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The Exchange Rate and Monetary Conditions in the Euro Area

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The views expressed are those of the authors and do not necessarily correspond to the views of the Bank of Finland

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Abstract

Using information from a variety of sources, including our own estimates from quarterly data for each of the countries over the period 1972–1997, this paper suggests that the exchange rate will play an important role in the transmission of the impact of monetary policy through to the real economy and inflation in the euro area. Although the share of external trade in the euro area's GDP is only around 10 per cent this is only one factor that affects the transmission mechanism and the role of the exchange rate is likely to be substantially greater when all factors are taken into account. As a first approximation it would be reasonable to assume that an increase in the real 90-day interest rate of 100 basis points would have approximately the same effect on demand pressure two years later as a 3.5 per cent fall in the real euro exchange rate. This implies that the euro area will tend to behave like a large open economy rather than a closed economy and hence that it would be helpful in informing monetary policy to construct a Monetary Conditions Index (MCI) using these weights. A separate paper (Mayes and Virén, 1998) suggests how an MCI provides a useful summary of high frequency information to assist monetary policy and financial markets in short run decisions.

Keywords: monetary conditions index, exchange rate, monetary policy, euro area

Valuuttakurssi ja rahapolitiikan vaikutukset euroalueella

Suomen Pankin keskustelualoitteita 27/98

David G. Mayes – Matti Virén
Tutkimusosasto

Tiivistelmä

Tässä tutkimuksessa osoitetaan, että valuuttakurssilla on tärkeä rooli rahapolitiikan vaikutusten välittymisessä euroalueen reaalitalouteen ja inflaatioon. Päätelmä perustuu useista eri lähteistä saataviin tietoihin ja tässä tutkimuksessa saatuihin ajanjaksoa 1972–1997 koskeviin estimointituloksiin. Vaikka ulkomaankaupan osuus euroalueen kokonaistuotannon arvosta on vain noin 10 %, on tämä osuus vain yksi tekijä, joka vaikuttaa rahapolitiikan välitysmekanismiin, ja on todennäköistä, että valuuttakurssin vaikutus on olennaisesti suurempi, kun kaikki muuttujat otetaan huomioon. Voidaan pitää mielekkäänä arviona, että kolmen kuukauden korkojen nousu yhdellä prosenttiyksiköllä vaikuttaa kysyntään suurin piirtein samalla voimalla kuin reaalisen valuuttakurssin 3.5 prosentin vahvistuminen. Tämä merkitsee sitä, että euroalue käyttäytyy paljolti samalla tavalla kuin suuri avoin talous. Rahapolitiikan tueksi olisi siksi hyödyllistä muodostaa rahapolitiikan vaikutusindeksi (Monetary Conditions Index, MCI) käyttäen yllä mainittuja kertoimia indeksin painoina. Erillisessä raportissa (Mayes ja Virén 1998) kuvataan miten vaikutusindeksi tarjoaa hyödyllisen tavan tiivistää suuren frekvenssin informaatiota tukemaan rahapolitiikkaa ja rahoitusmarkkinoita lyhyen aikavälin päätöksenteossa.

Asiasanat: rahapolitiikan vaikutusindeksi, valuuttakurssi, rahapolitiikka, euroalue

Contents

1 Introduction

Monetary policy has its influence on the economy and on price stability in particular through a variety of channels (Mishkin (1997) provides a helpful summary). While there is debate over the existence of a separate 'credit' channel attention is usually focused on three channels: a direct effect on expectations, transmission through interest rates and transmission through the exchange rate. Interest rates, by changing the costs of borrowing and the returns to saving, affect demand pressure in the economy. The exchange rate also has an influence on demand by altering the relative price of tradeable goods and services. Furthermore the exchange rate has a more direct effect on consumer prices in so far as imports enter directly and indirectly into the consumer price index. Other influences will also be at work through the impact on asset prices and cashflows.

The time paths for the impact through the exchange rate and the interest rate are likely to be different. Existing evidence and the results summarised later in this paper suggest that there is considerable variation in the impact of both interest rates and the exchange rate across the member states of the euro area. This variation affects both extent of the impact for a given change in the two variables and the length of time it takes. However, our analysis suggests that there is far less variation in the *ratio* of the impact through the exchange rate and the impact through the interest rate in three respects: across the euro area countries; across different sources of estimates and over time after the first few quarters. Thus while there may be considerable uncertainty about the *extent* and the *timing* of the impact of monetary policy in the euro area through these channels, there is likely to be rather less about the *relative* impact of the exchange rate and interest rates.

Estimation of the impact of these two channels of monetary policy faces very considerable difficulty and no method is totally satisfactory (Ericsson et al., 1997). Focusing on their relative impact does not get round these problems and ratio estimators typically tend to have larger variances than their component parts. Nevertheless several central banks (including the Bank of Finland (Pikkarainen, 1993)) have persevered as have the IMF and the OECD and a variety of large private sector financial institutions (IMF, 1996; OECD, 1996; Ericsson et al., 1997; BNP, 1998; MSDW, 1998). Estimates for the relative size of the interest rate and exchange rate impacts in the euro area have varied between a ratio of 2 to 1 by Dornbusch et al. (1998) and 10 to 1 by Peersman and Smets (1998) but the bulk of the estimates for the various component countries and our own lie between these extremes. A ratio of X to 1 implies that a change in the exchange rate by X per cent has the equivalent impact to a 100 basis point change in the interest rate. Thus the larger the ratio the *weaker* is the relative impact of the exchange rate. Large relatively closed economies such as the US or Japan are thought to have ratios around 10 to 1 and very open economies around 2 or 3 to 1 (Table 1).

Table 1. **Estimated MCIs**

	Other estimates			Our estimates					
	Dornb[1]	NIGEM[2]	Other[3]	long sample	short sample	short +prices	short ΔGDP	short SURE	short +bondr
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Austria			3.3(4)	14.3	2.4	3.1	1.3	1.2	14.4
Belgium		(1.5)	0.4(6)	60.1	60.6	88.9	6.4	6.2	2.2
Denmark			1.9(6)	3.6	8.3	9.6	−13.3	14.4	−4.1
Finland			2.5(6)	8.9	3.1	3.2	3.3	3.4	4.3
France	2.1	3.0 (2.0)	3(2),4(3),3.4(4),2.1(5),3.5(6)	19.2	2.5	1.9	2.5	3.4	2.1
Germany	1.4	4.0 (6.1)	2.5,4(2),4(3),2.6(4),4.2(5),2.3(6)	29.7	3.6	2.5	4.9	3.4	2.7
Italy	2.9	0.1 (1.8)	3(2),4(3),6.6(4),6(5),4.1(6)	17.7	7.8	8.4	2.4	4.3	13.1
Netherlands		(3.0)	3.7(4),0.8(6)	12.8	2.3	2.3	2.8	1.2	3.4
Portugal				−4.6	11.6	5.6	2.3	14.8	3.6
Spain	1.5	1.3	1.5(3),2.5(4),4.2(6)	−2.1	0.8	0.8	0.6	0.5	3.7
Sweden	8.1		3-4(1),1.5(3),0.5(4),2.1(6)	5.2	1.2	1.3	0.7	1.2	0.8
UK		6.2 (4.6)	3(2),4(3),14.4(4),5(5),2.9(6)	0.8	1.5	0.3	1.5	1.1	0.9
Ireland					2.0	1.5	1.9	1.1	−1.7
Australia			2.3(3),4.3(6)						
Canada			2.3(1),4(2),2.3(3),4.3(5),2.7(6)						
Japan			10(2),4(3),8.8(5),7.9(6)						
New Zealand			2(1)						
Norway			3(1),1.4(6)						
Switzerland			6.4(4),1.7(6)						
US			10(2),9(3),39(5),10.1(6)						

[1] Drawn from Dornbusch et al. (1998) Table 10.
[2] Drawn from Banque de France (1996) Table 1. Numbers in parenthesis are drawn from Peeters (1998) Table 5. Peeters also provides estimates from EUROMON: Belgium, 6.7; France, 3.5; Germany, 9.0; Italy, 5,7; Netherlands, 8.1 and UK, 3.0.
[3] Drawn from Ericsson et al. (1997) Table 1. Numbers in parenthesis denote sources of estimates as follows: (1) central banks, (2) IMF, (3) OECD, (4) Deutsche Bank, (5) Goldman Sachs and (6) JP Morgan.

Using these ratios as weights it is then possible to construct a single indicator of the potential impact of both channels of the transmission mechanism on the economy. Such indicators are normally referred to as Monetary Conditions Indexes (MCIs). There is considerable debate over how these indicators should be used in the formulation of monetary policy, which we address in a companion paper (Mayes and Virén, 1998).[1] Our conclusion in that paper is that MCIs should be used with caution, not least because they are not particularly robust, but that they have an important role to play in the period between full revisions of a central bank's forecasts (usually at three or six month intervals) when sources of changes in monetary conditions are difficult to identify. They do not reflect the total of all influences on price stability and hence have to be used in combination with other information. Moreover, comparisons across time periods are dependent upon the whole range of external factors that influence inflation in each of the periods.

Our purpose in the present paper is strictly limited. After a short section clarifying the problem, we set out the different ways of estimating an MCI ratio, and, with the use of a dataset covering all the euro area countries (except

[1] This debate has been sufficiently acrimonious and the strength of the immediate reaction to mentioning the term MCI sufficiently great that we are very tempted to avoid using it at all as we do not ourselves use it in its controversial role. However, since the concept is widely used, particularly in financial markets, this would not be an informative approach.

Luxembourg) for the period 1972–1997,[2] seek to account for the variation in existing estimates and provide new estimates over our own that suggest that an MCI ratio of the order of 3.5 might be an appropriate starting point for computing an MCI when the euro begins full operation on 1st January 1999. Producing an MCI for the euro area is particularly problematic, as we have to look forward to how the euro economy will operate with a new currency, the Growth and Stability Pact and increasing integration. Yet we only have data on past behaviour and limited evidence on how people respond to regime changes. However, despite the difficulties, decisions still have to be made about the relative importance of the exchange rate in transmitting monetary policy and our review of the evidence suggests it would be mistaken to treat the euro economy as being largely closed and to neglect the role of the exchange rate. When interest rate and exchange rate movements are positively correlated monetary policy would tend to be over-reactive. When they are negatively correlated it would tend to be insufficiently accommodative of external shocks.

In this analysis we do not treat the exchange rate as being a policy instrument. Although the ECB can intervene in foreign exchange markets we assume that the ESCB effectively only has one 'instrument' for monetary policy, namely the ability to exert substantial control over short-term interest rates. In influencing that short rate it will affect the whole spectrum of interest rates and the exchange rate as international financial markets are strongly integrated. The ESCB cannot therefore exert any lasting control over the *mix* of monetary conditions between interest rates and the exchange rate, although by moving the short rate it can have a clear influence on the overall *level* of monetary conditions. An MCI helps in making judgements about whether changes in the mix also represent changes in the level and about how important such changes might be for price stability.

Furthermore, in exploring the importance of the role of the exchange rate in the transmission of monetary policy we are not suggesting that the central bank should or even could have a separate objective for the exchange rate. Indeed our conclusion that the euro economy is relatively open means that it would not be possible to pursue a separate policy for the exchange rate independent of the maintenance of price stability.

2 Monetary conditions indexes

Normally an MCI is defined as

$$MCI_t = \sum_s w_s (P_{st} - P_{s0}), \qquad (1)$$

where the P_s are variables related to monetary policy actions A_j (j indicating the actions available) and thought to affect demand (Y) or inflation (π).[3] Thus there will be relationships of the form

$$Y = f(P_{1,\dots,s}, X), \quad (\text{or } \pi = g(P_{1,\dots,s}, X)), \qquad (2)$$

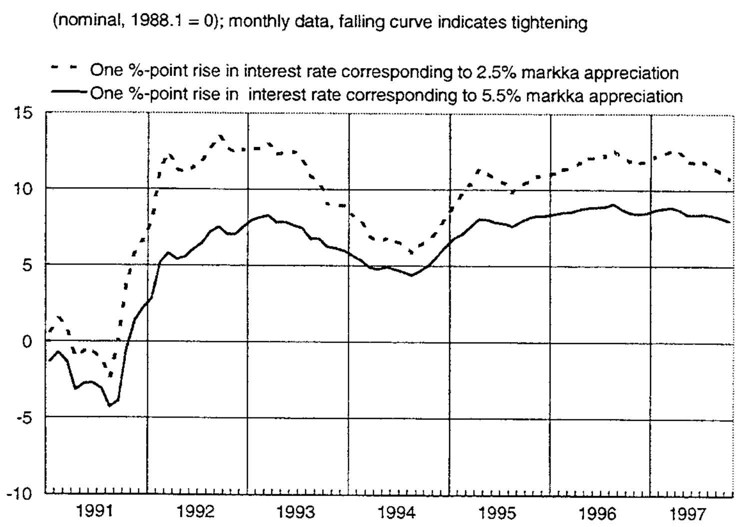
[2] The data for Ireland only cover 1984–1997.

[3] While it is normal to include the level of interest rates, exchange rates are normally included in log form.

X representing all the other variables in the model that also have an impact on demand (or inflation).[4] The weights w_s will be computed from the partial derivatives of the appropriate elements in f (g) including due allowance for the dynamic structure. An MCI is thus conditional on a particular model of the economy.[5] The more complex the model, particularly if it contains a monetary policy reaction function and model consistent expectations, as is the case with most of the central bank models considered here, the more qualified the role of the MCI. If the model is too simplified, does not address fundamental properties of the data, such as stationarity, and leaves out key characteristics of behaviour, then the estimation of the weights will tend to have rather poor econometric properties, as pointed out by Eika et al. (1996).

In all the cases considered here only short interest rates, i, and exchange rates, e, are included in the MCIs. However, the inclusion of other financial prices, such as the stock market index, has been contemplated (Mayes and Razzak, 1998). It is also possible to consider including both long and short interest rates if they are affected by monetary policy actions and they have differential effects on aggregate demand or inflation (Kennedy and van Riet, 1995). The deviations of the P_s in period t from the base period 0 are weighted by w_s and summed to form the index. The index is usually normalised in the base period. Fig. 1 illustrates this technique for the case of Finland, where the two MCIs available continuously from the Bank of Finland information system are shown, using ratios of 2.5 and 5.5.

Figure 1. **Monetary conditions index**



Source: Bank of Finland

[4] MCIs are normally computed on the basis of the effect on excess demand rather than inflation (Nadal De Simone et al., 1996, is a counter example). In part this reflects the fact that MCIs were originally derived from a simple IS curve. Tracing the effect through to inflation requires a more complete model. Since most MCIs are also specified in real terms, models that also include price determination are much more complex to simulate, as performing real shocks requires an iterative process. If the feed-through to inflation is not clear then the value of MCIs as a policy indicator is reduced.

[5] In practice central banks tend to choose robust values for the MCI weights that are consistent with quite a wide range of plausible models.

3 Computing an MCI

There is no way of computing an MCI that does not involve some drawbacks. The caution about how MCIs should be used and computed is well summarised by Ericsson et al. (1997) who list six drawbacks that have to be overcome:[6]

- There are several relationships between the key variables involved (output, inflation, interest rates and the exchange rate) these must be specified if the estimates are to unbiased
- In particular assumptions about exogeneity of the instruments of monetary policy and other variables must not be too strong
- Normal considerations of cointegration should be applied – many MCIs in practice have confused levels and differences of variables in their structure – the dynamics of the relationships are important and need to be carefully modelled
- The impact of the components of an MCI varies over time so an MCI needs an explicit time horizon
- It appears that the coefficients of MCIs are not stable over time – this will be in part due to failure to allow for the first three problems listed here
- Estimates are subject to wide variances.

We deal with each of these problems in our discussion, starting with the need to have a complete set of relationships; bias from omitted variables is one of the most obvious problems we face. However, as a generality, the simpler the model that is used the more of these six difficulties it is likely to encounter.

In the sections that follow we consider estimates by other authors along with our own direct estimation using a data set for all the euro countries except Luxembourg for the years 1972 to 1997 (this is explained in more detail in the data appendix). By this means we explore the region in which robust estimates appear to lie. In order to make this process as clear as possible we have summarised the various estimates in Table 1. Column 1 shows the recent results obtained by Dornbusch et al. (1998). Column 2 lists the results from a study by the EMI (Kennedy and van Riet (1995), which has since been published by the Banque de France (1995)).[7] While the third column, with multiple entries, is derived from the survey of previous work by Ericsson et al. (1997) and other examples we have found. Our own estimates complete the right-hand side of the Table. Subsequent tables develop our results.

The obvious approach for estimating an MCI is to derive it from the macroeconomic model that the central bank uses for forecasting and monetary policy analysis. Such models by their very nature have to include the routes of influence of policy on inflation if they are to be of value to the bank. In due time this should be possible with the ESCB's multi-country model but that has yet to be completed let alone tested to the point that simulations for all of the component countries could be released. However, many central banks use a variety of methods in forecasting and do not base their forecasts on a single model. The Federal Reserve Board for example deliberately develops forecasts from a number

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[6] But not in this order.

[7] These include the sum of the short and long interest rate effects.

of models as part of the process of forming a view of the future. Other central banks use different models for policy simulations and for forecasts as the two purposes have rather different requirements. Relatively few central banks have models that are core to both purposes and even fewer publish them or a good enough guide to their properties for us to be able to compute an MCI.[8] Of those that do the Bank of Canada and the Reserve Bank of New Zealand use calibrated models, so their estimates of the MCI are primarily derived from other sources and the model calibrated to reflect them.[9]

Central banks are not the only providers of estimated macroeconomic models so alternative models such as the National Institute's NIGEM or the Commission of the European Communities QUEST can be used to derive MCIs as well. Indeed it is NIGEM that was used by the EMI (Kennedy and van Riet, 1995) and it is the use of this model that is discussed in the next section (3.1).[10] However, not only is the MCI dependent on the specific model but most existing models use a trade weighted exchange rate which covers all other countries not just those that will be outside the euro area.[11] So they are not so well tuned to our purpose of estimating an MCI ratio for the euro area. In any case some large macro-models are too complex and non-linear to be solved for the MCI ratio. They have to be simulated for the impact of exchange rate and interest rate shocks using a set of assumptions about the reaction of the rest of the economy.[12]

Since re-estimating these macro-models is not a viable proposition an alternative approach is required. One possibility is to estimate a simplified macro-model with a clear structure based on a coherent economic theory. This we consider only briefly in section 3.2 as this route has not generally been followed in practice. However, simplicity has its own drawbacks, the most important of which is that the lag structure is likely to be too simple. The opposite extreme would be to estimate a VAR. Here the lag structure can be complex and there is far less need to commit to a specific structural view of the economy, merely to sufficient restrictions to identify the model. However, as we discuss in section 3.3, estimation of the impact of monetary policy using VARs is the subject of considerable controversy. Intermediate formulations such as VECM models (Jacobsen et al., 1998, for example) and somewhat more complex but small sized models such as Britton and Whitley (1997) are also possible. In practice central banks have largely resorted to even simpler specifications involving either just an open economy IS curve (Canada, Norway, New Zealand) with an additional price equation in the case of Sweden (section 3.4).

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[8] The Bank of Finland is a clear counter-example (Bank of Finland (1985, 1990) and Willman et al. (1998)). OECD (1996) also makes it clear that the MCI weights it uses are computed from the impulse responses generated by its INTERLINK model and then rounded.

[9] The Bank of Canada model QPM is described in Black et al. (1994), Armstrong et al. (1995), Coletti et al. (1996) and Butler (1996) and the RBNZ model in Black et al. (1997).

[10] As we show in the next section, it has since become possible to extend the Kennedy and van Riet analysis to all of the euro countries except Luxembourg as NIGEM now has separate models for each of them. However, the models for many of the smaller countries contain fewer relationships.

[11] Our results suggest that including intra-euro area exchange rates can make a substantial difference to the estimates.

[12] The nature of the conditionality is discussed in the next section. Generally model simulations tend to address the appropriate assumptions rather weakly.

3.1 Using a Complex Macro-model

Only one current central bank model in the euro-area has been published, Bank of Finland model BOF5 (Willman et al., 1998).[13] This model provides a MCI ratio of 1.8 to 2 over the policy horizon when simulated into the future.[14] A smaller model of the Finnish economy, QMED, also used in the Bank (Hukkinen and Virén, 1998) shows a nominal MCI of 2.3 (the individual interest rate and exchange rate effects differ more between these models). However, the relative effect on inflation from the exchange rate over that horizon is much more substantial with an MCI ratio of 0.6 (Hukkinen and Virén, 1998).

MCIs can, however, be computed from other macro-models of the EU countries that are available for public access. Kennedy and van Riet (1995) use the NIESR NIGEM model to provide estimates for France, Germany, Italy, Spain and the UK (shown in column 2 of Table 1).[15] Peeters has also used a more up to date version of NIGEM for Belgium, France, Germany, Italy, Netherlands and the UK. With the exception of the UK Peeters' estimates are all a little larger than the earlier Kennedy and van Riet results. What we find then typically from this form of analysis is MCI ratios in the range 1 to 5 for European economies. The MCI ratios computed in terms of inflation turned out to be much lower being in the range of 0.1 to 1.6. However, these results are of only limited value as they use the trade-weighted exchange rates with respect total trade and not just with countries outside the euro area. It is not correct to assume that because of this misspecification of the relevant exchange rate that the impact of extra-euro area exchange rate on output will be smaller just because the amount of trade involved is smaller. Intra-euro area exchange rate influences may have muted or amplified the effects depending upon the correlation of intra and extra-euro area exchange rates over the period and the size of the relevant elasticities. Moreover, the results with these models are based on nominal, not real, values of interest rates and exchange rates. This obviously makes a lot difference, in particular, in terms of the long-run effects.

We have therefore extended the analysis substantially, using the July 1998 version of NIGEM and running the model for each of the EU countries individually (except for Greece and Luxembourg for whom there are no separate models) and for the euro11 as a whole. This version of the model allows us to simulate shocks to the US$ exchange rate. Results are shown in Fig. 2 for a 1 % shock to the US$ and to the three-month interest rate for a five-year period starting in 1998Q1, which is the start of the forecast run supplied with the model. We use that forecast as the base for our simulations. The MCI ratios are shown both for the impact on GDP and on the GDP deflator in the individual countries.

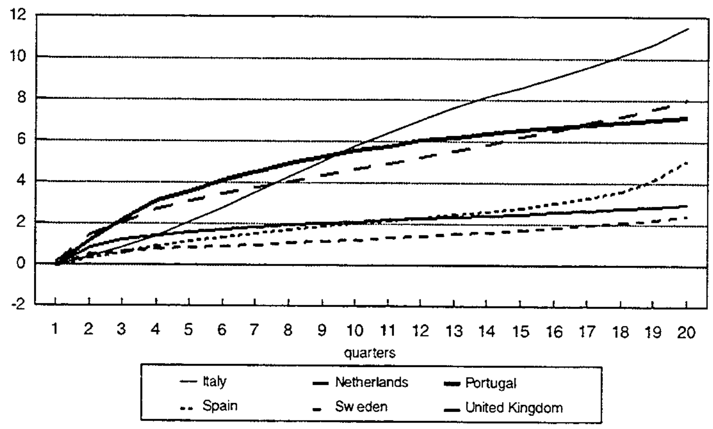
[13] Peeters (1998) shows some results using the Nederlandsche Bank's EUROMON model (see Table 1 footnote 2). These results produce higher values for some of the countries than the other models. The MCI ratio for a euro area of Belgium, France, Germany, Italy and the Netherlands is 19, giving the rather unlikely implication that this area will be more closed than the US and Japan.

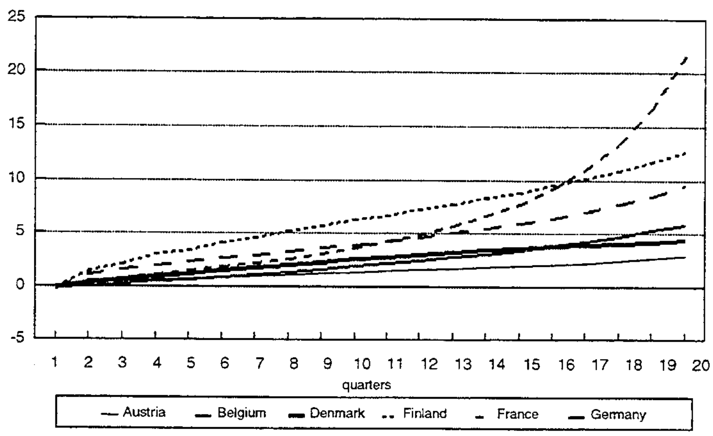
[14] A further complication with many complex macro-models is that the simulation results vary according to the data period over which the model is run. Extra-euro area trade is growing relative to GDP in Finland so the external exchange rate is attaining increasing importance as time passes.

[15] Kennedy and van Riet (1995) has not been published but the results have been published in Banque de France (1996), which we refer to here.

However, for the euro11 as a whole, the consumers' expenditure deflator is used, as the GDP deflator is not available.[16]

Figure 2. **NIGEM simulation: MCIs for impact on GDP (quarter 1 is 1998Q1)**





The MCIs rise for each country as the time period is extended because the exchange rate effect tends to fade out while the interest rate effect continues. The exchange rate change is offset by the reaction of the domestic price level, whereas the interest rate change is not. Indeed, the interest rate shock has to be temporary to avoid disrupting the long-run equilibrium of the model. Over the policy-relevant horizon, thought to be around two years ahead for most countries, the MCI ratios for GDP lie mainly between 1 and 5 in line with the estimates from earlier versions of the model. Comparable estimates to the Kennedy and van Riet (1995) and Peeters (1998) results using a three-year time horizon are shown in Table 2. Here the average of the MCIs for the EU countries is 4 on a GDP basis.

[16] This consumers' expenditure deflator is also a better proxy for the HICP (harmonised index of consumer prices) that has been announced as the ESCB's target.

Table 2. **MCI ratios derived from NIGEM (July – 1998 version) model simulations**

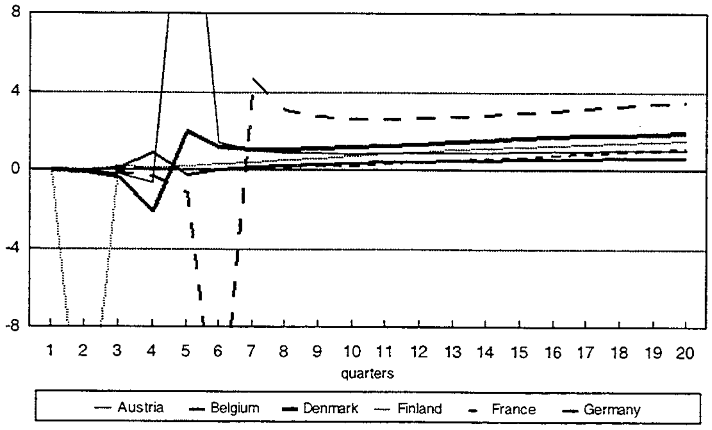
	GDP effects	GDP deflator effects
Austria	1.5	0.9
Belgium	2.5	0.5
Denmark	3.0	1.4
Finland	7.3	0.9
France	4.9	0.4
Germany	4.7	2.7
Ireland	5.6	0.4
Italy	7.0	2.5
Netherlands	2.3	1.2
Portugal	6.0	3.2
Spain	2.3	2.5
Sweden	1.5	0.6
United Kingdom	5.3	2.0
Average	4.1	1.5

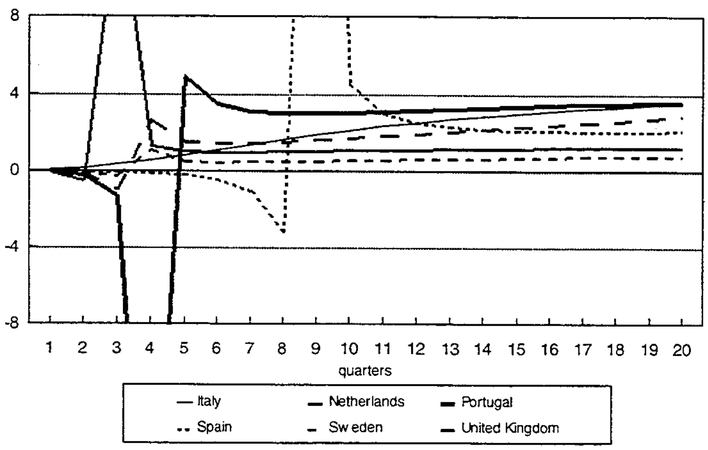
Simulation results for euro11

	GDP	Consumption prices
4 quarters	3.1	0.5
8 quarters	6.3	1.9
12 quarters	9.1	3.3

The MCIs for the impact on prices (GDP deflators) have two features. There is some substantial initial variation as short-run effects can have a perverse sign or very small values for one or other shock. However, from two years ahead onwards the results are much more stable, as shown in Fig. 3, and unlike the GDP results do not exhibit any strong tendency to rise over time. Secondly the MCI ratios are much smaller than for GDP, ranging from 0.4 to 3.2 at the three-year horizon, with an average of 1.5. From this point of view the exchange rate effect is clearly very important – much more so than one would exect from trade shares.

Figure 3 **NIGEM simulation: MCIs for impact on GDP deflator (quarter 1 is 1998Q1)**





The euro11 picture is rather different. Here values are substantially higher in the case of GDP with an MCI of 6.3 after two years. This is in contrast to the results that Peeters (1998) obtains from a slightly earlier version of NIGEM, including only Belgium, France, Germany, Italy and the Netherlands, where the MCI is 4.3 for a two-year horizon.[17] The consumer price MCI that we obtain is still low at 1.9. Taken together therefore it appears that the substantial changes in the various aspects of NIGEM over the last few years have had relatively little impact on the implicit MCI ratios. It may also imply that behaviour in the euro countries has been changing only slowly.

The feed-through from the exchange rate in NIGEM and similar macromodels is influenced by a variety of factors. In direct pricing, it depends on the structure of the industry as to whether the foreign seller or purchaser absorbs any of the exchange rate change. In any case trade shares and currency of invoicing shares can vary markedly (Grilli and Roubini, 1990; Page, 1981). In general, the US

[17] There is clearly a problem in computing synthetic euro area MCIs in these sorts of models. Not only do our results with NIGEM seem to rise to rather high levels but Peeters (1998) result from EUROMON is much higher than the MCIs from any of the component countries. In the EUROMON case this may be explained by the use of the DM exchange rate but it is clearly crucial to find out how such aggregated models are constructed as they are not similar to weighted aggregates of the parameters.

dollar is much more important in international pricing than US trade shares, although that position weakened during the 1980s.[18] That weakening has continued and is likely to be accelerated by the introduction of such a substantial production bloc as the euro-area. Nevertheless, assuming that the role of the US dollar and other non-euro currencies falls to their trade share would require radical changes. In any case, the direct price effect is only a part of the transmission mechanism.

Of course, re-estimating using extra- and intra-euro area and exchange rates as separate explanatory variables would not necessarily provide good estimates of the likely role of the extra-euro area exchange rate after Stage 3 of EMU starts if pricing behaviour changes markedly as a result of the regime change. In general as integration of markets proceeds the domestic sector tends to respond more rapidly to external price shocks even if the goods and services involved are not themselves traded.

In recent year macro-models have become more complete in two senses. First of all they have incorporated forward-looking expectations and secondly they have incorporated 'reaction' functions that set out the stylised reactions of policy-makers to shocks. These are important steps forward from the point of view of explaining how people are likely to react to news. They mean first of all that the coverage of the transmission mechanism is more complete in that people take into account in their actions today what they expect to happen tomorrow.[19] Thus asset prices can move very quickly in response to news. In particular they would respond to an announced or perceived change in the objectives of monetary or fiscal policy. Normally such responses are progressive, either because it takes some time for people to work out ('learn') what the shock implies or because some people are constrained from reacting immediately. This alters the profile of the response to a shock considerably (see Willman et al. (1998) for the impact on BOF5). Thus the level of the MCI will be affected (increased) over shorter time horizons and the ratio may be affected if the impact on the two components is different. In BOF5, for example, the MCI ratio increases after the first few quarters as the weight on the forward-looking element of expectations rises.[20]

The specification of reaction functions is also important because it enables us to distinguish between two sorts of shock, one that is exogenous and the other that is caused by the authorities, either because they change their behaviour deliberately (say by announcing a new inflation target) or because they do not respond as people expect. An example of the second surprise by the authorities would be where they interpret the potential impact of a shock differently from the market.

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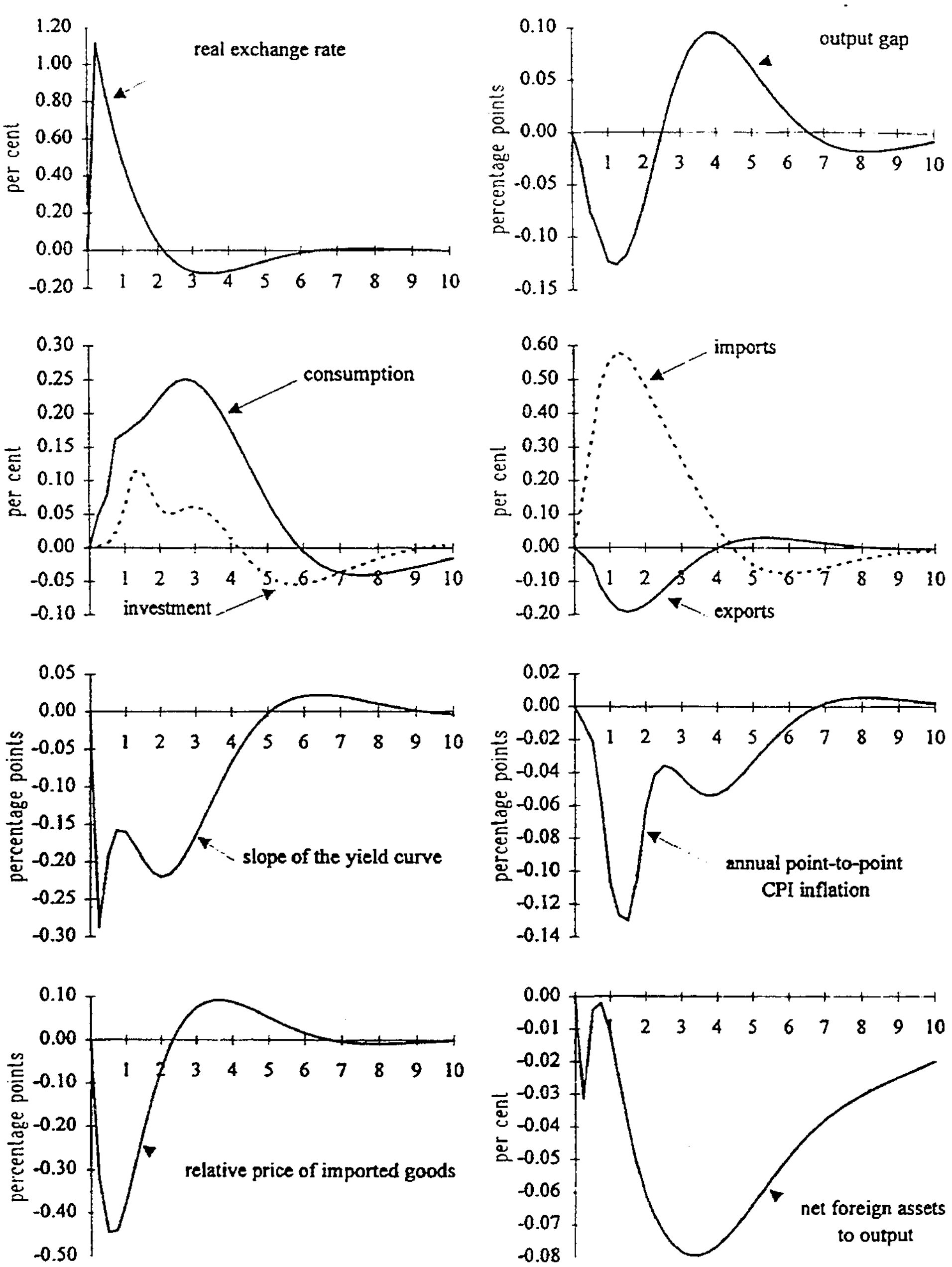
[18] The US dollar was used in around half of world trade whereas the US share of world trade was only around a quarter during the 1980s.

[19] The effect on expectations is a key feature of the monetary transmission. One the reasons why we put it first in the description. If policy-makers can act or commit themselves to act in a credible manner then the size of the changes in the settings of the instruments monetary policy can be smaller to achieve any desired change in forecast inflation or output (Mayes, 1998).

[20] At the same time the effects of policy come through much faster and smaller policy responses are required to any given shock.

Figure 4. **A temporary real exchange rate appreciation**



Black et al. (1997) Figure 5.7.

The existence of these mechanisms poses a problem for simulations. If the authorities always react to exogenous shocks so as to neutralise their impact on forecast inflation (or whatever is the target variable) then we would have difficulty in tracing out the components of an MCI.[21] Similarly, models will posit a link between domestic and foreign asset prices, say, through uncovered interest parity, so a shock to either the exchange rate or domestic interest rate would tend

[21] This finding was noted over 25 years ago when trying to measure the effectiveness of fiscal policy (Blinder and Solow, 1993).

to elicit a response from the other. These responses will vary depending upon whether the response is perceived to be permanent or temporary. Indeed the authorities' response will also depend upon that perception. As a generality, monetary authorities will tend to accept a 'supply-side' shock, such as a change in commodity prices, as being a relative price shock that they have to accommodate and will only respond to demand shocks.

In calibrated models such as the Bank of Canada's QPM and the RBNZ's FPS the direct and indirect channels of influence on prices are deliberately accounted for. In Fig. 4 (drawn from Black et al. 1997) the effect of a temporary real exchange rate shock has twin peaks on inflation. The direct feedthrough into the relative price of imports occurs almost immediately but has been completely reversed after two years by which time the exchange rate shock itself has dissipated. The demand effects, however, take about six years to flow through the economy completely. Although the initial output gap response is negative (as we would expect from an MCI related to output) a positive output gap emerges after 2 to 3 years, largely because monetary policy responds to the initial exchange rate shock and short-run interest rates are lowered. In MCI terms the initial shock is negative as interest rates cannot 'correct' the exchange rate shock immediately and hence a positive MCI is required later.[22]

The full macromodel approach hence makes it difficult to extract the message of what is required for the components of monetary conditions in a manner that could be readily communicated to financial markets, the public or indeed to many policy-makers.

3.2 Small structural models

While potentially a helpful route small structural models that are analytically tractable yet large enough to cover all the key features of the transmission mechanism have tended to have too simple a lag structure to make estimation of an MCI very illuminating (Nadal De Simone, 1996; Collins and Nadal De Simone, 1996). Although they do illustrate that the time horizon over which the MCI is estimated is important. If the time horizon is only 2 to 4 quarters ahead then the relative importance of the exchange rate will be considerably greater but by the sort of time horizon of 6 or more quarters that is more common for monetary policy decision-making the MCI has stabilised and changes little further as the horizon is extended indefinitely.

3.3 Reduced form estimation

In practice, therefore, recourse has normally been made to simple models, usually in reduced form. Duguay (1994), in what appears to be the first published estimates of the Bank of Canada's MCI, uses simply an IS curve of the form

[22] In real terms there is actually a third phase of a negative MCI again to help damp out the cycle. The return to asset equilibrium takes even longer and is still not complete by the end of the 10 year period illustrated as can bee seen from the bottom right-hand chart in Fig. 4.

$$y_t^d = a_0 - a_1 r_t + a_2 q_t + a_3 y_t^* + v_t \qquad (3)$$

where domestic output y_t^d depends on the real rate of interest r_t, the real exchange rate q_t and foreign demand y_t^* and

$$q_t \equiv e_t + p_t^* - p_t, \qquad (4)$$

p_t^* being the price of foreign goods and services, p_t the price of domestic goods and services, e_t the nominal exchange rate and v_t the domestic demand disturbance.[23] The United States is the 'foreign country' in the model rather than some weighted aggregate as would be more appropriate for most euro countries. The lag structure is also a little more complex

$$\Delta GDP_t = \underset{(1.0)}{0.13} + \underset{(4.8)}{0.52}\Delta GDP_{USt} + \underset{(4.2)}{0.45}\Delta GDP_{USt-1} - \underset{(1.8)}{0.40}r + \underset{(1.3)}{0.15}q$$

$$\overline{R}^2 = 0.64, \quad SEE = 0.62, \quad DW = 1.96 \quad \text{sample } 1980Q1-1990Q4$$

where Δ denotes the quarterly growth rate, r is the 8-quarter moving average of the quarterly change in the 90-day commercial paper rate less a one-quarter lag of the four quarter growth rate of the of the GDP deflator and q is the 12-quarter moving average of the quarterly growth rate in the real Canada-US exchange rate (defined in terms of relative GDP deflators), t-ratios in parentheses. From this Duguay concludes that the rounded value of the MCI for policy purposes should be treated as 3 (2.67 in the equation).[24]

The main source of the estimates for the RBNZ MCI that is used in practice (Dennis, 1996b) also follows this reduced form approach as does the Norwegian MCI based on the work of Jore (1994). The Sveriges Riksbank goes a little further in adding an inflation equation (Hansson, 1993; Hansson and Lindberg, 1994), where inflation depends on its own lags, the output gap and current and lagged foreign inflation. These results are shown in column 3 of Table 1 (marked (1) for central banks' estimates).[25] While the values fall in a narrow range and all show an importance for the exchange rate in excess of the relevant foreign trade share in total activity, Ericcson et al. show that the 95 % confidence intervals for the MCIs are wide (Canada –1.72 to 8.85; New Zealand –0.16 to 3.66; Norway –0.94 to 5.23) except Sweden (1.17 to 2.87).[26]

Dornbusch et al. (1998) seek to get out of these difficulties by estimating a two equation model composed of a monetary policy reaction function and an output growth function for Germany, France, Italy, Spain, the UK and Sweden. The reaction functions differ in form according to the regime deemed to be in place over the estimation period (1987–1996). They assume that the central banks

[23] These approaches are, however, much more open to the criticisms of Ericsson et al. (1997).

[24] Neither the interest rate nor exchange rate coefficients are particularly well determined.

[25] Except for Sweden where the Riksbank publishes an estimate of 3–4 as opposed to the value estimated in Hansson and Lindberg of 2.

[26] Ericsson et al. use three bases for calculating confidence intervals for the MCI ratio. We report those based on the Wald statistic primarily because this makes them comparable with the estimates used by Dornbusch et al. (1998).

set short-run interest rates according to the deviation of the exchange rate, inflation rate and output growth from their respective targets, with a lagged dependent variable to allow for instrument smoothing. Germany is assumed to be setting policy based on the trade-weighted exchange rate with respect to the other European currencies, a quadratic output trend and stable inflation. France, Italy and Spain are assumed to be targeting the Dmark and German inflation and output growth.[27] Lastly the UK and Sweden are included as inflation targeters in their own right.[28]

Output growth functions are then estimated using the fitted values of the monetary policy reaction function as one of the arguments. The other explanatory variables are inflation and its lagged value and 7 to 12 lags on the exchange rate (data are monthly).[29] Taking these results together gives the MCI ratio estimates shown in column 1 of Table 1. However, it is instructive to look at the whole range of their estimates, Table 3, as they show two characteristics that are important for the successful use of an MCI. First, the elasticities with respect to the interest and exchange rates individually are not large and, second, with the exception of Sweden, the MCI ratio, both as a point estimate and as an interval, lies within a somewhat narrower interval than Ericsson et al. (1997) found in their study of Canada, New Zealand, Norway, Sweden and the United States. It is Sweden that is the surprising result because this is the only case where Ericsson et al. obtain closely determined estimates. However, data periods are very different and Dornbusch et al. use monthly rather than quarterly data. As we show in the next section results can be quite sensitive to the choice of data period, although typically it is the longer period that gives the weaker results as it tends to include regime shifts.

Table 3. **Estimates of the MCI from Dornbusch et al. (1998)**

Country	Exchange rate elasticity	Interest rate elasticity	MCI ratio	95 % confidence interval for MCI ratio
Germany	1.01	1.40	1.39	0–2.8
France	0.73	1.54	2.10	0.35–3.85
Italy	0.74	2.14	2.89	0.59–5.29
Spain	1.05	1.54	1.46	0–2.9
Sweden	0.29	2.36	8.13	–3.0–19.2

In a more recent paper Peersman and Smets (1998) have produced results from output growth equations for Austria, Belgium, France, Germany, Italy and the Netherlands that suggest that the US$/DM rate is unimportant. Their model also includes foreign output growth the DM and their own real interest rates and the exchange rate with the DM. The model is estimated on quarterly data for the period 1978–1995. Numerical estimates are not given but it is interesting to note how much these results differ from the Dornbusch et al. (1998) findings. Our own results for the period 1987–1997 show a much larger role for the US$ exchange

[27] Our results show that the explicit 'foreign' demand variable matters. With an area as large as the euro area, assuming that even OECD GDP is the appropriate variable may be mistaken.

[28] However, Sweden has the same specification as France, Italy and Spain.

[29] The exchange rate is with the Dmark except in the case of Germany when it is with the US dollar.

rate and a rather poorly determined role for the DM, in some cases with perverse signs. It is the more recent period that is the more relevant for the euro area and there are structural breaks in the earlier period. The results also differ from Smets earlier (1996) results where both elasticity and VAR estimates come out substantially less than trade shares (Table 4).

Although the estimation of straight-forward IS curves of the form shown in equation (3) presents a range of problems it is the method used for the construction of a number of MCIs used in practice at present (Canada, New Zealand, Sweden, Finland and Norway) and hence it is helpful to begin our analysis with a direct comparison from our wider data set of 12 EU countries (covering the period 1972.2 to 1997.4, quarterly).[30] We have only considered the MCI in real terms and have used only a limited specification search in order to provide robust estimates. We searched up to eight lags for each variable except the dependent variable, where only 2 lags were considered.[31] Since we are interested in MCIs relating to the euro area we have considered only the bilateral exchange rate with the US dollar in the initial estimates. Our foreign demand variable relates to the OECD as a whole in all cases and we have not attempted to obtain more specific measures related to each individual country's trade pattern. The resultant MCIs are shown in col. 4 of Table 1 and the equation estimates themselves in Table 5 as the first row for each country.[32]

[30] We use quarterly data, as it is not possible to interpolate GDP data in a satisfactory manner to compare with the US. The use of industrial production as a substitute output variable is likely to introduce a range of complications with the switch to outsourcing and substantial changes in public and privately-provided services in the EU countries. However, the use of longer time periods makes the identification of the lag structure a little more problematic as a quarter may be long enough to permit 'contemporaneous' policy reactions to some shocks. Nevertheless the problem may be limited as the monetary authority faces not the final published data used in this analysis but first and partial estimates, which may in fact turn out to be rather different (see Mayes, 1981 for an extreme case with UK national accounts data).

[31] We began our analysis with the usual cointegration inspection to check that the statistical properties of the data were likely to be consistent with obtaining usable estimates. The Dickey-Fuller tests are shown in Appendix Table 1. The analysis suggested that filtering of the GDP data is necessary. We experimented with alternative filters (and also with unfiltered data) and found that the results are not overly sensitive with respect to the choice of the filter. The HP filter was therefore chosen mainly for ease of comparability with the previous studies discussed here.

[32] The lag for the interest rate, exchange rate and foreign demand variable are shown in order under the country mnemonic in col. 1 of Table 5. Thus in the case of Austria the sequence 2,1,2 that is shown indicates a two quarter lag on interest rates, a one quarter lag on the exchange rate and a two quarter lag on foreign demand.

Table 4. **Ratios for the relative weights from Smets (1996)**

Country	Openness	Elasticity ratio	G7 exch rate	5 variable VAR USD	ECU	DM
	(1)	(2)	(3)	(4)	(5)	(6)
United States	15.7	2.3				
Japan	13.3	4.55	2.7	3.55		
Germany	4	0.67	1	11.5	0.03	
UK	5.25	0.33	negative	negative		
Canada	4.26	2.85	2.85	3.17		
France	4.55	0			0.41	0.92
Italy	4.88	0.33			3.55	3.17

Col (1) shows MCI that would be implied by using the ratio of exports to GDP (in real terms, averaged over 1980 to 1996.2.

Col (2) shows MCI implied by using the ratio of the elasticity of output growth wrt. the real interest rate to the elasticity wrt. the real G7 weighted exchange rate in a VAR using 12 lags on all variables a time trend, constant and the real foreign interest rate with the same lags.

Cols (3) to (6) show the ratios from a 5 variable VAR where the additional variable is the foreign interest rate. Four exchange rates are used: col (3) G7 as in col (2); col (4) US dollar; col (5) ECU and col (6) deutschemark.

It can be argued that it would be appropriate to include inflation in the estimated equation as well as it is clearly an omitted variable in the model as a whole. This is, therefore, shown as row 2 for each country in Table 5. While the individual coefficients on the price term tend to be significantly different from zero in most case, prices are clearly only slightly intercorrelated with the other variables as their coefficients do not change markedly. Where the MCI is rather fragile only small changes in the coefficients will result in substantial changes in the MCI ratio.[33]

With other EU markets being the most important markets for both imports and exports for many of these countries one might expect that the DM exchange rate rather the US$ would act as a better explanatory variable. This possibility is explored for each country (except Germany) in the respective row 3s of Table 5. This does indeed result in an increased role for the exchange rate in most cases but it has very little impact on the overall fit. Table 6a shows that, as might be expected, the DM and US$ exchange are only weakly correlated, so one would expect their explanatory roles also to be decidedly different. Table 6b explores the impact of including both variables (for a shorter data period 1987.1–1997.4). Significance levels tend to be rather weak but in only three cases (out of 11) does addition of the DM exchange rate increase the relative importance of the exchange rate channel.[34] In four cases it renders the total effect perverse.

[33] Inflation is not the only plausible candidate for an omitted variable. One might wish to consider the role of fiscal policy, for example.

[34] The DM exchange rate only shows a coefficient different from zero at the 5 per cent level in the case of Finland, Italy and Portugal.

Table 5. **IS curve estimates for 1972.2–1997.4**

Name lags	∇y_{t-1}	∇y_{t-2}	rr_{t-k}	re_{t-k}	$oecd_{t-k}$	Δp_{t-k}	R^2 (SEE)	DW	λ
Austria 2,1,2	.587 (7.10)		–.040 (1.59)	.003 (0.60)	.216 (2.37)		.495 (0.84)	2.01	14.3
Austria 2,1,2,2	.610 (7.31)		–.075 (2.51)	.005 (0.96)	.257 (2.90)	–.055 (1.75)	.512 (0.83)	2.05	15.9
Austria 2,1,2,2	.598 (6.92)		–.062 (2.02)	.020 (1.13)	.237 (2.98)	–.065 (2.22)	.517 (0.83)	2.06	3.2
Belgium 3,1,1	1.289 (17.88)	–.616 (9.20)	–.024 (1.74)	.001 (0.16)	.199 (3.71)		.885 (0.42)	1.85	60.1
Belgium 3,1,1,8	1.294 (17.38)	–.608 (8.29)	–.041 (2.71)	.001 (0.48)	.173 (3.33)	–.029 (2.53)	.890 (0.42)	1.89	34.9
Belgium 3,1,1,8	1.276 (15.88)	–.599 (8.42)	–.039 (2.37)	.009 (0.95)	.188 (3.40)	–.022 (1.38)	.890 (0.42)	1.87	4.2
Denmark 2,3,1	–.904 (5.41)	–.160 (0.98)	–.050 (1.21)	.014 (2.52)	.182 (0.86)		.726 (1.16)	2.02	3.6
Denmark 2,3,1,5	.863 (6.02)	–.139 (1.01)	–.052 (1.49)	.016 (2.46)	.187 (1.00)	–.052 (1.66)	.739 (1.13)	2.00	3.3
Denmark 2,3,1,5	.904 (5.74)	–.195 (1.31)	–.035 (1.03)	.040 (1.35)	.139 (0.67)	–.060 (1.81)	.727 (1.16)	2.00	0.9
Finland 3,2,2	.641 (5.66)	.120 (1.36)	–.111 (2.73)	.013 (1.20)	.427 (2.15)		.726 (1.43)	1.87	8.9
Finland 3,2,2,2	.636 (5.73)	.150 (1.77)	–.108 (2.68)	.014 (1.33)	.383 (2.228)	–.057 (2.47)	.737 (1.41)	1.91	7.7
Finland 3,4,2,2	.633 (5.42)	.145 (1.57)	–.102 (2.49)	.010 (0.71)	.345 (2.00)	–.055 (2.29)	.734 (1.42)	1.92	10.2
France 3,2,2	.983 (9.82)	–.231 (2.26)	–.037 (1.91)	.002 (0.50)	.106 (1.58)		.747 (0.56)	2.03	19.2
France 3,2,2,7	.957 (8.51)	–.197 (1.41)	–.060 (1.97)	.004 (0.94)	.088 (1.63)	–.025 (1.63)	.752 (0.56)	2.05	14.5
France 3,1,2,7	.970 (8.40)	–.217 (1.62)	–.048 (1.89)	.001 (0.09)	.088 (1.55)	–.016 (0.84)	.749 (0.56)	2.05	47.8
Germany 3,1,1	.666 (5.06)	.188 (1.72)	–.156 (4.50)	.005 (1.29)	.062 (0.70)		.816 (0.90)	2.11	29.7
Germany 3,1,1,6	.656 (5.16)	.201 (1.72)	–.157 (4.38)	.005 (4.38)	.050 (0.53)	–.030 (0.81)	.817 (0.90)	2.10	29.1
Italy 3,8,2	1.245 (14.03)	–.593 (6.63)	–.015 (0.91)	.001 (0.19)	.208 (2.12)		.828 (0.62)	2.31	17.7
Italy 3,8,2,2	1.212 (13.62)	–.520 (5.45)	–.037 (1.90)	.002 (0.52)	.176 (1.81)	–.027 (1.98)	.835 (0.61)	2.29	16.5
Italy 3,8,2,2	1.210 (14.20)	–.565 (6.71)	–.030 (1.48)	.006 (1.05)	.246 (2.84)	–.026 (1.96)	.846 (0.61)	2.35	5.0