly data generated by linear interpolation of annual data and a constant and seasonal dummies. We then adjusted the interpolated annual data by applying the obtained coefficients. The quarterly series were then backdated using the growth rates of the adjusted linearly interpolated series.

Appendix-Table 1: Sources of residential property prices series

Country	Series	Source
Australia	RBA Dwelling Price Index	Central Bank
Belgium	Index of house prices	Stadim, Antwerpen
Canada	Multiple listing service price index of existing homes	Central Bank
Denmark	Cash price of one-family houses sold	Statistics Denmark
Finland	National house price index	Central Bank
France	BIS estimate of residential property prices for the whole country	INSEE and Chambre des Notaires
Germany	Average sales price of dwell-ings in Frankfurt, Munich, Hamburg and Berlin	Ring Deutscher Makler
Ireland	Average prices of new houses for which loans were approved by all lending agencies	Department of the Environ-ment
Italy	Price index for homes	Scenari Immobiliari
Japan	Nation-wide land price index	Japan Real Estate Institute
New Zealand	Average house prices	Central Bank
Netherlands	Average housing prices	Central Bank
Norway	National house price index	Central Bank
Spain	National house price index and Madrid house prices	Central Bank
Sweden	Single-family house price in-dex	Central Bank
United Kingdom	All dwellings price index	Department of the Environ-ment
United States	Median sales prices of new one-family houses	Bureau of the Census