The IS Curve and the Transmission of Monetary Policy : Is there a Puzzle ?[*]

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ABSTRACT

In this paper we assess the performance of the New Keynesian IS Curve for the G7 countries. We find that there is an IS puzzle for both the purely backward-looking as well as for the forward-looking IS curve. The real interest rate does not have a significantly negative effect on the output gap. Based on an extended specification of the IS curve, also including asset prices and monetary aggregates, we are able to restore a significantly negative interest rate effect on aggregate demand in all countries. This finding suggests that a richer specification of the IS curve in empirical work may be necessary in order to obtain an unbiased estimate of the effect of monetary policy on aggregate demand.

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1. Introduction

The New Keynesian model of monetary transmission has become a standard tool for the analysis of monetary policy[1]. The model reduces the economy to a two equation system, comprising an aggregate supply or Phillips Curve and an aggregate demand or IS Curve. The Phillips Curve reflects intertemporally optimal price setting decisions by monopolistically competitive firms (Taylor, 1980, Rotemberg, 1982, Calvo, 1983). The IS Curve represents the intertemporal Euler consumption equation. The theoretical version of the New Keynesian Phillips Curve and the New Keynesian IS Curve are purely forward looking. The Phillips Curve relates inflation to expected future inflation and the output gap. The IS Curve relates the output gap to the expected future output gap and the ex-ante real interest rate. In empirical applications, however, backward-looking specifications of both the Phillips and the IS Curve are often preferred in order to match the lagged and persistent responses of inflation and output to monetary policy measures that are found in the data (Rudebusch, 2002).

The performance of forward-looking versus backward-looking specifications of the New Keynesian Phillips Curve has been subject of extensive research efforts over the last couple of years (Fuhrer, 1997, Roberts, 1998, Gali and Gertler, 1999). In contrast to this, only few studies have analysed the empirical performance of the New Keynesian IS Curve. Most studies rely on a purely backward-looking specification of the IS Curve[2]. Rudebusch and Svensson (1999) and Peersman and Smets (1999) estimate backward-looking IS Curves for the US and the euro area respectively and both find a significantly negative real interest rate elasticity of around 0.1. Nelson (2001, 2002), on the other hand, fails to find a significant effect of the real interest rate on the output gap in the US and the UK. He refers to this finding as the IS puzzle.

[1] Basic references for the foundations of the New Keynesian model are Clarida et al. (2000), Goodfriend and King (1997), McCallum and Nelson (1999a, b) and Rotemberg and Woodford (1999).
[2] Exceptions are Fuhrer (2000) and Fuhrer and Rudebusch (2002), who also allow for forward-looking elements in the US IS Curve.

How can the IS puzzle be explained? Nelson (2001) discusses various potential explanations for the IS puzzle, but does not assess their empirical relevance. The IS puzzle may arise because of (i) simultaneity bias arising from forward looking monetary policy, (ii) mis-specification because of omission of forward-looking elements, which is strongly suggested by theory, or (iii) because of mis-specification due to omission of other determinants of aggregate demand. The first explanation would invalidate any attempt to estimate IS curves empirically, but there is little empirical evidence of the monetary authorities being sufficiently good forecasters for this to be a plausible explanation. The latter two potential explanations would imply that the IS puzzle might be resolved by choosing an alternative specification of the IS Curve.

Tests of the empirical performance of the backward-looking New Keynesian IS curve are available only for the US, the UK and the euro area, but not for other major industrialised countries. In this paper we aim to fill this gap by estimating backward-looking IS Curves for the G7 countries. We find that the real interest rate coefficient is always insignificant, suggesting that there is strong international evidence of an IS puzzle in backward-looking specifications of the IS Curve. In order to assess the empirical relevance of the potential explanations for the IS puzzle, we then estimate forward-looking IS Curves and augmented backward-looking IS Curves also including other asset prices and monetary aggregates besides the short-term real interest rate. We find that adding forward-looking elements does not, while adding other asset prices does, help to resolve the puzzle. The forward-looking specification of the IS Curve yields a significantly negative interest rate elasticity only for the US, the extended specification of the IS Curve for all G7 countries.

The plan of the paper is as follows. In Section 2 we discuss the potential explanations for an IS puzzle to emerge. In Section 3 we estimate backward-looking, forward-looking and extended backward-looking IS curves for the G7 countries. Section 4 concludes.

2. The IS Puzzle: Potential explanations

There are various potential explanations for the empirical finding of an insignificant interest rate elasticity in simple empirical representations of aggregate demand such as the backward-looking specification of the New Keynesian IS Curve. First, the estimated interest rate elasticity may be downward biased because of simultaneity bias arising from forward looking monetary policy. This criticism implies that the validity of any attempt to estimate structural IS Curves can be questioned and that the analysis of monetary transmission should rather focus on the effect of the exogenous or unsystematic component of monetary policy. In fact, partly as a result of this criticism, the bulk of the literature on monetary policy transmission is now based on VAR impulse response analysis, which aims at identifying and simulating the effect of monetary policy shocks, in order to disentangle the demand effect of monetary policy from its endogenous response to economic activity[3]. A severe limitation of the VAR approach is, however, that it provides evidence only for the effect of monetary policy shocks, which account for a negligible share of overall interest rate movements, while nothing is learnt about the effect of systematic monetary policy measures.

Another potential explanation for the IS puzzle is that empirical IS curves are mis-specified. First, theory suggests that the IS curve is forward looking and that the relevant real interest rate measure is the ex-ante real interest rate, i.e. the nominal interest rate less expected future inflation, rather than the ex-post real interest rate. Omission of forward-looking elements in empirical IS curves may give rise to a downwards biased interest rate elasticity. Second, other variables besides the short-term real interest rate may affect aggregate demand. In empirical open economy extensions of the New Keynesian model (Ball, 1998 and Svensson, 2000), the exchange rate appears as an additional variable, besides the short-term real interest rate, in the IS curve. A depreciation of the real exchange rate makes domestic goods more competitive and therefore has a positive effect on net exports. The exchange rate is often considered to be the most important determinant of aggregate demand besides the real

[3] For a survey of the VAR literature see Christiano et al. (1999).

interest rate in small open economies where net exports account for a large share of aggregate demand[4].

The real exchange rate is not the only candidate for addition to the IS Curve. Fuhrer and Moore (1995) and Nelson (2002) suggest that it is the ex-ante long-term real interest rate rather than the ex-post short-term real interest rate that matters for aggregate demand. Fuhrer and Moore (1995) show that the time series properties of the ex-ante long term real rate resemble that of the short-term nominal interest rate, so that the latter can be used as a proxy for the former in empirical analysis. Several empirical studies (e.g. Bernanke and Blinder, 1992, Fuhrer and Moore, 1995, Wright, 2000) find a significant effect of the nominal interest rate on the output gap. Nelson (2002) shows that, given a stable demand function for base money, real base money growth proxies the ex-ante long-term real interest rate. He reports evidence suggesting that real base money growth has a significantly positive effect on the output gap in the US and the UK.

Property and share prices and broad monetary aggregates may also affect aggregate demand via wealth effects. A change in perceived lifetime wealth, caused by a change in asset prices or broad money, may induce consumers to change their consumption plans (Modigliani, 1971). Evidence reported in Case et al. (2001) suggests that property prices have a particularly strong effect on household consumption. Another, 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, which gives rise to adverse selection and moral hazard problems[5]. 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 prices. Empirical evidence

[4] A Monetary Conditions Index (MCI), a weighted average of the short-term interest rate and the exchange rate, is commonly used as a composite indicator for the stance of aggregate demand by international organisations and central and private banks. See Eika et al. (1996), Ericsson et al. (1998) and Gerlach and Smets (2000) for an exposition and critical discussion of the MCI concept.

[5] Basic references of this literature are Bernanke and Gertler (1989) and Kiyotaki and Moore (1997). For a survey see Bernanke et al. (1998).

reported in Hofmann (2001, 2002) suggests that property prices have a significantly positive effect on credit aggregates both in the short and long-run[6].

If other variables besides the real interest rate also affect aggregate demand, the estimated interest rate elasticity in the standard IS Curve specification may be biased. The direction of the bias will depend on the correlation between the interest rate and the omitted variable. We can illustrate this point based on highly stylised model[7]. Suppose that aggregate demand is determined by a relationship of the form:

(1) $y_t = \beta_1 r_{t-1} + \beta_2 x_{t-1} + v_t$,

where *r* is a short-term real interest rate representing the monetary policy instrument and *x* is some other variable that also affects aggregate demand, e.g. the real exchange rate or some other asset price. If we would now estimate equation (1) omitting variable *x,* the OLS estimator of β_1 would be given by

(2) $\hat{\beta}_1 = \beta_1 + \beta_2 \operatorname{cov}(r_t, x_t) / \operatorname{var}(r_t)$.

The omission of variable *x* would therefore give rise to a biased estimate of the interest rate effects on output. But this is not necessarily a reason to worry. The coefficient β_1 gives the direct effect of interest rates on output. However, interest rate changes may also be transmitted via variable *x.* E.g. an increase in the real interest rate is expected to have a negative effect on asset prices and monetary aggregates. If there is a relationship between *x* and *r* of the form

(3) $x_t = \gamma r_t$,

[6] See also Borio, Kennedy and Prowse, 1994, IMF, 2000, and BIS, 2001.
[7] The model is similar to Woodford (1994).

then the estimator of β_1 will be given by $\hat{\beta}_1 = \beta_1 + \beta_2\gamma$. Since γ is negative, the estimate of β_1 will be upwards biased. $\hat{\beta}_1$ will then give an estimate not only of the direct interest rate effect, but rather of the total effect of an interest rate change comprising all channels of monetary transmission.

However, it may also be that monetary policy successfully tries to neutralise the effect of *x* on output, so that the relationship between *x* and *r* is given by:

(4) $r_t = \lambda x_t$.

In this case we get $\hat{\beta}_1 = \beta_1 + \beta_2\lambda$. λ is positive, implying that the estimator is biased towards zero. In the extreme case where monetary policy completely neutralises the effect of *x* on *y*, $\lambda = -\beta_2 / \beta_1$ and $\hat{\beta}_1 = \beta_1 - \beta_1 = 0$.

3. Empirical Analysis

The backward-looking IS curve

In empirical applications (Fuhrer and Moore, 1995, Rudebusch and Svensson, 1999, Rudebusch, 2002), the forward looking theoretical IS Curve is often approximated by a backward looking specification of the form:

(5) $y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \beta(i_{t-1} - \pi_{t-1}) + \varepsilon_t$,

where *y* is the output gap, *i* is the short-term nominal interest rate, π is the inflation rate. Equation (4) has become one of the standard empirical models of aggregate demand in the US (Estrella and Fuhrer, 1998, Nelson, 2001). Rudebusch and Svensson (1999, p.4) argue that the real interest rate term on the right hand side of equation (5) ''…is a simple representation of the monetary transmission mechanism, which, in the view of many central

banks, likely involves nominal interest rates (e.g., mortgage rates), ex ante real short and long rates, exchange rates, and possibly direct credit quantities as well.'' They conclude that equation (2) ''…appears to be a workable approximation of these various intermediate transmission mechanisms.'' This argumentation implies that Rudebusch and Svensson assume that the true model for aggregate demand is given by equation (1) and that all other variables appearing in the IS Curve besides the real interest rate are determined according to a relationship as equation (3). Rudebusch and Svensson (1999) estimate equation (5) for the US over the sample period 1961:1-1996:4 and obtain:

$$(6) \qquad y_t = \underset{(0.08)}{1.16}\, y_{t-1} - \underset{(0.08)}{0.25}\, y_{t-2} - \underset{(0.03)}{0.10}\left(i_{t-1} - \pi_{t-1}\right) + \eta_t ,$$

using the Congressional Budget Office's estimate of the output gap for *y*, the four quarter average of the Federal Funds Rate for *i* and is the four quarter average of the GDP deflator inflation rate for π. Peersman and Smets (1999) estimate equation (5) for the euro area over the sample period 1980-1998 and obtain very similar results. Nelson (2001, 2002) estimates backward looking IS curves very similar to equation (5) for the US and the UK over the sample period 1982-1999. For both countries he fails to find a significantly negative real interest rate coefficient.

No attempt has yet been made to assess the performance of equation (5) for a larger group of countries. In the following we estimate equation (5) for the G7 countries over the sample period 1982-1998 using quarterly data[8]. As a measure of the output gap we use the percent gap between real GDP and potential real GDP, calculated using a standard Hodrick-Prescott-Filter with a smoothing parameter of 1600[9]. Following Rudebusch and Svenssson (1999) we use a four-quarter moving average of the short-term money market rate for *i* and a four-

[8] The sample period was chosen in order to avoid that the large increase in short-term real interest rates in the early 1980s dominates the estimation results and also to make it match the sample period of Nelson (2001, 2002).

[9] The Hodrick-Prescott Filter trend was calculated over the period 1970-2001. The trend estimates from other trend filters, such as a bandpass filter, were very similar.

quarter moving average of the CPI inflation rate for π. The data were taken from the IMF and the BIS database.

The equations were estimated separately by OLS. The second lag of the output gap was retained only if it was significant at least at the 10% level. The results are reported in Table 1. For each country we report the coefficient estimates with t-statistics in parentheses, the adjusted coefficient of determination ($\overline{R}^2$) and the Durbin-Watson statistic (*DW*). The results suggest that there is strong evidence of an IS Puzzle in the G7 countries. In no country do we find a significantly negative real interest rate elasticity. Only in Canada is the t-statistic is close to the 10% significance level (-1.64). Taken literally, this result means that there is no significant link from the monetary policy instrument to the real economy. In other words, monetary policy is ineffective.

Table 1: OLS estimates of the backward looking IS Curve, 1982:1-1998:4

	y_{t-1}	y_{t-2}	$i_{t-1} - \pi_{t-1}$	$\overline{R}^2$ DW
Canada	1.313 (12.19)	-0.425 (-3.852)	-0.09 (-1.63)	0.87 2.19
France	0.91 (15.77)	---	-0.043 (-1.38)	0.79 1.86
Germany	0.72 (7.90)	---	-0.053 (-0.58)	0.48 2.15
Italy	0.763 (9.80)	---	-0.059 (-1.25)	0.62 1.92
Japan	0.78 (10.21)	---	-0.057 (-1.12)	0.62 2.25
UK	1.222 (10.73)	-0.328 (-2.91)	-0.017 (-0.45)	0.87 1.43
USA	1.308 (12.12)	-0.457 (-4.37)	-0.021 (-0.66)	0.85 2.40

Note: The table reports the results obtained from estimating equation (5) by OLS. T-statistics are in parentheses.

The forward-looking IS Curve

In the previous section we have argued that one potential explanation for the IS puzzle is mis-specification of the IS curve due to omission of forward-looking output terms. While there are various studies estimating forward-looking New Keynesian Phillips Curves[10], only a few studies have tried to estimate forward-looking New Keynesian IS Curves[11] . In the following we estimate an IS curve specification that also incorporates forward-looking output expectations. Following Fuhrer and Rudebusch (2002) we choose a hybrid specification of the form[12]

$$(7)\quad y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \mu E_t y_{t+1} - \beta(i_t - E_t \pi_{t+1}) + \varepsilon_t$$

Equation (7) differs from equation (5) by comprising, in addition to two lags of the output gap, also the current period's expectation of next period's output gap ($E_t y_{t+1}$). Also, instead of the ex-post real interest rate an ex-ante period real rate measure is used, defined as current period's short-term nominal interest rate less current period's expectation of next period's inflation rate ($E_t \pi_{t+1}$).

We estimate equation (7) by Generalised Method of Moments (GMM) using four lags of the output gap, the short-term nominal interest rate and the inflation rate as instruments. The second lag of the output gap was again retained only if it was significant at least at the 10% level. In Table 2 we report the coefficient estimates with t-statistics in parentheses. T-statistics were calculated based on heteroskedasticity and autocorrelation robust Newey-West standard

[10] See for instance Gali and Gertler (1999) for the US and Gali, Gertler and Lopez-Salido (2001) for the euro area.

[11] Fuhrer (2000) and Fuhrer and Rudebusch (2002) estimate forward-looking specifications of the IS Curve for the US and conclude that there is little evidence that forward looking expectations are an important determinant of current output.

[12] Empirically, the purely forward-looking IS curve was found to be unable to match the dynamics of aggregate output (Cogley and Nason, 1995 and Estrella and Fuhrer, 1998). For this reason, hybrid specifications of the IS curve, including both forward-looking and backward-looking elements, are preferred in empirical analysis. Fuhrer (2000) shows that such hybrid specifications can be theoretically motivated by habit formation in consumption.

errors. We also report the adjusted coefficient of determination ($\overline{R}^2$), the Durbin-Watson statistic (*DW*) and the J-statistic of the overidentifying restrictions with probability values in parentheses.

The results suggest that omission of forward-looking elements in the IS curve is not the cause of the IS puzzle. We find a significantly negative real interest rate elasticity only in the US. In the other countries the real interest rate elasticities are insignificant, in Canada it is even significantly positive.

Table 2: GMM estimates of the forward looking IS Curve, 1982:1-1998:4

	$E_t y_{t+1}$	y_{t-1}	y_{t-2}	$i_t - E_t \pi_{t+1}$	$\overline{R}^2$ *DW*	*J-test*
Canada	0.483 (13.71)	0.505 (19.74)	---	0.038 (2.21)	0.94 2.71	5.09 (0.75)
France	0.474 (7.24)	0.54 (9.48)	---	-0.011 (-0.86)	0.899 2.99	6.06 (0.64)
Germany	0.498 (5.45)	0.477 (6.84)	---	0.034 (0.75)	0.62 3.07	5.14 (0.74)
Italy	0.482 (5.44)	0.52 (6.99)	---	-0.005 (-0.18)	0.76 3.10	4.55 (0.80)
Japan	0.459 (6.13)	0.556 (9.87)	---	-0.028 (-1.38)	0.71 3.14	7.30 (0.50)
UK	0.344 (3.90)	0.845 (8.31)	-0.209 (-3.59)	-0.014 (-0.66)	0.94 2.85	7.64 (0.37)
USA	0.957 (7.79)	0.029 (0.14)	0.226 (1.82)	-0.041 (-1.88)	0.89 1.87	6.93 (0.44)

Note: The table reports the results obtained from estimating equation (7) by GMM. T-statistics are in parentheses.

An extended IS Curve

In the previous section we have shown that if aggregate demand also depends on other variables besides the real interest rate and if these variables are not a function of interest rates according to equation (3), but if interest rates are rather a function of these variables according to equation (4), then the estimated interest rate effects will be biased towards zero. In order to assess the empirical relevance of this argument, we estimate an extended version of the IS Curve, adding one lag of the real effective exchange rate (*rex*), the nominal short-term interest rate (*i*) and the annual rate of change in real residential property prices (Δhp), real share prices (Δsp), real base money (Δm^{base}) and real broad money (Δm^{broad}). For the non-US countries we also include the lagged US output gap (y^{US}).

All variables, except for the US output gap are four quarter moving averages in order to make the analysis compatible with the specification of the standard IS Curve estimated in the previous section and in order to keep the empirical analysis tractable given the rather small sample period and the rather high number of regressors.

The real effective exchange rate index was taken from the OECD Main Economic Indicators and 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. The share price index and the base money series were taken from the IMF International Financial Statistics. The broad monetary aggregate was taken from the OECD Main Economic Indicators. Broad money is M3 for Germany, France and Italy, M2 for the US and Canada, M4 for the UK and M2 plus certificates of deposit for Japan. Residential property price indices were taken from national sources as described in the data appendix[13].

[13] For Italy and Japan semi-annual data and for Germany annual data from the first quarter of each year were converted to quarterly frequency by linear interpolation.

The extended IS Curve is of the form:

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \beta_1 (i_{t-1} - \pi_{t-1}) + \beta_2 rex_{t-1} + \beta_3 i_{t-1}$$
$$+ \beta_4 \Delta hp_{t-1} + \beta_5 \Delta sp_{t-1} + \beta_6 \Delta m_{t-1}^{base} + \beta_7 \Delta m_{t-1}^{broad} + \beta_7 y_{t-1}^{us} + \eta_t \quad (8)$$

Since the variables of the right hand side of equation are obviously correlated, the estimating equation suffers from multicollinearity which was reflected by insignificant t-statistics when the full specification was estimated. For this reason we estimate equation (8) starting with the full specification and then progressively eliminate the least significant variable until all retained variables were significant at least at the 10% level.

In Table 3 we report the results of this estimation procedure. The results are quite clear cut. The short-term real interest rate is now significant in all countries except for the UK and the change in real property prices is significant at least at the 10% level in all seven countries. In the UK, aggregate demand is influenced by the short-term nominal interest rate rather than the short-term real rate. The US output gap is significant only in Canada and Italy. We do not find evidence of a significant effect of the real exchange rate, real share prices and real base money growth in any country. Broad money growth is significant only in the UK.

Thus, the real interest rate and real property prices are the most important determinants of aggregate demand. The general pattern is that the short-term real interest rate and the change in real residential property prices enter significantly the IS Curve. The extended specification yields significant real interest rate coefficients, suggesting that the IS puzzle disappears when a richer specification of the IS curve is chosen. For the UK it appears that the IS Curve should be modelled in terms of the short-term nominal rate and not the short-term real interest rate.

Table 3: OLS estimates of the extended IS Curve, Sample 1982:1-1998:4

	y_{t-1}	y_{t-2}	$i_{t-1}-\pi_{t-1}$	rex_{t-1}	i_{t-1}	Δhp_{t-1}	Δsp_{t-1}	Δm_{t-1}^{base}	Δm_{t-1}^{broad}	y_{t-1}^{us}	$\overline{R}^2$ DW
Canada	0.941 (6.61)	-0.277 (-2.50)	-0.086 (-1.65)	-----	-----	0.026 (2.14)	-----	-----	-----	0.265 (2.52)	0.87 1.95
France	0.922 (16.40)	-----	-0.055 (-1.79)	-----	-----	0.025 (2.26)	-----	-----	-----	-----	0.80 2.03
Germany	0.67 (7.57)	-----	-0.174 (-1.77)	-----	-----	0.054 (2.80)	------	------	------	------	0.53 2.24
Italy	0.562 (5.68)	-----	-0.122 (-2.54)	------	------	0.017 (1.82)	------	------	------	0.133 (2.57)	0.66 1.90
Japan	0.585 (4.87)	0.237 (1.96)	-0.094 (-1.85)	------	------	0.052 (2.49)	------	------	------	------	0.90 1.94
UK	0.82 (18.25)	------	------	------	-0.058 (-2.57)	0.016 (1.66)	------	------	0.046 (2.17)	------	0.90 1.94
USA	1.121 (10.02)	------	-0.056 (-1.80)	------	------	0.095 (3.61)	------	------	------	------	0.88 2.22

Note: The table reports the results obtained from estimating equation (8) by OLS. Insignificant variables were eliminated. T-statistics are in parentheses.

4. Conclusions

In this paper we assess the performance of the empirical New Keynesian IS Curve, which is widely used for the analysis of monetary policy. We show that the standard backward-looking specification of the IS Curve does not work in the G7 countries. The real interest rate elasticity is always insignificant, implying that the central bank can not stabilise the economy. Nelson (2001) terms this finding as the IS Puzzle.

We then assess empirically the two most promising explanations for the IS puzzle. First, mis-specification due to omission of forward-looking elements in the IS curve. Second, mis-specification due to omission of other determinants of aggregate demand besides the real interest rate. The evidence appears to favour the latter rather than the former explanation. Except for the US, we do not obtain significantly negative interest rate elasticities from estimating forward-looking IS curves, while extended IS Curves yield significantly negative real interest rate elasticities for all G7 countries, except for the UK, where it is the short-term nominal interest rate rather than the real rate that affects the output gap.

Besides the interest rate, property prices are found to enter with a significantly positive elasticity the IS curves in each country. Real share prices and the real exchange rate are not found to have a significant effect on the output gap. The same applies to monetary aggregates, except for the UK where real M4 growth has a significantly positive effect on the output gap.

Thus, the results from estimating extended IS curves for the G7 countries suggest that the standard specification of the IS curve is not sufficient to properly identify the effect of interest rates on aggregate demand and that a broader framework, also taking into account the demand effects of other variables, especially property prices, might be more appropriate. However, some qualifications are in order. First, it should be noted that the extended IS curve is not derived from an optimising model but is specified rather ad-hoc. The extended IS curve may therefore reflect reduced form rather than structural relationships. More work on the theoretical underpinnings of an extended IS curve of the form estimated in this paper is needed.

Second, the evidence presented in this paper should not be interpreted as suggesting that monetary policy should react mechanically to property price movements. It can easily be shown that in an empirical model comprising an extended IS curve of the form estimated in this paper, a Taylor-rule designed to stabilise output and inflation will actively respond to property prices in order to off-set the effect of property price movements on aggregate demand. However, this conclusion would be highly misleading, since asset prices are endogenous, which must be taken into account when evaluating the optimal response of monetary policy to asset price movements. The optimal policy response will depend on the driving force of asset price fluctuations (Gerlach and Smets, 2000, Smets, 1997) and the effect of interest rates on asset prices. The finding of a significant effect of property prices is therefore not sufficient to conclude that monetary authorities should directly respond to property price movements. In order to assess the optimal response of monetary policy to asset prices, a richer empirical model, also including behavioural equations for asset prices, would be needed.

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Data Appendix

Definitions and sources of residential property price series

	Definition	**Source**
United States	Single-family house price index	OFHEO and National Association of Realtors
Japan	Nation-wide land price index	Japan Real Estate Institute
Germany	Average sales price of owner occupied dwellings in Frankfurt, Munich, Hamburg and Berlin	Ring Deutscher Makler
France	Residential house price index	Bank of France
Italy	National house price index	Bank of Italy/ 'Il consulente immobiliare'
United Kingdom	All dwellings price index	Department of the Environment
Canada	Multiple listing service price index of existing homes	Bank of Canada