External MPC Unit

Discussion Paper No. 1

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by Nicoletta Batini and Kenny Turnbull

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ISSN: 1748 – 6203

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Monetary Conditions Indices for the UK: A Survey

Nicoletta Batini* and Kenny Turnbull**

September 2000

Abstract

Monetary Conditions Indices (MCIs) are weighted averages of changes in an interest rate and an exchange rate relative to their values in a base period. A few central banks calculate MCIs for use in monetary policy. Although the Bank of England does not calculate such an index, several international organizations as well as financial corporations construct MCIs for the UK on a regular basis. In this article we survey those indices and compare their performance. We also suggest an alternative MCI for the UK to be used as a coincident indicator of stance, obtained estimating and simulating a small-scale macro-econometric model over the period 1984 Q4 1999 Q3. To overcome familiar criticisms of MCIs, our measure innovates upon existing MCIs in several respects. In this sense it may be more informative than those in understanding whether an existing level of interest rates, given the existing level of sterling, makes monetary policy "tighter" or "looser" than in previous periods.

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We are profoundly indebted to DeAnne Julius for prompting us to investigate this issue and, more generally, for useful discussions on MCIs. A particular thank you goes to Edward Nelson who suggested avenues of research and gave us many helpful advises. We also thank Larry Ball, Rebecca Driver, Neil Ericcson, Richard Harrison, Steve Nickell, Glenn Rudebusch, Alasdair Scott, Helen Smith, Ryland Thomas and Robert Tetlow for extremely valuable suggestions on an earlier version of this paper. Remaining errors, and the views expressed herein are those of the authors and not of the Bank of England.

1. MCIs as indicators of monetary pressure

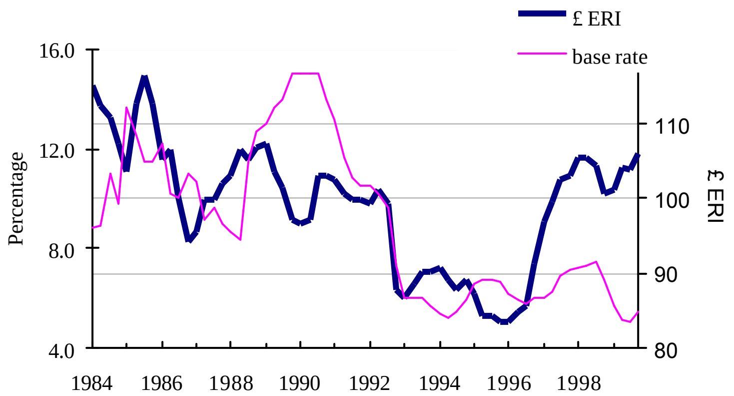
Monetary policy affects economic activity and inflation through numerous channels, usually referred to as the transmission mechanism. Changes in the immediate instrument of policy, the official interest rate, affect market interest rates, which in turn affect households' spending and saving plans by altering the mortgage rate and the cost of consumer credit and firms' investment and borrowing decisions by altering the cost of capital. In an open economy, other things being equal, changes in the official rate also tend to produce changes in the value of the domestic currency vis-à-vis other currencies. By influencing the competitiveness of domestic exports and imports, this affects net trade and hence aggregate demand. In addition, because some of the goods consumed domestically are imported, changes in the exchange rate usually also have direct effects on consumer price inflation.

When there are multiple channels of monetary transmission, it may be desirable to consider as many of them as possible to evaluate the general stance of monetary policy. In an open economy like the UK, for instance, the extent of monetary tightening or ease relative to previous periods may best be gauged by looking at both principal channels of transmission, i.e. exchange rates and interest rates. This is particularly true when movements in relative interest rates cannot fully explain movements in the exchange rate.

The logic behind this is that a high level of the exchange rate can reinforce the contractionary effects of the central bank-controlled interest rate, leading to a tighter policy stance than would otherwise have been, were the exchange rate lower, and vice versa.

Chart 1 below emphasizes this point, showing episodes of simultaneously high interest and exchange rates[1] the UK's participation in the ERM between 1990 and 1992 and the long period of sterling appreciation since 1996 Q3.

Chart 1: UK base rate and nominal £ ERI



The way some central banks in open economies notably the Bank of Canada and the Reserve Bank of New Zealand summarize the stance of monetary policy so as to account for multiple

[1] In the chart the exchange rate is measured using sterling's effective exchange rate index (£ ERI).

channels of transmission is to calculate indices of monetary pressure directly based on both interest and exchange rates. Perhaps the most prominent of these are known as Monetary Conditions Indices (MCIs). MCIs are also computed by governmental organizations and non-bank financial corporations to infer the extent of internal and external influences on the overall monetary conditions of a country.

Definition of a MCI

A MCI is a weighted average of the percentage point change in the domestic interest rate(s) and percentage change in an exchange rate, relative to their values in a base period.[2] It can be computed using either nominal or real variables.[3] In real terms, a MCI at time t can be written as:

$$MCI_t = A_R (r_t - r_b) + A_s (q_t - q_b) \quad \textbf{(1)}$$

where r_t is the short-term real interest rate, q_t is the log of the real exchange rate (where a rise in q_t represents an appreciation), and r_b and q_b are the levels of the interest rate and the exchange rate in a given base period.

A_R and A_s are the MCI's weights, with the ratio A_R/A_s reflecting the relative impact of interest rate and exchange rates on a medium-run policy goal (such as output, say). By construction, an A_R percentage point rise in r_t has the same impact on that goal of a A_s% real appreciation in the domestic currency. So, for instance, a ratio of 3:1 ($A_R = 3$, $A_s = 1$) indicates that a 1 percentage point change in the short term real interest rate has about the same effect on the policy goal as a 3 percent change in the real exchange rate.

Finally, note that, since the index is constructed using differences between actual and arbitrarily chosen levels, no significance is usually attached to the level of the index; rather, the index is intended to show the degree of tightening or easing in monetary conditions from the base or some other historical period.

Possible uses of a MCI

In principle, a MCI like **(1)** can be used for policy in various ways. It can serve as an *operational target*; as an *indicator*; or as a *monetary policy rule.*

In the first case, this typically implies identifying a 'desired' MCI, i.e. a combination of the interest rate, less its equilibrium value, and the exchange rate, less its equilibrium value, that is believed to be associated with the long run objectives of policy. It then requires acting so as to bring the level of the actual MCI in line with this desired level. Because precise estimates of both the equilibrium

[2] For a comprehensive review of the existing literature on MCIs, see Ericsson and Kerbeshian (1997).
[3] Ericsson *et al* (1997) point out that, from an operational point of view, switching between these two specifications should be relatively safe inasmuch as inflation and relative prices are nearly constant during the horizon over which MCI-based policy is typically implemented.

interest rate and the equilibrium exchange rates are hard to obtain, as well as usually subject to unanticipated shocks, the use of a MCI in this way is particularly complicated.

If used as an indicator, a MCI does not require changing the level of monetary conditions so as to hit a desired, intermediate MCI target, as its use as an operational target would prescribe. This is because, in this case, the MCI is not used to inform changes in monetary conditions directly, but rather to offer information about the level of the policy stance. For instance, a MCI can be calculated relative to a previous or benchmark period as in equation **(1)** to indicate whether policy has become 'tighter' or 'looser' relative to those periods. Since, in this circumstance, the MCI does not measure the level of the policy stance relative to equilibrium, it cannot tell whether this is 'tight' or 'loose' in absolute terms, nor whether this is in line with the ultimate goals of policy. In general, a MCI like **(1)** will typically be a 'leading' indicator of stance, inasmuch as changes in current-dated interest rate and exchange rates are yet to have an effect on output and inflation.

Finally, a MCI can be re-arranged normalizing on the interest rate to obtain a policy rule where the interest rate is set so as to parallel movements in the exchange rate. This is equivalent to feeding back on the level of the exchange rate, i.e. it is akin to exchange rate targeting. Ball (1999) recently suggested an alternative 'MCI-based' rule. This implies setting monetary conditions, as expressed in equation **(1),** so as to correct deviations of inflation from target and of output from potential.

So far, no central bank has ever embraced MCIs explicitly in the form of a rule. However, MCIs have been used as operating targets by the central banks of Canada and New Zealand, informing the response of monetary authorities to divergences between actual and desired monetary conditions.[4] Because they are intended to measure a broader range of monetary variables than just the central bank-operated interest rate, MCIs are also often used by many other central banks as indicators of monetary stance alongside other data.[5]

Pitfalls of MCIs

Although MCIs expressed relative to a base period are relatively simple to calculate and appear to have intuitive appeal as measures of the stance of monetary policy in an open economy, they have been criticized both on their conceptual and empirical foundations [see among others, Eika, Ericsson and Nymoen (1996); King (1997); Ericsson *et al* (1998); and Stevens (1998)].[6]

The major criticisms of current MCIs' include:

[4] Although, in the recent years, the use of the MCI as an operational target has been progressively de-emphasised in New Zealand (see RBNZ 1996). Similarly, in Canada, MCIs play now a less important role in the setting of monetary policy (Freedman 199x).
[5] Harrison (1999) offers a clear discussion of potential uses of MCIs.
[6] See Harrison (*op. cit*.).

Model dependence. MCI weights cannot be observed directly, so they are usually derived empirically from a model of the economy. So MCI measures typically depend on the assumptions made to estimate them (including parameter constancy, cointegration, dynamics, exogeneity, estimation uncertainty and the choice of variables), and hence are model-specific.[7]

Dynamics. The MCI is an average of an asset price and a rate of return, which may affect inflation at different speeds. Thus, the responses of inflation to changes in the MCI will differ according to which component has changed. Even if medium run multipliers are used to derive the MCI weights   i.e. even if account is taken of the existence of lags in the estimated reduced form model of the economy   MCIs built aggregating time-t levels of interest and exchange rates may give a misleading picture of the stance of policy in the short run.

Shock identification. Different types of shocks have different implications for monetary policy. By construction, an MCI complicates the identification of exchange rate shocks because this requires focusing on movements in the exchange rate and interest rates separately, rather than aggregated together.

These criticisms apply regardless of whether MCIs are used as operational targets or indicators or rules because they relate to the way MCIs are constructed rather than to the way in which they are used. However these criticisms are particularly worrisome when MCIs serve as operating targets. This is because, in this case, MCIs directly inform changes in monetary policy, and hence it is not possible to ignore the problems that they pose for the identification of shocks. Moreover, in this case, use of a MCI is complicated by the need of estimating equilibrium interest rate and equilibrium exchange rates to get a measure of desired monetary conditions   an intermediate target for actual monetary conditions. Taken together, this may explain why the use of MCIs as operating targets has sometimes created difficulties [Freedman (1995); RBNZ (1996)].

In the next section we offer a survey of existing MCIs used as indicators for the UK. Most of these are subject to the above criticisms related to their construction, so later we develop an alternative MCI for possible use as an indicator of UK monetary conditions.

2. A survey of MCIs for the UK

MCIs for the UK are computed and used for analytical purposes by several international organizations as well as financial corporations. In particular, since they are often considered convenient summary calculations of the overall change in monetary conditions, and because they incorporate information about monetary pressure not present in the interest rate alone, the calculation and use of MCIs as indicators for the UK gained renewed momentum after the rise in sterling in 1996. In what follows we review eight of these measures.

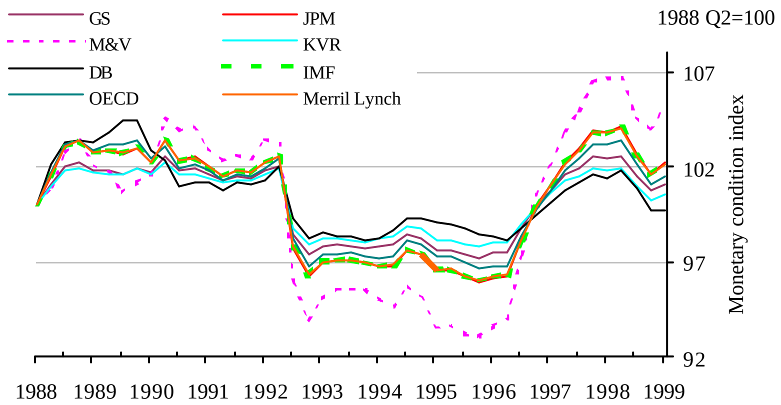
[7] For instance, most critics argue against the practice of the New Zealand and Canadian central banks, to derive MCI weights from an estimated aggregate demand equation, when their target is inflation.

Selected MCIs for the UK

Chart 2 below plots MCIs for the period 1988 Q1 to 1999 Q4 prepared by two governmental organizations (IMF and OECD); by a set of financial corporations (Deutsche Bank, Goldman Sachs, J.P. Morgan and Merrill Lynch);[8] and by two groups of researchers in the academic community [Kennedy and Van Riet (1995) and Mayes and Viren (1994) 'KVR' and 'MV' hereafter].

In the chart, MCIs are calculated using the 3-month LIBOR minus actual inflation as a proxy measure of the ex ante short term real interest rate ('LIBOR'), and the real yield on 10 year index-linked gilts ('10yrG'), and sterling real effective exchange rate index (broad, trade weighted) (£ ERI), as measures of the long-term real interest rate and the real effective exchange rate, respectively.[9] By construction, a rise in the interest rate increases the MCIs, as does an appreciation of sterling as they are regarded as putting downward pressure on aggregate demand and inflation. Therefore, a rise in the indices is interpreted as a tightening of monetary conditions.

Chart 2: Selected real MCIs



The chart shows that, the selected MCIs moved quite closely together throughout the period. In particular, they seem to indicate unanimously that policy got tighter about one year before entrance and during the ERM period relative to the second half of the '80s; that policy then eased considerably at the end of 1992 when the regime shifted from ERM membership to inflation targeting; and that monetary conditions tightened again with the surge in the value of sterling after 1996 Q3.

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[8]Greenwich Natwest also computes a MCI for the UK. This is similar to those prepared by the IMF and Goldman Sachs (with a value of the ratio for the interest rate variable lying in between their values for that ratio), so we do not present it here.

[9] We index the MCIs so that 1988 Q2 =100 in all cases. This enables us to compare them to the index we construct in section 3 below, which we can compute from 1988 onwards.

Differences in the patterns associated with each MCI at various points in time are mainly due to differences in their relative interest and exchange rates weights, with the MV's index which assigns by far the largest weight to the exchange rate constantly lying farthest away from the other indices. These differences partly reflect the use of different models and different sample periods.[10]

Exact relative weights for each MCI are listed in Table 1. The table shows that these differ significantly, with the MV's ratio of weights as low as 1.1 implying an almost equal effect of interest and exchange rates on aggregate demand and the DB's ratio as high as 14.4 implying a negligible effect of the exchange rate relative to the interest rate.

Table 2, which summarizes the main features of each MCI in the selection, shows that, in practice, most MCIs are computed using the three-month Treasury bill rate ('3mTB') and sterling effective exchange rate. On occasions, the LIBOR or the midpoint between this and the LIBID are preferred measures of the short-term interest rate in the belief that these rates more accurately reflect the prices faced by agents. For similar reasons, two of the MCIs analyzed here include a long-term interest rate (so that the MCI becomes a weighted average of three, rather than two asset prices), aiming to better capture the effects on demand of rates at various positions on the yield curve.

Table 1: Weights used to calculate MCIs[1]

	Ratio for interest rate variable	Short term int.rate weight expressed as a fraction	Long term int.rate weight expressed as a fraction	Exchange rate weight exp. as a fraction
MV	1.1	0.52	-	0.47
IMF	3	0.75	-	0.25
OECD	4	0.80	-	0.20
DB	14.4	0.93	-	0.06
KVR	6.2	0.43	0.43	0.13
GS	5	0.47	0.35	0.18
JPM	2.9	0.74	-	0.25

Notes:
(1) All ratios show values applied to the interest rate variable and reflect the impact on output only.

[10] However, Ericsson *et al* (*op. cit.*) show that, empirically, confidence intervals of relative weights derived from estimated models are also large.

Table 2: Main features of selected MCIs

	Type of MCI	Short-term interest rate	Long-term interest rate	Exchange rate	Model
MV	nom	3mTB	-	£ ERI	Red. form
IMF	nom	LIBOR	-	£ ERI	-
OECD	real	3 m TB	-	£ ERI	
DB	real	3mTB	-	£ ERI(2)	Red. form
KVR	nom	3mTB	10yrG	£ ERI	Struct. form
GS	real	3mTB	10yrG	£ ERI	Red. form
JPM	real	LIBOR-LIBID midpoint	-	£ ERI(2)	X/GDP ratio

Notes:

(1) Own measure.

Three standard approaches for estimating MCIs' weights

The weights that underly the MCIs in our selection have been derived using three different methods. In what follows we describe those methods and explain why they make the monetary conditions indices shown in chart 2 potentially uninformative for policymaking purposes.

(a) Single equation based MCIs

The IMF, OECD, Deutsche Bank (DB), Merrill Lynch (ML), KVR and MV construct MCIs for the UK employing relative weights that intended to represent the relative impact of interest and exchange rates on aggregate demand.[11] In most cases, the weights are either directly derived by estimating an aggregate demand equation (DB and MV[12]), or are based on prior estimates of aggregate demand equations of existing models (more specifically, the OECD bases its weights on equation estimates in the OECD Interlink Model; and KVR derive their weights from the National Institute of Economic and Social Research's NIGEM multinational model). The IMF employs arbitrary relative weights. However, these are in line with other MCIs' weightings derived from estimating an aggregate demand equation with UK data.

(b) Trade share based MCIs

[11] The last time that the IMF published MCIs for the UK was in the 1996 and 1997 editions of *World Economic Outlook*.

[12] MV in turn follow Duguay (1994).

J.P. Morgan (JPM) constructs a real MCI for the UK in which the weight placed on the exchange rate variable is a function of the long-run exports to GDP ratio. The interest rate weight is then calculated as one minus the exchange rate weight. So the weights are interpreted as a crude relative measure of the effect of the exchange rate on UK's GDP (through its net trade component) vis-à-vis the interest rate effect on GDP.

(c) Multiple equation based MCIs

To compute an MCI for the UK, GS estimates an unrestricted vector autoregression in four endogenous variables (GDP, the short-term interest rate, the 10-year gilt yield and sterling ERI) and one exogenous variable (oil prices). MCI weights are obtained by looking at the impulse response functions (IRFs, hereafter) of GDP to a shock to each of the other three endogenous variables in the system.[13] In particular, weights are based on the cumulative average responsiveness to the three shocks over a period of 50 quarters. Since the combined average cumulative interest rate responsiveness of GDP is around 80%, GS gives a weight to the (combined) interest rates which is five times larger than the weight on the exchange rate. These weights are then used to derive an MCI in the usual way.

MCIs calculations under (a)-(c) are potentially uninformative for the reasons sketched out in section 1. In particular, the equations estimated to derive MCIs' weights in (a)-(b) suffer from exogeneity problems due to the fact that the single equation being estimated contains variables that are correlated with the residuals and are not parameter constant since coefficients obtained to derive weights appear to be sensitive to the sample period chosen for the estimation.[14]

The MCI in (c) is an improvement over those in (a) and (b), but it too has a number of flaws. Empirically, even though all variables in GS' VARs are trended, in the estimation no account is given to possible cointegrating relationships. Also, the VAR contains no dummies (either intercept or shift), although it is improbable that no regime breaks occurred over the sample period used for the estimation. Theoretically, basing the weights on the *average* cumulative responsiveness of GDP to shocks at various quarters (4, 8 and 12 in their exercise) may be misleading if exchange rates and interest rates affect inflation and output at different times.

3. An alternative indicator of monetary pressure for the UK

In this section we develop an alternative approach to deriving a MCI, in order to overcome at least some of the shortcomings discussed above for the other indices. The main differences are: (a) our approach derives the weights for a MCI from a system of equations, rather than just one

[13] GS does not identify the shocks before deriving impulse responses. Because the reduced form shocks from an unrestricted VAR are typically combinations of shocks to each equation in the VAR, the impulse responses from which the GS' MCI weights are drawn may be responses to a combination of interest and exchange rate shocks rather than to these shocks in isolation. This implies that, in fact, the weights in GS' MCI may bear no direct relationship with the relative degree of responsiveness of GDP to interest and exchange rates.

[14] For instance, MV carry out a test on the validity of shortening the sample period by varying the sample period. They find that the results are highly sensitive to the sample period used.

equation;[15] (b) in selecting that system, we check that the empirical model takes account of the usual estimation concerns (non-stationarity, exogeneity, parameter constancy); (c) once we have derived the relative weights, we build the MCI accounting for differences in the dynamics of interest and exchange rates effects on output. In this sense, the MCI that we obtain is a 'dynamic MCI' ('DMCI' hereafter).

In more detail, our approach consists of four steps:

(i) We first estimate a small macro-econometric model over the period 1984 Q4 1999 Q3 [equations **(1A) - (3A)** in section 3A of the the Data Appendix]. There are six endogenous variables in the model:[16] log detrended output (y_t);[17] the four quarter log-change in RPIX ($\mathbf{p}_t$) scaled into quarterly units (e.g. an observation of 0.025 indicates an annual inflation rate of 10%); the log of the deviation of the real effective exchange rate from its Hodrick-Prescott trend ($qhat_t$), where a fall in $qhat_t$ represents an appreciation;[18] the nominal interest rate (interbank lending rate), measured as an annualized fraction ($4{*}R_t$), and the real ex post yield on ten-year index-linked gilts, also measured as an annualized fraction
($4{*}rl_t$).[19]

Over our sample period, there have been two main breaks in the UK's monetary policy regime [the UK's ERM years (1990-1992)]; and, following its move to an inflation targeting regime in 1992Q4). In our model, the restriction that the parameter non-constancy is confined to the equations' intercepts is not rejected in any of the equations. In addition, the restriction that the coefficients of the intercept dummies are zero is also not rejected in the inflation equations.[20] So we simply augment the short-term interest rate and the output equations of the model with two regime-shift intercept dummies, $DERM_t$ and $D924_t$.[21]

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[15] Bernanke and Mihov (1998) also derive an indicator for the overall stance of monetary policy using identified shocks from a vector autoregression by means of an alternative method.

[16] For simplicity, here we do not model (either endogenously or exogenously) aspects of fiscal policy, world trade and/or world demand.

[17] Derived as a residual from a prior regression of the log of real GDP (quarterly, seasonally adjusted) on a constant linear trend over 1982 Q1 1999 Q3.

[18] We use an HP filter with a lambda parameter set equal to 1,600 because our data is quarterly. This seems the best option after having experimented with alternative lambdas (varying from 100 to 15,000) because it provides enough smoothing to make the real exchange rate stationary (see Table 1 in the Data Appendix), but at the same time it does not iron out movements in the exchange rate as smaller lambdas do. This enables us to treat $qhat_t$ and actual, unfiltered q_t interchangeably when calculating the dynamic monetary condition index below. Ideally, the real exchange rate should be made stationary by taking differences from a proper measure of the equilibrium exchange rate, like a measure of the fundamental equilibrium exchange rate (FEER) [see Driver and Wren-Lewis (1998)]. At present this measures only goes up to 1997, so we plan to derive a FEER-based measure of as soon as the data becomes available.

[19] We tried to include the log of the real price of oil denominated in domestic currency, treating it as exogenous in the inflation equation **(3A)** but this did not seem to enter significantly the equation.

[20] F-statistics for that restriction (where the restriction includes a zero-coefficient restriction on the $D924_t$ dummy variable in the inflation equation): for the output equation: $F(8, 39) = 2.03$ (p-value = 0.07); for the inflation equation: $F(5, 50) = 2.16$ (p-value = 0.07); for the short-term interest rate equation: $F(6, 63) = 0.60$ (p-value = 0.72).

[21] These variables take the value 1.0 for 1990Q4–1992Q3 and 1992Q4 onwards, respectively.

All the endogenous variables in our model are adequately described as stationary [I(0) or trend-stationary processes], and so a Johanssen-style co-integration approach to our model is not required. As a consequence, we estimate each equation of the system in levels using OLS. Section 2A of the Data Appendix reports the estimation output and ADF test statistics rejecting the null of a unit root in favor of the alternative of stationarity [or in the case of R_t, an I(0) series with structural breaks].

(ii) We then augment the estimated model with a real interest parity condition, a term structure relationship, and a Fisher equation expressed as below:

$$q_t \;=\; E_t\, q_{t+1} \quad r_t \;+\; rf_t \;+\; k_t \qquad \textbf{(2)}$$

$$rl_t \;=\; E_t \quad {}_{j=0}^{M}\, r_{t+j} \;+\; m_t \qquad \textbf{(3)}$$

$$r_t \;= R_t \quad E_t\, p_{t+1} \qquad \textbf{(4)}$$

where r_t and rf_t are the domestic and foreign real ex ante short-term interest rates, M = 40 quarters (i.e. ten years), and finally, k_t and m_t are stochastic risk premia capturing exchange rate and long-term interest rate persistent departures from their otherwise implied paths. In **(2)**, the shock term $_t$ that produces deviations from strict UIP is assumed AR(1), with coefficients 0.753 and standard deviations 0.92% in line with estimates for UK data in Batini and Nelson (2000). m_t, the shock term in **(3)**, is also modelled as an AR(1) with autoregressive coefficient set at 0.97, in line with prior empirical estimates for UK data in Remolona, Wickens and Gong (1999). For simplicity we set m_t's standard deviation equal to an arbitrarily small number (0.0001%), therefore we effectively ignore shocks to the term premium.
Combining equations **(1A)**-**(3A)** with equations **(2)**-**(4)** gives us a complete model (six equations in six unknowns y_t, p_t ,R_t, q_t, r_t, rl_t).

(iii) We solve the model given by equations **(1A)**-**(3A)** plus **(2)**-**(4)** and stochastically simulate it using the variance-covariance matrix of shocks derived above, to generate artificial data for the variables.[22] On these data we run a regression of y_t, on $q_{t\ 1}$, $q_{t\ 2}$, $q_{t\ 3}$,..., $q_{t\ k}$, $r_{t\ 1}$,..., $r_{t\ k}$, and on the exogenous regressors (e.g. equations' innovations), making sure that k is high enough to produce a good fit [section 4A in the Data Appendix reports estimation outputs for this regression, which shows rightly signed coefficients and a high R^2 (0.9715)]. [23]

In practice, this amounts to re-expressing the previously estimated output equation of the system (where y_t is a function of lagged y_t, lagged q_t, lagged r_t, and lagged rl_t) in its 'final form' [where y_t is

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[22] We use Klein's algorithm to solve the model. The number of replications that we chose for the stochastic simulations is 500.

[23] Since the complete model already incorporates a term structure [equation **(4)**], we do not need to include long-term interest rates in this final form regression separetely, as information from long rates will be subsumed in the regressors that we include.

given by an infinite distributed lags of q_t and r_t going from $A(L)X_t = B(L)Z_t$ to $X_t =$ inv($A(L)$)$B(L)Z_t$)].

Conveniently, however, in its final form, output depends only on current and previous levels of interest and exchange rates the two prices in an MCI and does not include any other exogenous variables apart from the shocks. And importantly, because the artificially generated series are obtained using a model where output depends on the usual regressors (lags of itself, other endogenous variables and exogenous variables), re-estimation in final form on these series guarantees that the information from that model is retained in the final form' interest and exchange rate coefficients.

(iv) Finally, we use coefficients on q_t and r_t from the final form regression in y_t to build a real 'dynamic monetary conditions index' (DMCI). Algebraically, the DMCI is given by:

$$DMCI_t = a_1(r_{t\text{-}2} - r_b) + ... + a_{12}(r_{t\text{-}2\text{-}k} - r_{b\text{-}k}) + a_{13}(q_{t\text{-}6} - q_b) + ... + a_{24}(q_{t\text{-}6\text{-}k} - q_{b\text{-}k}) \quad \textbf{(5)}$$

where a_i (i = 1,...,k) are the coefficients on lags of q_t and r_t that are significant at the 5% confidence level in the final form regression of y_t. In **(5)**, the first interest rate term is $r_{t\text{-}2}$ and the first exchange rate term is $q_{t\text{-}6}$ because these are the lags at which interest and exchange rates make their first appearance in the models' estimated equations. Table 3 below lists the values of the a_i coefficients used to compute **(5)**.

Table 3: DMCI weights

Lag	Coefficient on		Lag	Coefficient on	
	r_t	q_t		r_t	Q_t
t 2	-0.3045		t 10	-0.1179	-0.0045
t 3	-0.2269		t 11	-0.1247	-0.0138
t 4	-0.1911		t 12	-0.0595	0.0049
t 5	-0.1652		t 13	-0.1517	-0.0247
t 6	-0.1623	0.0166	t 14		0.0150
t 7	-0.1393	0.0150	t 15		0.0122
t 8	-0.1094	0.0149	t 16		0.0127
t 9	-0.1102	0.0059	t 17		0.0285

As the table illustrates, on average the DMCI gives a much lower weight to the real exchange rate than to the interest rate. Indeed, in cumulative terms, i.e. aggregating across individual lags, the ratio for the interest rate variable is 21.7:1 in the DMCI corresponding to a weight of 0.956 on the short-term interest rate expressed as a fraction compared to an average ratio of 5.43:1 for MCIs in our selection, and to the familiar 3:1 used broadly in the literature on MCIs. However, changes in the exchange rate as those in the interest rate tend to have a protracted effect on the DMCI due to the fact that the dynamic specification of this index embeds all the lags it takes for monetary impulses to get transmitted to the economy. As we will see, this has implications for the interpretation of the DMCI at each point in time.

General properties of the DMCI

As anticipated, the DMCI in **(5)** differs from the MCIs described in Section 2 in various respects.

On *model dependence*, in deriving the DMCI we have tested for possible non-stationarity in the variables and parameter non-constancy in the regressions. Both of these appeared absent from the empirical model. In addition, the estimates of the DMCI's weights are obtained by estimating a system of equations, rather than a single equation. Since they arise from a complete model which specifies the shocks and imposes arbitrage relationships between assets' yields suggested by economic theory, it avoids exogeneity problems because the estimated equations do not condition on current r_t or q_t.

On *dynamics*, the DMCI is constructed using the weights on the individual lags of r_t and q_t as they appear in the final form regression. So, contrary to other measures of monetary conditions, which aggregate time-t interest and exchange rate levels, ours does take into account the different impact over time of interest and exchange rates on output. Since it measures the effect of policy variables given (i) past changes in those variables and (ii) the time it takes for those changes to have an impact on output (and inflation), the DMCI should be interpreted as a 'coincident' indicator of stance. Notably, because it is expressed in terms of lags of the policy variables, the DMCI can be projected forward in order to obtain a forecast of the future policy stance. This may help understand whether, at each point in time, more changes in monetary conditions are desirable given the monetary impulses that are already built into the transmission mechanism.

On the other hand, the DMCI is not immune to the problem of *shock identification*. This is because, similar to other indices in the sample, it aggregates interest and exchange rates together. The latter can change not only because interest rates have changed in an unanticipated fashion, but also because of shocks that are unrelated to changes in policy. When the source of an exchange rate change can be identified, then it is best analysed in isolation rather than together with interest rates.

More importantly, perhaps, not all shocks that alter the level of the exchange rate do eventually correspond to changes in monetary conditions. For instance, an adverse relative price shock would typically not affect the stance of policy, while a similarly sized portfolio shock would. It follows that ours, as other MCIs, must be used judiciously along with other economic analyses and forecasts, if it is to provide useful information to policymakers. It should not be used mechanistically or as an operating target. However, as we show below, it can serve as a valuable indicator of stance and, thus, can help in predicting inflation.

Indicator properties of the DMCI

What is the benefit of looking at a DMCI, and concentrating on changes in the output gap due to the "policy variables" [i.e. interest rates and exchange rates aggregated as in equation **(5)**] for predicting inflation?

Table 4 below, presents dynamic correlations computed over the period 1990 Q4 and 1999 Q3 [since the DMCI is only available starting from 1988 Q1] between detrended output (y_t) and: (i) the level of DMCI; (ii) the first difference in the DMCI; (iii) a moving average of the level of the DMCI. We would expect detrended output to be negatively correlated with the DMCI measures, inasmuch as a higher level of the DMCI has a contractionary effect on economic activity.

Table 4: Dynamic correlations between detrended output and the DMCI

	K									
Lags	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Corr (y_t ,DMCI $_{t-k}$)	-0.12	-0.16	-0.20	-0.23	-0.26	-0.29	-0.34	-0.39	-0.41	-0.40
Corr (y_t, DDMCI$_{t-k}$)	0.30	0.24	0.18	0.17	0.11	0.11	0.22	0.22	-0.015	-0.19
Corr ($y_{t\,t}$,MA5DMCI$_{t-k}$)	-0.88	-0.86	-0.82	-0.79	-0.76	-0.75	-0.74	-0.73	-0.72	-0.69

The table shows that despite correlations of output with changes in the DMCI are negative only at longer lags, correlations between output and the *level* of the DMCI are negative at all lags, and become stronger at longer lags, with the maximum negative correlation coefficient at time *t*   8 (-0.41). Besides, negative correlations with the moving average of the DMCI   a smoother measure of dynamic monetary conditions   are very strong at all lags (with an average correlation of -0.77 over the nine lags). This is in line with our intuition, because as interest rates and the exchange rate enter in levels in the output regression **(1A),** we would expect the *level* of DMCI to be the most relevant variable for correlation purposes.[24]

Results from regressions of detrended output on lags of itself and the *level* or the *moving average of the level* of the DMCI estimated over the period 1990 Q4 –1999 Q4 confirm these findings. In the first case, the current level and lags of the level of the DMCI enter significantly (at the 5% level) and with the 'right' (negative) long-run coefficient in a regression of detrended output on lags of itself (although the short-run coefficients on two of these lags are positively signed).[25] In the second case, time-*t* MA5DMCI$_t$ enters significantly (at the 1% level, partial $R^2 = 0.20$) in a regression of output on lags of itself (up to lag 2) with the 'right' (negative) sign (R^2=0.95, DW =1.99). The long-run coefficient is also significant and negatively signed (coefficient = - 0.0073, SE = 0.0016).

[24] However, changes in the DMCI also seem to matter considerably for output. In this case, however, the correlation coefficients are large and negative at longer lags and mainly when we look at the moving average of the changes rather than at the raw changes.

[25] We also find that the ninth lag of the first difference of the DMCI enters significantly at the 10% level a similar regression, but in this case the long-run coefficient is positive.

Taken together, this suggests that the DMCI in levels, or a moving average of this, is a good coincident indicator of stance. And since it is constructed using lags of interest rates and exchange rates, the DMCI may hence contain information useful to predict output.

Table 5 lists dynamic correlations computed over that same period between the four-quarter change in RPIX ($D4RPIX_t$) and the DMCI. In addition, the table lists correlations between changes in RPIX inflation ($DD4RPIX_t$) and, as before, (i) the level of the DMCI; (iii) a five-quarter moving average of the DMCI ($MA5DMCI_t$). As a memo item, it also presents correlations between inflation and detrended output. Intuitively, changes in inflation should be negatively correlated with the DMCI variables (a high DMCI implying a tight or tightening monetary policy stance and hence, low or falling inflation), while it should be positively correlated with output.

Table 5: Dynamic correlations between RPIX inflation and the DMCI

	k									
Lags	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Corr ($D4RPIX_t$,$DMCI_{t-k}$)	0.74	0.69	0.67	0.65	0.64	0.63	0.61	0.59	0.55	0.50
Corr($DD4RPIX_t$, $DMCI_{t-k}$	-0.52	-0.52	-0.53	-0.52	-0.49	-0.47	-0.44	-0.41	-0.37	-0.28
Corr($DD4RPIX_t$,$MA5DMCI_{t-k}$)	-0.52	-0.50	-0.47	-0.45	-0.42	-0.39	-0.36	-0.33	-0.29	-0.25
Memo item										
Corr ($D4RPIX_t$,y_{t-k})	0.21	0.45	0.64	0.76	0.81	0.85	0.87	0.88	0.88	0.86

The table shows that the correlation between inflation and the output gap has the ‘right’ (positive) sign at all lags.

The sign of the correlation between inflation and the *level* of the DMCI is ‘wrong’ (positive) for both shorter lags and longer lags. This is not surprising, given that the level of the DMCI should be more informative for the *change* in inflation rather than its *level* (see section 1). Indeed, (contemporaneous and) dynamic correlation coefficients between changes in inflation and the level of the DMCI or for a moving average of that level, respectively, are negative at all lags, suggesting that the link between these variables goes in the right direction.

Regressions of changes in RPIX inflation on lags of itself and lags of the level of the DMCI estimated over the period 1990 Q4 –1999 Q4, again show that the latter enter the equation significantly, with both the short- and the long-run regression coefficients ‘properly’ signed (suggesting that a high level of the DMCI is associated with falling inflation and vice versa).[26] Similarly, a five-quarter MA of changes in the DMCI enters significantly with (both short- and long-run) negative coefficient in a regression for changes in inflation that already includes lags of itself on the right hand side.

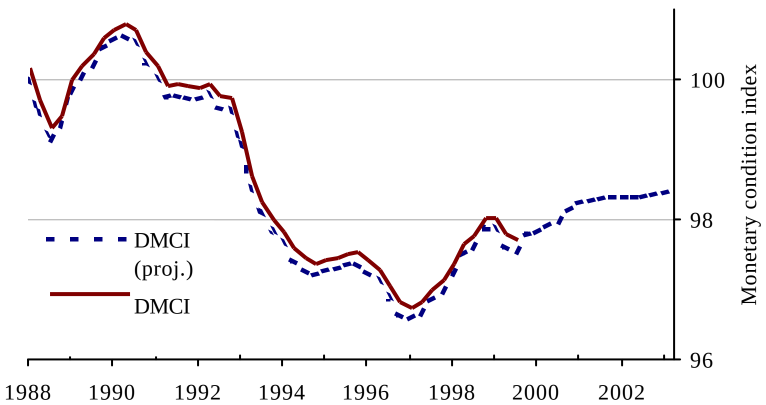
[26] More precisely, the first lag of the level of the DMCI enters with a coefficient of –0.0004 (SE=0.0001) in an equation for changes in RPIX inflation estimated over the period 1990 Q4-1999 Q3.

These results seem to suggest that, at least for the '90s, focusing on variations in the output gap due to the "policy variables", i.e. interest rates and exchange rates assembled in the form of a (backward-looking moving average of changes in the) DMCI, can also help predicting inflation.

4. A visual comparison of alternative MCIs

Chart 3 plots the DMCI for the period 1988 Q1-1999 Q4, indexed so that 1988 Q2 = 100 (brown solid line).[27] As before, a rise in the interest rate reduces aggregate demand and inflation and increases the DMCI, as does an appreciation of sterling, so a rise in the index is interpreted as a tightening of monetary conditions. The dashed line in blue shows a forecast of monetary conditions up to 2003 Q2 (i.e. 3 ½ years ahead), assuming that the real effective exchange rate and the real ex post short-term interest rate stay constant at their 1999 Q4 levels (i.e. 129.71 and 2.99%, respectively).

Chart 3: DMCI (£ ERI)



Like the selected MCIs, the DMCI indicates that policy tightened when the UK joined the ERM and that it eased almost monotonically afterwards, till 1997. In line with this, it also suggests that sterling appreciation (from 1996) and the move to operational independence (in 1997) made the policy stance more restrictive than before. But in addition, the DMCI suggests that much of the rise in the exchange rate has yet to be felt and so, if interest and exchange rates remained constant,

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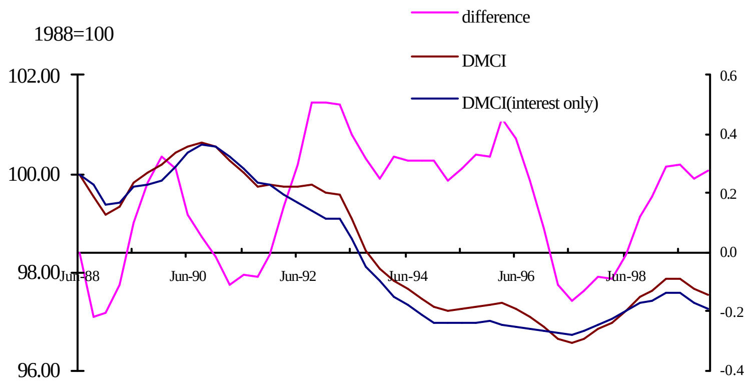
[27] The dataset covers the period 1988 Q1 to 2000 Q1, because 2000 Q1 was the most recent observation available on real £ ERI at the time of writing. The interest rate included in the MCI is the 3-month LIBOR and is calculated by subtracting the rate prevailing in the base period (1984 Q1) from the rate prevailing in the current period. The figure is converted into a fraction by dividing by one hundred. The exchange rate data used is calculated by taking the natural logarithm of the exchange rate prevailing at the current time period divided by the exchange rate prevailing in the base period ($q = \log(Q_t/Q_b)$).

monetary conditions would continue to tighten gradually till the end of the 2002 Q2 (i.e. the end-point of the 2000 Q2 Bank's forecast horizon).

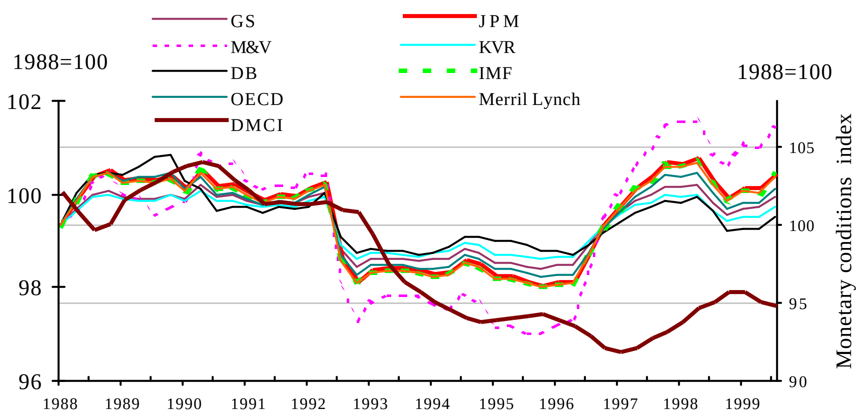
Chart 4 compares our DMCI with an interest-rate-only DMCI (LHS axis), i.e. a DMCI obtained giving a zero weight to the exchange rate terms in equation **(5)**; and plots the difference expressed in basis points units between the two at each point in time (RHS axis). A positive difference indicates that our DMCI implies that conditions are tighter than the interest-rate-only DMCI suggests. As the chart shows, the two DMCIs move closely together. This should not come as a surprise, given the already small weights assigned to exchange rates relative to interest rates in equation **(5)**. However, the chart also shows that the two indicies can occasionally deviate by a non negligible amount (e.g. in 1992 Q3); and that our DMCI (including exchange rates) is more volatile than the other, because it takes account of the extra 'kick' on stance coming from the exchange rate when interest rates change. Taken together, this seems to suggest that, despite their small weight in the DMCI, the cumulative effects of exchange rate movements are still a key determinant of monetary conditions in the UK.

Chart 4: DMCI vs DMCI (interest rate only)



Finally, for comparison, Chart 5 plots, for the period 1988 Q1-1999 Q4, the DMCI vis-à-vis the MCIs in Chart 2.

Chart 5: Selected real MCIs (£ ERI)



Although similar in shape to the other MCI measures, the pattern of the DMCI generally looks smoother. This in part reflects differences in weights; but is mostly due to the more sophisticated dynamic structure of the DMCI, which incorporates lags in the transmission of monetary policy. In particular, the DMCI suggests that: (a) the peak in monetary conditions occurred between 1990 and 1991 rather than before 1990 as the other MCIs suggest; (b) the easing in monetary conditions following the exit from the ERM and shift in regime towards inflation targeting was gradual and protracted; (c) such easing continued into 1997 when the combination of a strengthening pound and the interest rate rises put in place by the newly established Monetary Policy Committee led to the end of this relatively loose stance. According to the DMCI, monetary conditions have been tightening throughout 1998 and during the first quarter of 1999 whereas other MCIs suggest a loosening starting from mid 1998; (d) much of the contractionary impact from the rise in the exchange rate has yet to come through, other things being equal.

5. Conclusions

Monetary policy affects aggregate demand and inflation through several channels. These typically include the channels connecting official interest rates and economic activity. In an open economy, the exchange rate is also an important channel of transmission affecting the net trade position of the country as well as the domestic price of imported goods.

Ideally, indicators of monetary stance should capture all of these channels. *De minimis*, in an open economy context, they should incorporate both interest and exchange rates. Monetary Condition Indices (MCIs), i.e. indicators based on both these variables, are often used in this role by central banks in highly open economies, by governmental organizations and by private financial institutions.

In this paper we reviewed a battery of MCIs currently computed for the UK for their indicator properties and discussed their main theoretical and empirical shortcomings, many of which have been well documented in the mainstream literature of similar measures of monetary conditions.

We then developed an alternative index of monetary conditions that incorporates features to overcome many of the shortcomings of traditional indices. We called this measure a ‘dynamic MCI’ (DMCI) because, among other things, it is built by aggregating individual lags of interest and exchange rates to capture the lags between the change in monetary conditions and their first effect on output.

The DMCI is strongly correlated with both output (in levels) and inflation (in differences), suggesting that a tight or tighter stance has contractionary effects on both variables, as one would expect. Regressions of changes in RPIX inflation on lags of itself and lags of the level of the DMCI seem to suggest that this contains information useful to predict future inflation. So the DMCI could serve both as a coincident indicator for stance and a leading indicator of inflation. In addition, since it is constructed using lags of the policy variables, it can be rolled over to offer projections of the policy stance conditional on existing levels of interest and exchange rates and on the monetary impulses that have yet to unravel. As with other MCIs, it should not be used as an operational target for policy because it is not immune to the problem of shock identification and this problem cannot be ignored if the index is used to inform policy changes directly.

In line with anecdotal and empirical evidence, our DMCI suggests that policy became tighter when the UK entered the ERM, but most of the tightening manifested itself between 1990 and 1991, rather than before 1990, as other MCI measures imply. The DMCI also indicates that the overall policy stance became tighter after the 1996 surge in sterling. However, it suggests that the first effects on monetary conditions materialized in mid-1997, i.e. almost one year after the beginning of that rise. Assuming that interest rates and the exchange rate stay constant at their 1999 Q4 level, a projection of the DMCI over the forecasting horizon indicates that, other things being equal, the policy stance will become tighter in the coming two years, because much of the past exchange rate appreciation and rate rises have yet to have their full effect on economic activity.

Data Appendix

1A Definitions of the variables used in the estimated model

The variables we use in the estimated model are:

y_t : residual from a prior regression of the log of real GDP (quarterly, seasonally adjusted) on a constant linear trend over 1982 Q1 1999 Q3.

p_t : ¼*log ($RPIX_t$ / $RPIX_{t\ 4}$), where $RPIX_t$ is the RPIX deflator in quarter t. Our use of the four-quarter inflation rate rather than the quarterly change is motivated by the fact that, historically, targets for UK inflation or other nominal aggregates have been expressed in terms of annual changes rather than quarter-to-quarter movements. It is also conceivable that a four-quarter inflation rate may be a better empirical measure of underlying quarterly inflation than actual quarterly inflation.

$qhat_t$: [log($RERI_t$ / $RERI_{t-1}$) log($RERITREND_t$ / $RERITREND_{t-1}$), where *RERI* is the Exchange Rate Index and *RERITREND* is its Hodrick-Prescott trend. This variable is measured such that an observation of + 0.10 indicates a depreciation of sterling relative to trend of 10%.

R_t : Quarterly average of the annualized nominal interbank lending rate, measured as a fraction.

rl_t : Quarterly average of the real yield on ten-year index-linked gilts, measured as an annualized fraction.

2A Time Series Properties of the Data

We model output as trend-stationary, with $_t$, $qhat_t$ and rl_t treated as I(0) series, and R_t as an I(0) series after controlling for key shifts in monetary policy regime. As evidence, in Table 1A below we present Augmented Dickey Fuller (ADF) statistics that test the null of a unit root for the variables in our model. Since our contention is that output can satisfactorily be modelled as trend-stationary, Table 1A actually gives a test for a unit root in *detrended* output. Two ADF test statistics are calculated for the nominal interest rate, R_t : the first includes only a constant in the ADF regression, whereas the second includes a constant, $DERM_t$, and $D924_t$ Excluding these dummy variables may bias the test toward suggesting a unit root in R_t.

Table 1A: ADF Tests for estimated model

Variable	ADF statistic
y_t	2.934*
p_t	2.940*
$Qhat_t$	3.047
rl_t	3.075*
R_t (no shifts)	1.984
R_t (shifts included)	3.648*

Note: A lag length of four is used in the ADF regressions for each variable except R_t (five lag). A * denotes significance at 0.05 level according to the Dickey-Fuller distribution's critical values; a ** significance at the 0.01 level according to these values. To test stationarity when shifts are included in the R_t equation we used critical values for the appropriate limiting distribution in Mackinnon J G (1991) "Critical values for cointegration tests" in R F Engle and C W J Granger (eds) Long-run economic relationships, Oxford University Press, 267-76

The tests generally reject the null of a unit root in favor of the alternative of stationarity (or, in the case of R_t , an I(0) series with structural breaks). Thus, we believe it is satisfactory to treat the elements of our estimated model are all I(0), and therefore do not apply cointegration analysis.

3A Model's estimates

Below we present estimates of the output, inflation and short-term nominal interest rate equations that we use in conjunction with equations (2)-(4) to generate data for the final form regression in y_t. The sample period for the estimation is 1984 Q4 – 1999 Q3. Standard errors are in parentheses.

Output equation

$$y_t = 0.888\, y_{t-1} \quad 0.762\, r_{t-2} - 1.103\, rl_{t-1} + 0.023{*}qhat_{t-6} \quad 0.013DERM_t \quad 0.012D924_t \qquad \textbf{(1A)}$$

(0.025) (0.220) (0.542) (0.012) (0..002) (0.002)

$R^2 = 0.9797$ = 0.391 % $DW = 2.02$

Inflation equation

$$p_t = \quad p_{t-1} + \quad 0.044\, y_{t-1} + 0.02MA9 \quad qhat_{t-1\; t} \qquad \textbf{(2A)}$$

(0.006) (0.01)

$R^2 = 0.33$ = 0.11% $DW = 1.72$

Short-term nominal interest rate equation (restricted)

$$R_t \;=\; 0.650\, R_{t-1} \;+\; 0.088\, y_t \;+\; 1.41\, p_t \qquad 0.010\, DERM_t \qquad 0.014\, D924_t \qquad \textbf{(3A)}$$
$$\qquad (0.11) \qquad\quad (0.05) \qquad (\text{---}) \qquad (0.004) \qquad\quad (0.004)$$

$R^2 = 0.9437$ $= 0.76$ % $DW = 1.58$

where ‘   ’ is the difference operator and ‘MA9’ is nine-quarter backward-looking moving average.

Equation (2A) is derived regressing the *change* in inflation (p_t)   which explains the low R^2 on detrended output, changes in the real exchange rate and the intercept dummy $DERM_t$. Re-arranging terms, we get an expression for inflation as a function of lag(s) of itself with a unit coefficient (in addition to other things). Since we interpret equation (2A) as a Phillips curve, this unit-restriction coefficient *de facto* ensures that the homogeneity assumption holds in the long run (ie that our Phillips curve is vertical in the long-run).

Equation (3A) is obtained imposing the restriction that the long-run response of the nominal interest rate to inflation is larger than one on equation (3A’) below. This restriction cannot be rejected [$^2(1)=0.062381$ (p-value = 0.8028)]. In addition, note that, although the value of the Durbin-Watson statistic is low, a four-lag LM test rejects the null of serial correlation at the 5% confidence level [F-form(4,50) = 1.865 [p-value 0.1312] **.**

Short-term nominal interest rate equation(unrestricted)

$$R_t \;=\; 0.528\, R_{t-1} \;+\; 0.094\, y_t \;+\; 1.80\, p_t \qquad 0.010\, DERM_t \qquad 0.014\, D924_t \qquad \textbf{(3A')}$$
$$\qquad (0.10) \qquad\quad (0.05) \qquad (0.61) \qquad (0.004) \qquad\quad (0.004)$$

$R^2 = 0.9438$ $= 0.77$ % $DW = 1.58$

4A Estimates of the final form regression

Equation **(4A)** is the estimated final form regression relating detrended output to the short-term ex-post real interest rate, the exchange rate and the model’s shocks. As the SE in parentheses suggest, all interest rate regressors in this equations are significant at the 5% level; however, not all the exchange rate regressors are. This may be due to collinearity between the lags in the exchange rate that feature as regressors in this equation. Thus, to test whether the separate lags are significant, we run a second regression, including the level of the real exchange rate at t 6 and changes in the real exchange rate at t 6, t 7, …, t 16. Since the coefficient on t 6 is highly significant in this second regression (coefficient = 0.0652, SE = 0.0270) we treat the exchange rate regressors in equation **(4A)** as significant and include them separately in the calculation of the DMCI.

Equation **(4A)**: *Output approximation regression (R^2=0.9715)*

Dependent variable: y_t								
var	coeff.	S.E.	var.	coeff.	S.E.	var.	coeff.	S.E.
q_{t-6}	0.0166	0.0184	r_{t-2}	-0.3045	0.0258	t	0.9954	0.0545
q_{t-7}	0.0150	-0.0247	r_{t-3}	-0.2269	0.0306	t-1	0.8674	0.0545
q_{t-8}	0.0149	0.0195	r_{t-4}	-0.1911	0.0306	t-2	0.7787	0.0549
q_{t-9}	0.0059	0.0195	r_{t-5}	-0.1652	0.0305	t-3	0.6887	0.0548
q_{t-10}	-0.0045	0.0194	r_{t-6}	-0.1623	0.0573	t-4	0.6034	0.0549
q_{t-11}	-0.0138	0.0194	r_{t-7}	-0.1393	0.0603	t-5	0.5304	0.0548
q_{t-12}	0.0049	0.0183	r_{t-8}	-0.1094	0.0601	t-6	0.4725	0.0571
q_{t-13}	-0.0247	0.0169	r_{t-9}	-0.1102	0.0603	t-7	0.4180	0.0574
q_{t-14}	0.0150	0.0099	r_{t-10}	-0.1179	0.0603	t-8	0.3653	0.0575
q_{t-15}	0.0122	0.0099	r_{t-11}	-0.1247	0.0603	t-9	0.3620	0.0577
q_{t-16}	0.00127	0.0099	r_{t-12}	-0.0595	0.0571	t-10	0.2938	0.0577
q_{t-17}	0.0285	0.0088	r_{t-13}	-0.1517	0.0513	t-11	0.2600	0.0577

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