The University *of* Manchester

Discussion Paper Series

Predicting Growth Regimes for European Countries

By

Denise R. Osborn†, Marianne Sensier† and Dick van Dijk*

†Centre for Growth and Business Cycle Research, School of Economic Studies, University of Manchester, Manchester, M13 9PL, UK

*Econometric Institute, Erasmus University Rotterdam, The Netherlands

December 2003
Number 039

THE UNIVERSITY
of MANCHESTER

Predicting Growth Regimes for European Countries

by

Denise R. Osborn†, Marianne Sensier†
and Dick van Dijk*

†Centre for Growth and Business Cycle Research
School of Economic Studies
University of Manchester, Manchester, M13 9PL, UK
e-mail: Marianne.Sensier@man.ac.uk
web address: http://www.ses.man.ac.uk/cgbcr/

*Econometric Institute, Erasmus University Rotterdam

Revised December 2003

Please do not quote without permission from the authors. The first two authors would like to thank the UK Economic and Social Research Council for financial support under grant L138251030.

ABSTRACT

This paper examines the roles of domestic and international variables in predicting expansion and recession regimes of the growth rate cycle for Germany, France, Italy and the UK over the period 1972 to 2003, using a range of real and financial variables as leading indicators. The output gap, stock market prices and interest rates are found to be the most important variables in the domestic models. Consideration of international variables leads to prominent roles for the composite leading indicators for Europe and the US, and sometimes for US or German interest rates. Both the domestic output gap and the international composite leading indicators typically play negative roles for the probability of a growth cycle expansion, so that relatively extreme values of these may be helpful in predicting regime changes. The models for all four countries predict the post-sample recessions which start between 1999 and 2001.

JEL classification: C25, E32, E37.

Keywords: growth rate cycles, financial variables, leading indicators, logistic classification models, regime prediction, growth cycle linkages.

1. Introduction

Forecasting the future state of the business cycle has since long been an important issue for policy-makers and other economic agents. Much of the voluminous literature on this topic has examined the business cycle in the sense of changes in a general measure of economic activity, such as real gross domestic product (GDP). However, also important are business cycles in the sense of expansions versus recessions, with an important recent strand of this literature examining this as a problem in the prediction of a binary business cycle regime indicator. Most such studies have examined the US economy, including Birchenhall, Jessen, Osborn and Simpson (1999), Chauvet and Potter (2001), Estrella and Mishkin (1998), Camacho and Perez-Quiros (2002), among many others. Recently, however, Sensier, Artis, Osborn and Birchenhall (2004) have considered important European economies, with both domestic and international (US and European) variables being found important for the prediction of their business cycle expansion and recession regimes.

The business cycle regimes considered in the above literature relate to the "classical" business cycle, which concerns expansions and recessions in the level of real economic activity. Examination of such business cycles has a long history, dating back to the seminal work of Burns and Mitchell (1946). Another widely referenced concept of the business cycle relates to the so-called growth cycle, in which case expansions and recessions refer to periods of increasing and decreasing growth, respectively. Therefore, a growth recession may occur without a decline in the level of output. Growth cycle regimes are typically defined after detrending the output series, so that peaks and troughs are maximum and minimum values (respectively) in relation to the trend. Canova (1999) compares the impact of various detrending methods on the dating of turning points. The cycles we use in this paper relate to the rate of growth, so that the detrending used is effectively first differencing. We refer to these as growth rate cycles and the corresponding expansions/recessions as growth regimes.

The present paper examines the prediction of growth regimes three months ahead for the European countries of Germany, France, Italy and the UK, which are the same countries for which Sensier *et al.* (2004) consider the prediction of classical business cycle regimes. By using the same set of countries and a similar set of prediction variables, we are able to draw comparisons between the important predictors for the two different types of business cycle regimes. In particular, in this European context, we are again particularly interested in examining the role of international variables relating to the US and Europe.

The content of the present paper is as follows. Section 2 discusses the chronology for the growth rate that we use in order to define the regimes to be forecast. Our methodology for regime forecasting, which draws heavily on that of Birchenhall *et al.* (1999) and Sensier *et al.* (2004), is outlined in Section 3. The prediction variables we consider are also described in this section. The substantive results are then discussed in Section 4 for each of the four countries. Finally, some conclusions are drawn in Section 5.

2. The Growth Rate Cycle

We adopt the turning point chronology of the Economic Cycle Research Institute (ECRI)[1] for the growth rate in each of the E-4 countries of Germany, France, Italy and the UK[2] over the period 1972-2003, which is effectively the same period for which Sensier *et al*. (2004)

[1] ECRI defines regimes in the growth cycle as "periods of cyclical upswings and downswings in growth" (http://www.businesscycle.com/research/intlcycledates.php). The alternative growth cycle chronology of the OECD sometimes differs substantially from the ECRI chronology. These differences may be attributed to differences in methodology, in particular the determination of trend output in the OECD, which can play a crucial role in dating growth cycle turning points (Canova, 1994).

[2] A growth cycle chronology for the Euro Area is also now available from the Centre for Economic Policy Research (CEPR). However, as this starts only in 1988, we do not include it in the present study.

consider prediction of the classical business cycle regimes for these countries. Peak and trough dates for the growth cycles are shown in Table 1.

Cycles in the growth rate typically exhibit more frequent regime changes than classical cycles, since a period of lower growth may be sufficient to define a growth recession without leading to the output decline required for a recession in terms of the classical cycle. For this reason, the growth rate cycle is closer to being symmetric in the sense of approximately equal numbers of observations falling in recessions and expansions. From the peak and trough dates in Table 1, it can be inferred that this also applies for the four European countries under consideration here.

Cycles related to growth are of interest to policymakers, such as the Organisation for Economic Co-operation and Development (OECD), which has its own set of leading indicators for the growth cycle. One reason for this interest may be their relationship to the output gap. The output gap, which is measured as the difference between the actual level and the "potential level" of real output, is a key concept in the monetary policy of independent central banks. Figure 1 shows the regimes we study (with growth recessions indicated by shading) in relation to the output gap, measured by the difference between monthly real industrial production and its value after application of the Hodrick-Prescott (1997) filter. Thus, as frequently done in the empirical monetary policy literature, we take the HP filtered value to represent potential output. For the UK we have available a monthly GDP indicator and we use this to capture the output gap, in preference to the gap measured in terms of industrial production, since we anticipate that this indicator will reflect more general movements in economic activity[3].

Although it is not one-to-one, Figure 1 indicates that growth recessions are associated with periods of overall decline in the output gap, and conversely that growth

[3] The monthly GDP series is estimated by the National Institute of Economic and Social Research, using the methodology described in Salazar *et al*. (1997). We are grateful to the National Institute for making this series available to us.

expansions are associated with periods of overall increase in the output gap. This relationship is particularly clear in the cases of Germany and the UK. Due to this relationship, the prediction of growth regimes may be of particular interest to central banks, including the Bank of England and (for the Euro Area) the European Central Bank.

Turning briefly to the turning points shown in Table 1, it may be noted that there are at least six complete cycles for each of our European countries during the period 1972-2003. Indeed, France and Italy have the smallest number of regime changes (namely 13) over the thirty years, while the UK has the greatest number (17). Although the peak and trough dates in Table 1 have been (roughly) aligned across countries, the international synchronisation of growth rate cycles here seems less obvious here than the classical cycles shown in the corresponding table of Sensier *et al*. (2004). [4]

3. Methodology and Predictor Variables

This section first outlines our modelling methodology, followed by a discussion of the predictor (or leading indicator) variables used.

The essential methodology used here follows Sensier *et al*. (2004), which in turn is built upon that of Birchenhall *et al*. (1999). Following these (and other) studies in the prediction of classical cycle regimes, we define a binary regime indicator as having the value unity during growth expansions and zero during growth ‘recessions. More explicitly, the value zero (unity) is assigned to each month subsequent to a peak (trough) up to and including the month of the following trough (peak). We predict the probability of a growth regime at a horizon of three months using

[4] This is clearly illustrated by the percentage of months for which two countries are in the same regimes, which ranges between a low of 54.2% for Germany and the UK and a high of 63.2% for France and the UK.

$$p_t = \Lambda(\beta' \boldsymbol{x}_{t-3}) \qquad (1)$$

where p_t is the probability that the regime for month t will be an expansion, based on information up to and including month t-3, with this information represented by the vector of prediction variables $\boldsymbol{x}_{t-3}$. The probability is constructed as a logistic function, namely $\Lambda(z) = \exp(z) / [1 + \exp(z)]$. The unknown coefficients in the vector β are estimated with maximum likelihood, with the log-likelihood function given by

$$\log(L) = \Sigma_1 \log(p_t) + \Sigma_0 \log(1 - p_t) \qquad (2)$$

where Σ_1 is the sum over all growth cycle expansion months, as defined by the binary regime indicator discussed above and Σ_0 is the sum over all months of growth recession.

The choice of the elements in $\boldsymbol{x}_{t-3}$ is a key feature of the method and proceeds as follows. We consider a wide range of macroeconomic and financial variables as potential predictors. For example, as discussed below, for the domestic models we consider two differences or lags of each of six different variables as elements of $\boldsymbol{x}_{t-3}$. Given this initial set of potential predictor variables, we select an optimal subset through the application of an automated search algorithm. This so-called *n-search algorithm* simply considers *all* possible models with subsets of k variables, for $k = 1, \ldots, n$, where n is specified in advance. For the detailed results presented in this paper (and in line with Sensier *et al*., 2004), n is set equal to 9. The optimal subset of predictors is selected with the Schwarz Information Criterion (SIC):

$$\text{SIC} = (-2\log L + k \log T)/T \qquad (3)$$

where L is the likelihood value from (2), k is the number of estimated coefficients and T is the number of observations in the sample used for estimation. The subset of predictors that minimises SIC is selected.[5]

As noted in the Introduction, we construct domestic and international models for the prediction of growth rate regimes in each country. For the domestic models, we consider a range of macroeconomic and financial predictor variables, namely the output gap (as shown in Figure 1), retail sales, a stock market price index, short and long-term interest rates, real money supply (M0 for UK and M1 for other countries) created as the nominal money series divided by the consumer price index[6]. Detailed information on these variables is provided in Appendix Tables A.2 to A.5. Retail sales, the stock market index and real money supply are expressed as growth rates over three or twelve months, by taking the relevant difference of the logarithm of the series. For both interest rate series and the output gap, the level in month t-3 or t-12 is used for predicting the probability of expansion in month t. For convenience, we refer to this as "lag three" and "lag twelve" below.

For the output gap, it is unclear whether the level or the change should be used as a regime predictor. Indeed, the relationship between the growth rate cycle and the output gap in Figure 1 indicates that the cycle is associated with the contemporaneous direction of change in the output gap. To the extent that the current regime predicts the future regime, the change in the output gap may be a useful regime predictor. Nevertheless, this predictor may be poor around turning points. Our response was a pragmatic one, comparing models using the level of the output gap with ones using the difference. When compared using

[5] It might be noted that hypothesis testing plays no role in the model selection procedure used. In any case, hypothesis testing would have to take account of the serial correlation consequent on the overlapping forecast horizons that apply when forecasting each month for three months ahead. Although methods are available that enable valid inference, we prefer SIC because it focuses more directly on forecasting performance; see the discussion in Sensier *et al*. (2003).

[6] The retail (all items) price index was used to deflate nominal M0 for the UK.

SIC, the output gap without differencing always produced lower SIC[7]. We also considered using the growth of industrial production (over three and twelve months), which may be expected to track the growth rate cycle. However, this was also dominated in terms of SIC by using the level of the output gap[8].

For the predictor variables that are transformed to growth rates, quarterly and annual growth rates are used in order to smooth very short-run month-to-month movements. Although our use of three and twelve months is relatively arbitrary, this does allow the model to select between a three-month difference that reacts relatively quickly to changes in direction and a twelve-month one that reflects longer term movements in a predictor variable. Other differences could be used, but our experience is that these two are sufficient to capture most relevant information in a predictor[9]. The same reasoning applies to the output gap and the interest rate series, for which the levels are considered at lags three and twelve only.

For the international models, we augment the initial set of potential domestic prediction variables with a range of international variables. These international variables include the exchange rate for each country, expressed as the number of US dollars to one unit of the currency of the country, the OECD composite leading indicator (CLI) for the US, the OECD aggregate CLI for the countries of the European Union (E15) or the Euro-Zone aggregate[10], together with the US short-term interest rate and the German short-term

---

[7] We also estimated domestic models where the initial set of variables included both the level and the difference of the output gap. The results of this exercise unambiguously show that the level of the output gap is much more important than the change for predicting growth cycle regimes. In particular, lag three of the output gap level was always included in the set of selected predictors, any included output gap differences contribute only marginally to the explanatory power of the model, and an almost identical set of other predictors was included compared to the presented models based on the levels of the output gap only.

[8] Industrial production growth was examined in place of the output gap in the domestic model for each country. Given the better fit obtained using the output gap, industrial production growth was not considered for the international models.

[9] Sensier *et al.* (2003) considered differences over 3, 6, 9 and 12 months. However, with four differences or lags for each predictor, this leads to a large number of combinations to be considered and increases the potential for selection of spurious lags.

[10] The form used is the amplitude adjusted composite leading indicator. This series has no overall trend and is designed to lead the growth cycle. It is useful to note that our study is not designed to evaluate the

interest rate (for countries other than Germany). Through these variables, we hope to capture important international influences in both the real economy and through monetary policy. In the classical business cycle prediction models of Sensier *et al*. (2004), international interest rates were found to be especially important. Lags at three and twelve months are considered for all these variables.

As for the output gap, discussed above, it is unclear whether the CLI for the US and Europe should be included as levels or differences. However, comparisons of models based on levels and differences always favoured the former, and hence these are reported in the present study[11].

After the appropriate transformations (such as differencing), all domestic and international predictor variables are standardised to zero mean and unit variance prior to inclusion in the logit model in (1). Therefore, the magnitudes of the coefficients can be used to compare the relative roles of these predictors in the estimated models.

Finally, a few details concerning the modelling methodology are worth mentioning. First, we consider one set of domestic models with short- and long-term interest rates and another using the term structure, together with other domestic variables. Having applied the search procedure to both sets of initial variables, we selected between the two resulting models using SIC. When international variables are added to the set, all domestic variables (at both lags/differences) are again considered, so that the search procedure selects from among this extended set. The same procedure is adopted for domestic interest rates in these international models, with SIC used to select between the separate inclusion of short- and long-term rates and the term structure.

---

information content in the OECD composite leading indicators. Such an analysis is complicated by the frequent changes in the composition of the CLIs. For this reason, we do not include the country-specific CLIs in the set of potential predictors for the domestic models, and we only use the CLIs as a convenient summary measure of future activity in the US or Europe.

[11] To be precise, we compared models using the levels of both the output gap and the CLI series to those using differences for both, with the former models always yielding lower SIC. Models that resulted from an initial set of variables including levels and differences of both the output gap and relevant CLI series tended to be highly parameterised with coefficients that were difficult to interpret.

Second, the OECD CLIs for the E15 and for the Euro zone obviously are closely related and therefore only one of these is used for each country. For France, Italy and the UK this is the E15 leading indicator, while for Germany it is the Euro Zone since this performed a little better in terms of SIC.

4. Results

The discussion considers the four countries in turn, with a separate subsection for each. Two models are presented for each country. The first is a purely domestic model, while the second adds international variables to the set of potential prediction variables.

All models are estimated using data from January 1972 to June 1999, with the subsequent 48 months to June 2003 used for post-sample forecasting. For all countries except France, the turning point dates of Table 1 provide at least one post-sample regime shift that can be used to assess the performance of our models. In addition to the coefficients, the associated minimum SIC value and the value of the maximised log likelihood of (2), we also present an error analysis. One error statistic is the value of the root mean-square error where the true value is the zero/one binary regime indicator for month t and the forecast value is the estimated probability of an expansion regime in that month based on data to t - 3.

We also show prediction errors as percentages of the number of observations classified by ECRI as within growth rate expansions and recessions. As usual in the regime prediction literature, estimated probabilities are converted to binary regime predictions using the “0.5 rule”, so that an estimated expansion probability over 0.5 is considered to be a prediction of expansion while one less than 0.5 is a recession prediction[12]. Corresponding regime prediction error information is provided for the 48 months of the post-sample period. However, this information has to be treated with some care, since turning points are classified after a delay, so that it is possible that further turning points may subsequently be dated by ECRI during this period. Finally, we also show expansion regime prediction probabilities for the months of July to September 2003, for which we did not have data when the analysis was undertaken.

4.1 Germany

Table 2 shows the results for Germany, with Figure 2 showing the corresponding regime predictions for each model; once again, recessions in the growth rate are shaded.

Using the range of domestic variables results in a parsimonious model, with only three separate variables selected. Increases in retail sales and in stock market prices, both computed over a year, act as predictors of growth rate expansions. The output gap, at a lag of three months, has a negative effect on expansion predictions. This presumably reflects the pattern seen for all countries in Figure 1, namely that the output gap is high at the beginning of a growth recession. Therefore, large positive values of the output gap are associated with the beginning of a recession, while large negative values are associated with the beginning of expansion, of the growth rate cycle. In terms of the magnitude of coefficients, the output gap is the most important variable for this domestic model for Germany.

The role of the output gap is maintained when international variables are introduced, while retail sales and stock prices also remain in the model. Further, in addition to bringing in both the US and Euro-Zone CLIs, domestic interest rates are now included.

---

[12] In their classical regime prediction models, Sensier *et al*. (2003) and Birchenhall *et al*. (1999) identify as "uncertain" any month where the estimated expansion probability is between 0.5 and the sample proportion of expansion months. However, this sample proportion is approximately 0.5 for the growth cycle regimes and hence we do not use the "uncertain" classification in the analysis of the present paper.

However, the signs on these domestic interest rates are opposite to those that might be anticipated. Interestingly, while the US CLI has a positive coefficient, that of the Euro Zone is negative. Like the interpretation for the output gap, the Euro Zone CLI may be acting primarily as a predictor of turning points, with high values indicating that the German economy (presumably along with other Euro Zone economies) may experience a peak in growth the near future. Low values similarly have the interpretation of predicting a future trough. The positive coefficient on the US CLI has a straightforward interpretation of the US economy leading that of Germany.

It is also notable that the model with international variables results in relatively modest improvement to the in-sample period error statistics (total error count and RMSE). However, this model does improve on a relatively poor post-sample performance by the domestic model, which fails to predict recovery from the growth rate recession during this period. A similar comment applies to the sample period recession of the mid-1990s, the duration of which is poorly predicted by this domestic model, but where international variables apparently provide important additional information, see Figure 2.

4.2 France

Turning to the domestic model for France in Table 3 and the upper panel of Figure 3, the output gap lagged three months plays a strong role, with a negative coefficient. Trends in stock market prices and real money (as measured by the annual differences) play positive roles, whereas short interest rates have a negative coefficient. With the possible exception of the output gap (but see the discussion for Germany above), all these signs are the anticipated ones. However, long interest rates enter the model with both three and twelve lags, the former positive and the latter negative. There is, therefore, a suggestion that it may be the change in the long rate that is important.

As a comparison of the two models for France in Figure 3 indicates, the introduction of international variables has a quite dramatic effect on the prediction of regimes in growth. In particular, with the exception of the mid-1980s expansion, this second model tracks the sample period regimes much more accurately. From Table 3 this is underlined by the overall error rate of 10 percent (compared with 19 percent for the domestic model), which falls even to 6 percent for the prediction of growth recession months.

Turning to the individual predictor variables of the international model for France, it is remarkable that the only domestic variables that enter are interest rates, with a similar pattern of coefficient signs as in the domestic model. Indeed, interest rates play a particularly important role in this international model, since German and US rates also enter. It is interesting that, like the domestic short rate, German interest rates enter at both three and twelve lags, in both cases with opposite signs to those of domestic long rates. US interest rates have a positive effect, as also found in the model for classical business cycle regimes in France in Sensier *et al.* (2004). Finally, and perhaps surprisingly, the OECD composite leading indicator for the E15 enters with a negative coefficient.

Although both models for France predict the post-sample recession, Figure 3 indicates that the date of its onset is not predicted well by either model. Indeed, the post-sample predictions differ primarily in terms of the length of this recession. Since the trough has not yet been dated, a full assessment cannot yet be undertaken and the post-sample error statistics in Table 3 should be treated with caution.

4.3 Italy

The domestic model for Italy with individual variables is particularly simple, with the only selected predictors being the output gap (negative) and the term structure (positive). The negative output gap coefficient is also found for other countries, while the positive term structure coefficient is as anticipated. However, this parsimonious domestic model incorrectly predicts the regime for the in-sample period for almost a quarter of the observations.

In contrast to the strong role of international variables for Germany and France, these play very little role for Italy. The only such variable that enters is the US interest rate at a twelve months lag, with a negative coefficient. Indeed, this variable has only a marginal effect, so that while it reduces the SIC the error count is marginally increased. It is also evident from the two panels of Figure 4 that these two models are very similar. As in the case of France, the models appear to have particular difficulty in predicting the growth regimes around the mid-1980s, where the information from the output gap does not clearly indicate changing regimes either (see Figure 1).

Both models for Italy predict the post-sample growth recession that began in February 2001, but they also indicate that it should have ended some time in 2002. As yet no trough has been dated by the ECRI, but such a trough may yet fall within the post-sample period here.

<u>4.4 UK</u>

As in Germany and Italy, the domestic UK model shown in Table 5 is quite parsimonious. In this case, only the output gap, stock market prices and the term structure are selected as predictors. It may be noted, however, that this model predicts recessions relatively poorly, with 26 percent errors. This is emphasised by the upper panel of Figure 5, where the long recessions of 1973-1975 and 1988-1991 are predicted accurately, but others are generally less well predicted. Nevertheless, the post-sample recession beginning in 2000 (for which no end has yet been dated) is clearly predicted.

In terms of coefficients, stock market prices and the term structure have the anticipated positive signs, while the output gap has a negative coefficient at a lag of three months and a positive (but smaller) one at a lag of twelve months.

These domestic variables continue to play a role when international variables are also considered, although now only the shorter lag of the output gap is selected and the separate short and long interest rates replace the term structure. The international variables are the exchange rate and the US composite leading indicator, so that no European indicators are selected for the UK. The role of the exchange rate is ambiguous, in that the coefficient of the three-month change is negative while that of the twelve-month change is positive, with the latter being the larger in magnitude. Thus, overall, an appreciation of the pound sterling in relation to the US dollar increases the probability of an expansion in growth, and vice versa for a depreciation of the pound. In contrast to the positive role of the US CLI for predicting the UK classical cycle in Sensier *et al*. (2004), the effect here is negative.

A comparison of the panels in Figure 5 implies that the principal role of the international variables is to improve prediction of the short recessions beginning in 1983 and 1985, together with that of 1997-1999. The post-sample recession is also more clearly predicted.

4.5 General Discussion

A number of general features emerge from a comparison of the prediction models across Tables 2 to 5.

The first common feature is the important role played by the output gap when only domestic variables are considered. For all four countries, the output gap at a three month lag has a negative impact on the probability of a growth rate expansion. Indeed, with the single exception of France, the output gap at this lag is the most important predictor of the regime, in the sense that its coefficient is the largest in magnitude of all selected variables.

It is evident from Figure 1, and reinforced by our estimated models, that the output gap obtained using the HP filter is associated with the growth rate regimes identified by ECRI. The nature of the association is, broadly, that a growth recession is associated with the decline in the output gap from a maximum to the subsequent minimum. It seems, therefore, that the negative role in our models is associated particularly with prediction of the regime for months around the turning point of the growth rate cycle, since for the latter part of a regime the output gap will be positively associated with the regime. As noted above, (unreported) results using the difference of the output gap always produce a higher SIC than the ones reported in this paper using the level.

Our models do not explicitly predict the turning points, but rather predict the regime three months ahead. If the role of the output gap is to predict turning points, as just argued, then it follows that other domestic variables must later outweigh the influence of the output gap to forecast the continuation of the regime.

Long and short interest rates, sometimes through the term structure, are selected as predictors in the domestic models for all countries except Germany. This is a similar finding as for classical cycles in Sensier *et al*. (2004). Another consistent result across these domestic models is that domestic stock market price changes predict growth rate regimes with positive coefficients (the only exception is Italy). In contrast, Sensier *et al*. (2004) find stock market prices to have negative coefficients for classical cycles for these countries, except again for Italy where this variable is not selected. The implication is that stock market increases (measured over the horizon of a year) in these European countries predict growth rate regimes, rather than the classical cycle.

It is also noteworthy that while some international variables are selected for each country when these are considered, they generally result in relatively modest improvements in the sample period regime prediction error statistics. Nevertheless, they do assist in the prediction of regimes during the 1980s, when domestic variables such as the output gap fail to provide clear signals of regime switches.

Where European CLI variables enter for the important countries of Germany and France, these variables have negative coefficients. It is also the case that the US CLI has a negative coefficient for the UK. Once again this contrasts for the positive role of such variables for the prediction of classical regimes. Like the output gap, these variables may be playing a role particularly at turning points. As noted for Germany, if the growth rate cycle in these countries is closely aligned with the cycle in Europe more generally, then to the extent that an extreme value of the European CLI predicts a turning point, then this prediction will also apply for these individual countries. The important roles played by Germany and France in Europe reinforces this interpretation. The fact that the US CLI apparently plays a similar role in the context of the UK lends supports to the well documented finding that short-run movements in UK activity have historically been more closely aligned to the US than Europe over this period (see, for example, Artis and Zhang, 1999, Perez, Osborn and Sensier, 2003).

5. Concluding Remarks

This paper has examined the prediction of regimes in the growth rate for the four major European countries of Germany, France, Italy and the UK. Although Artis, Baden-Hovell and Zhang (1995) examine the predictive content of the OECD leading indicators for the OECD growth cycle in the G-7 countries, we know of no previous study that examines the information in individual leading indicator series for the prediction of regimes in growth.

Growth rate regimes are predicted by movements in the output gap, which is of interest to policymakers, especially those concerned with the setting of monetary policy. Nevertheless, despite the close historical relationship between growth rate regimes and the output gap, our results indicate that financial variables, particularly interest rates and stock market prices, play a prominent role in terms of predicting the future regime. Further, international conditions are also relevant, with composite leading indicators of real activity in the US and/or Europe being important for all countries considered except Italy. For Italy and France, US or German interest rates enter as regime predictors, whereas it is only for the UK that exchange rate movements are relevant.

There is one important qualification to our results in terms of regime prediction, namely that our models are not "real time" ones. This is an important qualification in terms of both the output gap and the OECD composite leading indicators employed for the US and European aggregate. Indeed, Orphanides and van Norden (2003) show that historical estimates of the output gap frequently differ substantially from estimates made in real time. Also, the component series of the OECD composite leading indicators are regularly reviewed and up-dated, with the latest large-scale review being undertaken as recently as December 2002 (OECD, 2002). Therefore, we might anticipate that in real time these series would have less predictive content than in the models presented in this study; see Diebold and Rudebusch (1991) for an analysis using a US composite leading indicator. An interesting extension of the present study would be to examine the usefulness of both the output gap and the OECD composite leading indicators in a real time forecasting context.

References

Artis, M.J., R.C. Bladen-Hovell W. and Zhang (1995), Turning points in the international business cycle: an analysis of the OECD leading indicators for the G7 countries", *OECD Economic Surveys* **24**, 125-166.

Artis, M.J. and W. Zhang (1999), Further evidence on the international business cycle and the ERM: is there a European business cycle?, *Oxford Economic Papers* **51**, 120-132.

Birchenhall, C.R., H. Jessen, D.R. Osborn and P. Simpson (1999), Predicting US business-cycle regimes, *Journal of Business and Economic Statistics* **17**, 313-323.

Burns, A.F. and W.C. Mitchell (1946) *Measuring Business Cycles*, New York: National Bureau of Economic Research.

Camacho, M. and G. Perez-Quiros (2002), This is what the leading indicators lead, *Journal of Applied Econometrics* **17**, 61-80.

Canova, F. (1999), Does detrending matter for the determination of the reference cycle and the selection of turning points, *Economic Journal* **109**, 126-150.

Chauvet, M. and S. Potter (2001), Forecasting recessions using the yield curve, Staff Report No. 134, Federal Reserve Bank of New York.

Diebold, F.X. and G.D. Rudebusch (1991), Forecasting output with the composite leading index: a real-time analysis, *Journal of the American Statistical Association*, 86, 603-610.

Estrella, A. and F.S. Mishkin (1998), Predicting U.S. recessions: financial variables as leading indicators, *Review of Economics and Statistics* **80**, 45-61.

OECD (2002), An update of the OECD composite leading indicators, mimeo, Short Term Economic Statistics Division, Statistics Directorate, OECD.

Orphanides, A. and S. van Norden (2003), The unreliability of output gap estimates in real time, *Review of Economics and Statistics*, forthcoming.

Perez, P.J., D.R. Osborn and M. Sensier (2003), Business cycle affiliations in the context of European integration, Centre for Growth and Business Cycle Research, University of Manchester, Discussion Paper No. 29.

Salazar, E., R. Smith, M. Weale and S. Wright (1997), A Monthly Indicator of GDP, *National Institute Economic Review* **161**, 84-90.

Sensier, M., M. Artis, D.R. Osborn and C.R. Birchenhall (2004), Domestic and international influences on business cycle regimes in Europe, *International Journal of Forecasting*, forthcoming.

Table 1: ECRI Growth Rate Cycle Turning Points 1972-2003

Peak or Trough	Germany	France	Italy	UK
Peak	1973 m1	1973 m2	1973 m11	1973 m1
Trough	1974 m12	1975 m3	1975 m4	1975 m5
Peak	1976 m4	1976 m7	1977 m1	1976 m7
Trough	1977 m7		1977 m10	1977 m4
Peak	1979 m5		1979 m12	1979 m6
Trough	1982 m10	1980 m6	1982 m9	1980 m5
Peak		1982 m4	1984 m8	1983 m10
Trough		1984 m11	1986 m4	1984 m8
Peak	1986 m4	1985 m11		1985 m5
Trough	1987 m1	1987 m3		1985 m12
Peak	1991 m1	1988 m2	1988 m2	1988 m1
Trough	1993 m1	1993 m5	1992 m11	1991 m4
Peak	1994 m12	1995 m1		1994 m7
Trough	1997 m1	1996 m9		1995 m8
Peak	1998 m3		1996 m2	1997 m7
Trough	1999 m2		1998 m9	1999 m2
Peak	2000 m5	1999 m11	2001 m2	2000 m1
Trough	2002 m3			

Source: http://www.businesscycle.com/research/intlcycledates.php

Table 2. Prediction Models for Germany

Variable	Lag/ Difference	Domestic Model	International Model
Intercept		0.257	0.248
Domestic variables:			
Output gap	3	-1.913	-1.793
Retail sales	Δ_{12}	0.970	1.220
Stock market prices	Δ_3		0.498
Stock market prices	Δ_{12}	0.670	
Short interest rate	12		0.906
Long interest rate	12		-1.186
International variables:			
Euro Zone CLI	12		-1.176
US CLI	12		0.705
Summary Statistics:			
RMSE Sample		0.391	0.368
Log Likelihood		-151.0	-133.3
SIC		325.1	312.9
Errors In-Sample:			
Expansion		17% (32/182)	19% (36/182)
Contractions		29% (44/148)	26% (39/148)
Total		23% (76/330)	22% (75/330)
Errors Post-Sample:			
Expansion		76% (20/26)	34% (9/26)
Recessions		9% (2/22)	13% (3/22)
Total		45% (22/48)	25% (12/48)
Prediction:			
Forecast 2003m7		0.220	0.819
Forecast 2003m8		0.285	0.905
Forecast 2003m9		0.562	0.973

Notes: In-sample period is 1972m1-1999m6 and post-sample period is 1999m7-2003m6. All differenced series are included at a lag of three months. Figures in parenthesis for error statistics show the number of errors and the total number of observations in that regime.

Table 3. Prediction Models for France

Variable	Lag/ Difference	Domestic Model	International Model
Intercept		-0.746	-1.004
Domestic variables:			
Output gap	3	-1.896	
Stock market prices	Δ_{12}	0.492	
Short interest rate	3	-0.946	-3.390
Long interest rate	3	3.548	4.346
Long interest rate	12	-3.086	-5.201
Real M1	Δ_{12}	0.754	
International variables:			
E15 CLI	3		-1.630
E15 CLI	12		-4.320
US short rate	12		2.534
German short rate	3		3.197
German short rate	12		-3.098
Summary Statistics:			
RMSE Sample		0.377	0.278
Log Likelihood		-144.3	-88.09
SIC		329.3	228.4
Errors In-Sample:			
Expansion		29% (38/128)	14% (19/128)
Contractions		12% (25/202)	6% (14/202)
Total		19% (63/330)	10% (33/330)
Errors Post-Sample:			
Expansion		0% (0/5)	0% (0/5)
Recessions		60% (26/43)	88% (38/43)
Total		54% (26/48)	79% (38/48)
Prediction:			
Forecast 2003m7		0.563	0.992
Forecast 2003m8		0.861	0.995
Forecast 2003m9		0.907	0.996

Notes: See Table 2.

Table 4. Prediction Models for Italy

Variable	Lag/ Difference	Domestic Model	International Model
Intercept		-0.087	-0.105
Domestic variables:			
Output gap	3	-1.345	-1.376
Output gap	12	-1.211	-1.078
Term structure	3	0.678	0.552
International variables:			
US short rate	12		-0.512
Summary Statistics:			
RMSE Sample		0.390	0.386
Log Likelihood		-150.4	-146.1
SIC		324.0	321.3
Errors In-Sample:			
Expansion		26% (43/163)	25% (41/163)
Contractions		23% (39/167)	25% (42/167)
Total		24% (82/330)	25% (83/330)
Errors Post-Sample:			
Expansion		35% (7/20)	35% (7/20)
Recessions		60% (17/28)	60% (17/28)
Total		50% (24/48)	50% (24/48)
Prediction:			
Forecast 2003m7		0.665	0.825
Forecast 2003m8		0.699	0.845
Forecast 2003m9		0.672	0.832

Notes: See Table 2.

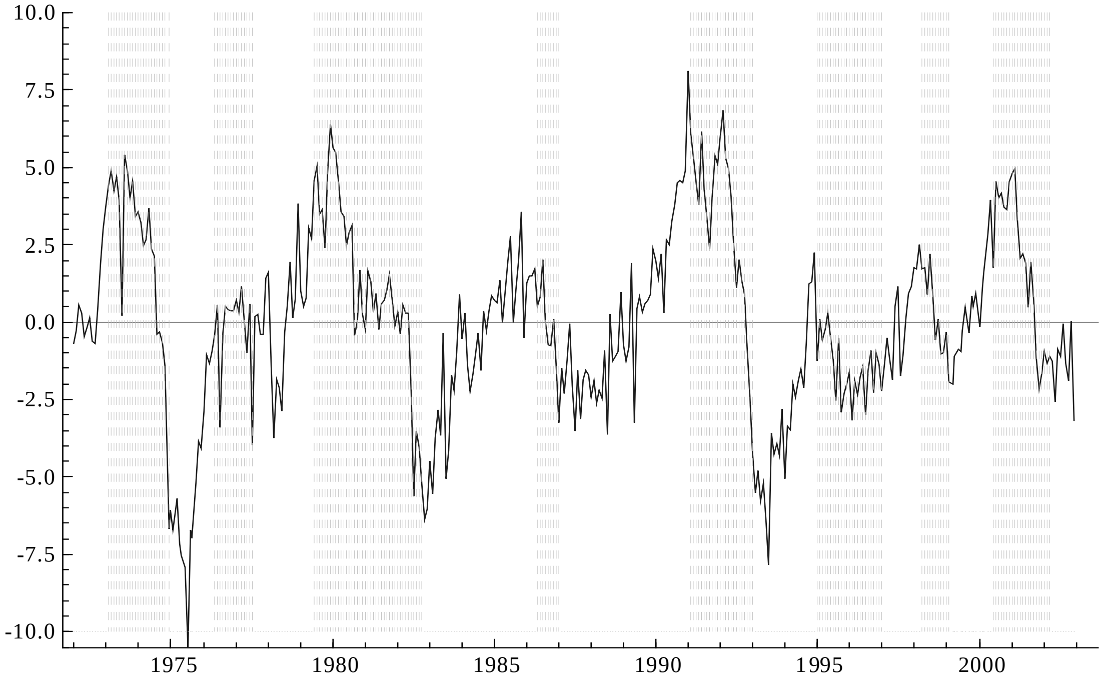
Table 5. Prediction Models for UK

Variable	Lag/ Difference	Domestic Model	International Model
Intercept		0.506	0.459
Domestic variables:			
Output gap	3	-2.475	-2.417
Output gap	12	0.670	
Stock market prices	Δ_{12}	1.349	2.106
Term structure	3	0.932	
Short interest rate	3		-1.529
Long interest rate	3		1.809
International variables:			
Exchange rate	Δ_3		-0.725
Exchange rate	Δ_{12}		1.200
US CLI	3		-0.741
Summary Statistics:			
RMSE Sample		0.334	0.307
Log Likelihood		-116.8	-98.74
SIC		262.7	243.9
Errors In-Sample:			
Expansion		9% (19/194)	8% (16/194)
Contractions		26% (36/136)	19% (26/136)
Total		16% (55/330)	12% (42/330)
Errors Post-Sample:			
Expansion		14% (1/7)	100% (7/7)
Recessions		4% (2/41)	0% (0/41)
Total		6% (3/48)	14% (7/48)
Prediction:			
Forecast 2003m7		0.354	0.385
Forecast 2003m8		0.454	0.480
Forecast 2003m9		0.473	0.383

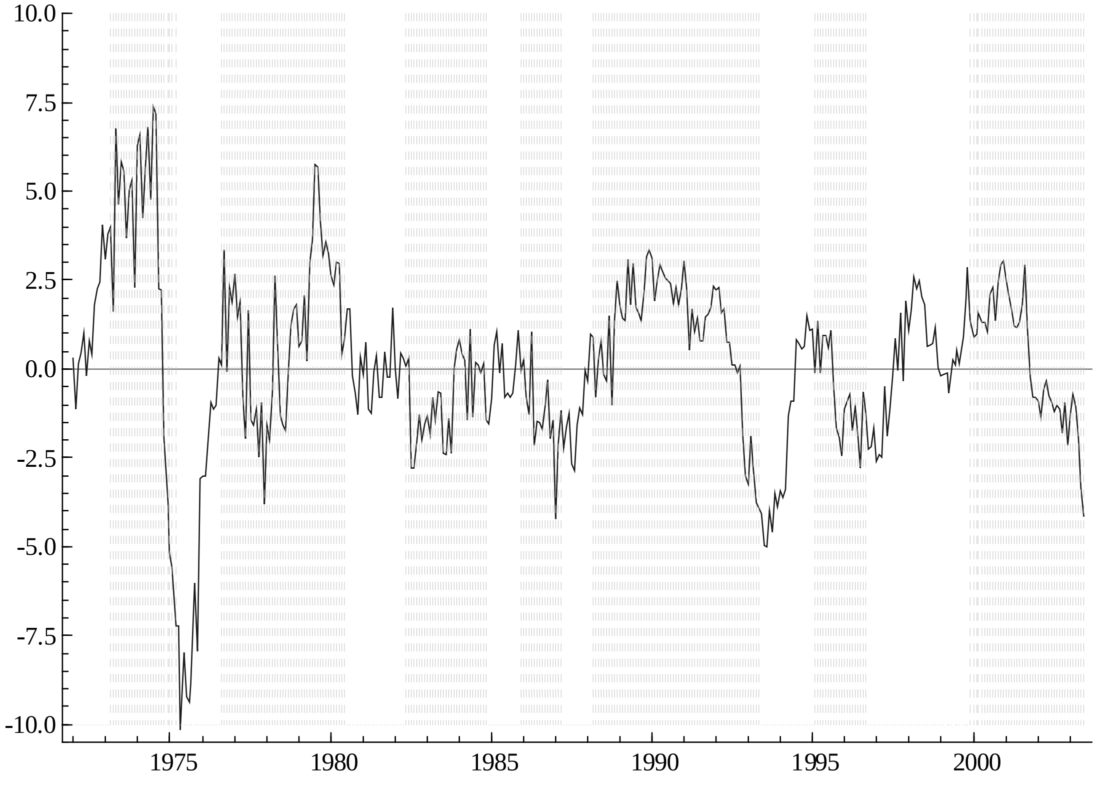
Notes: See Table 2.

Figure 1. Output gap and growth cycle recessions

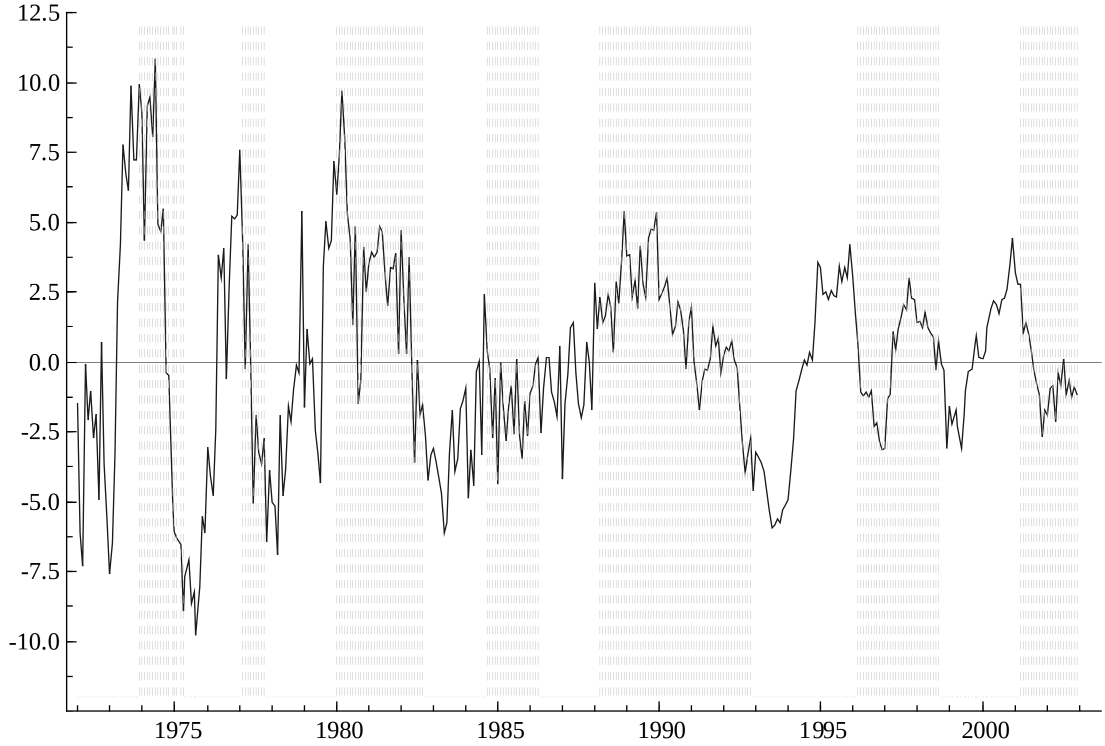
Germany



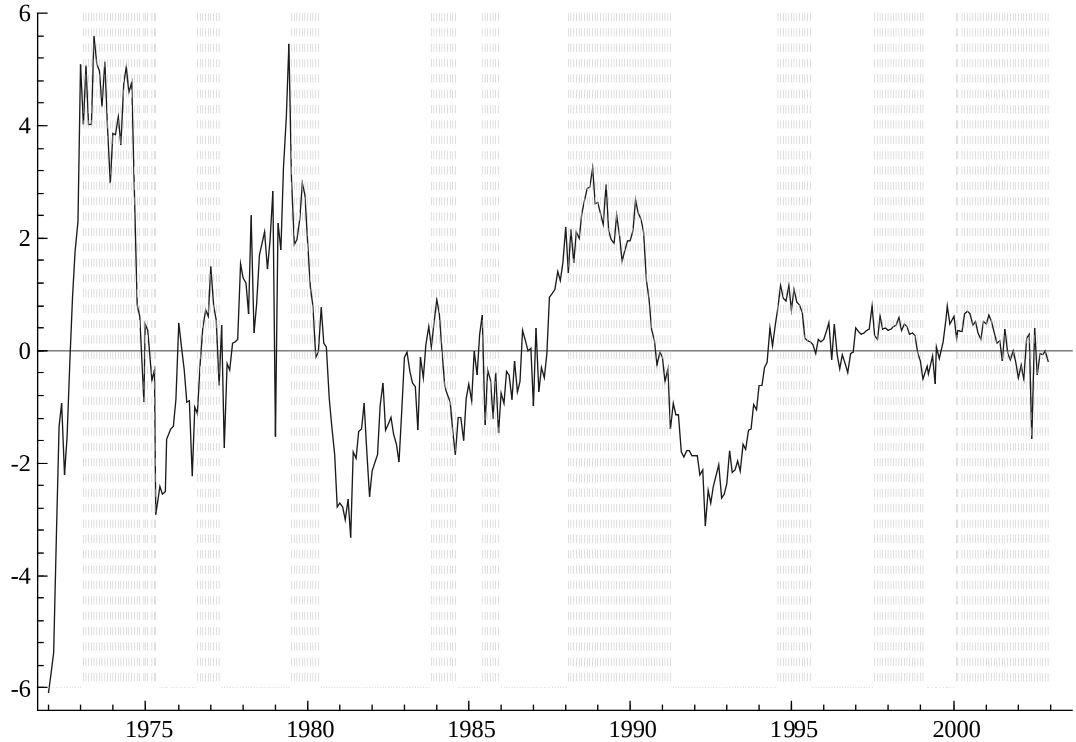
France



Italy



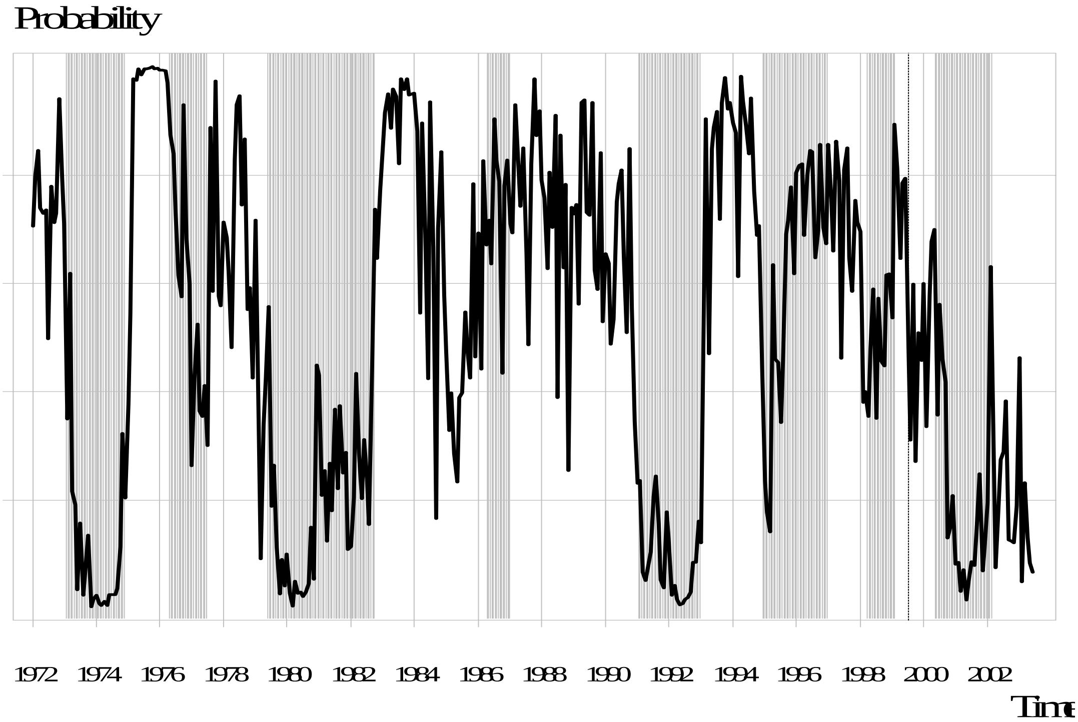
UK



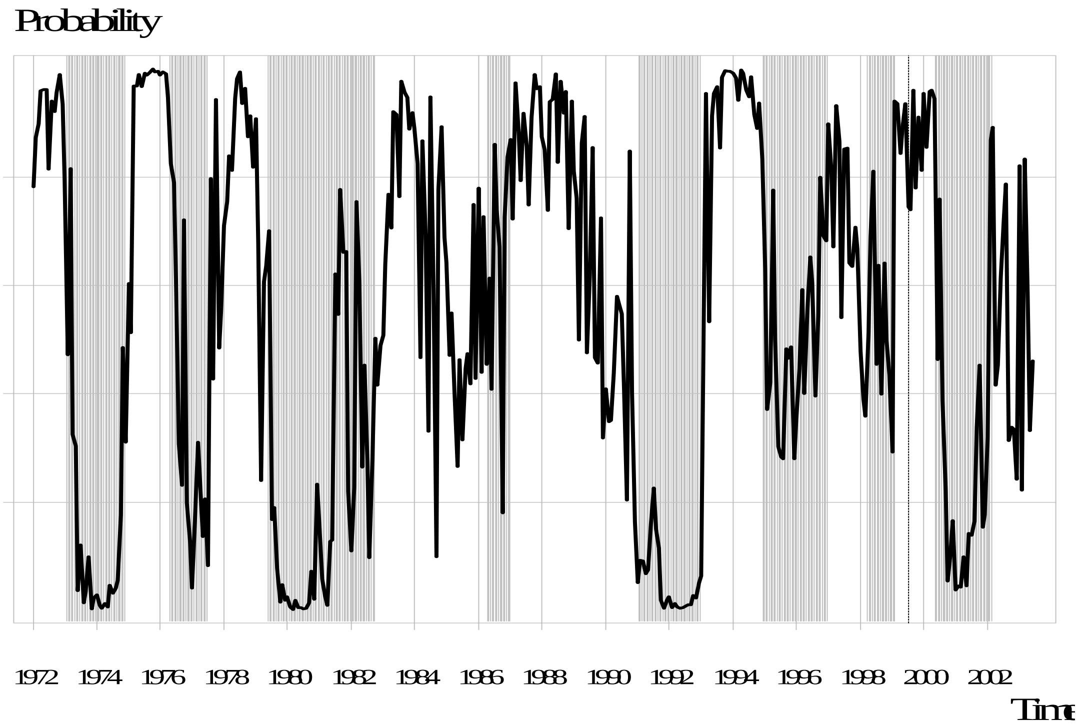
Note: Shaded periods are growth cycle recessions as dated by ECRI.

Figure 2. Expansion Probabilities for Germany

Domestic Model



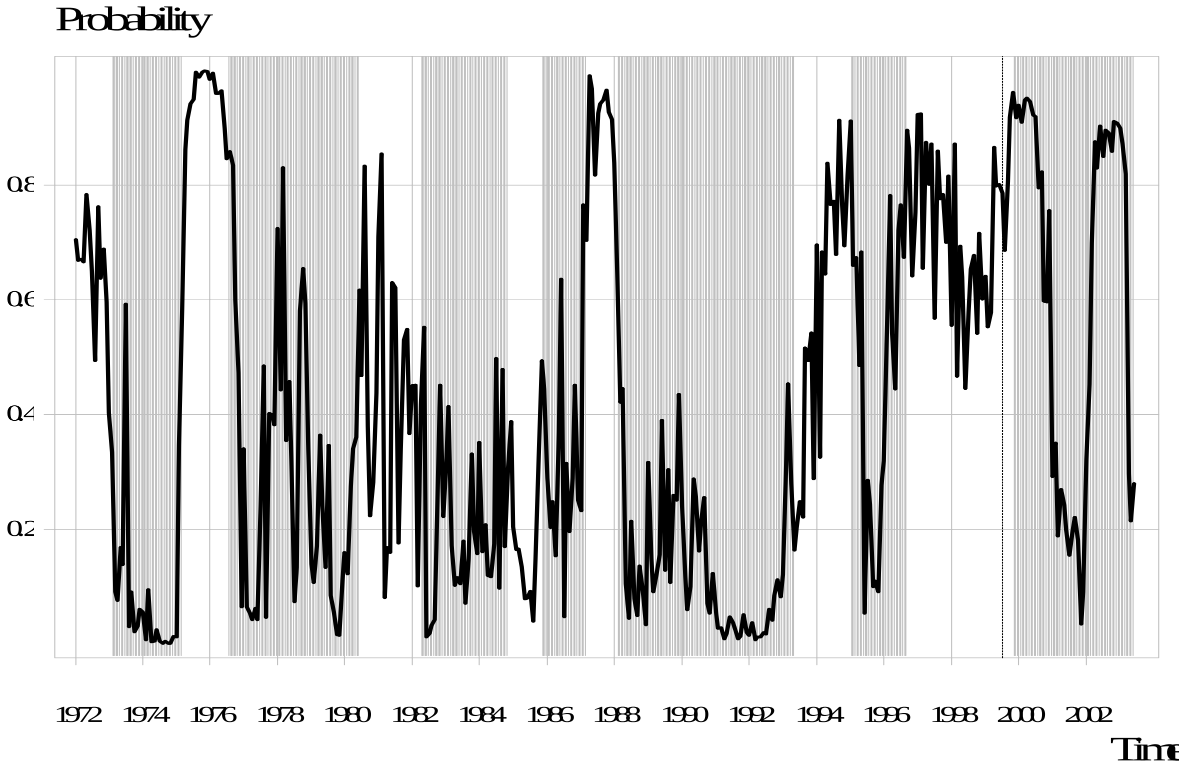
International Model



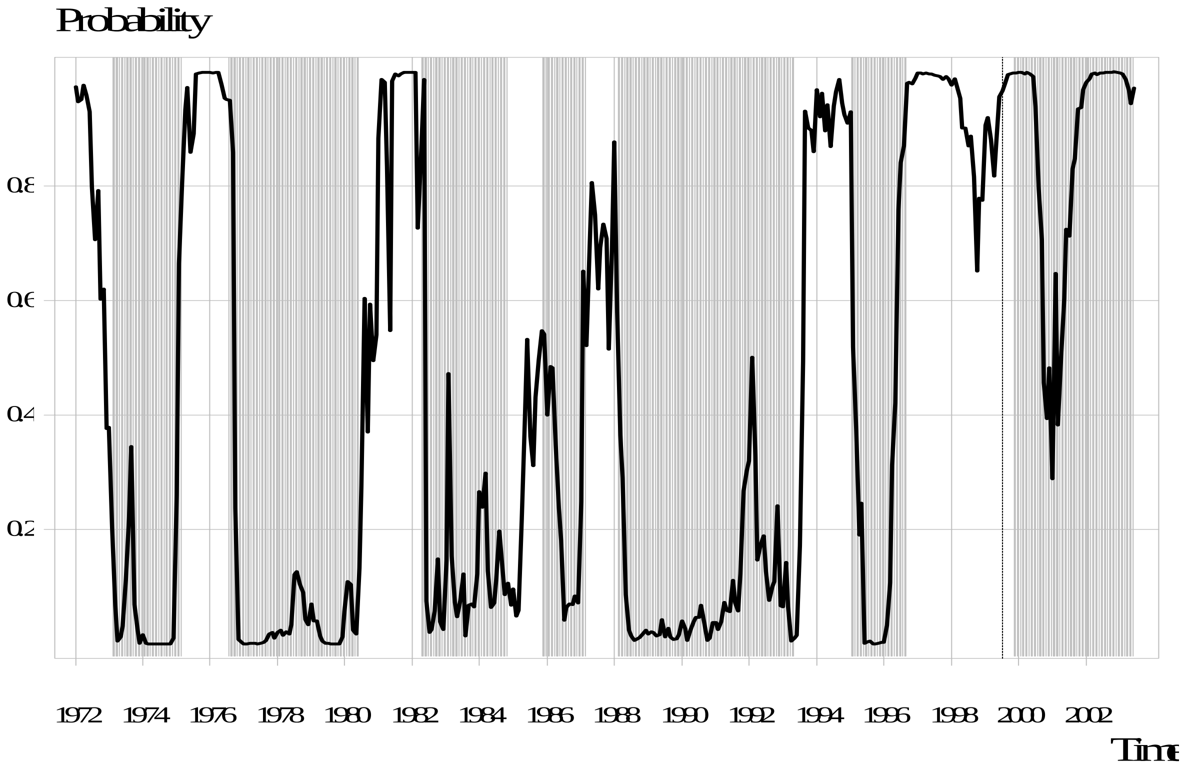
Notes: Shaded periods are growth cycle recessions for Germany as dated by ECRI. The values shown are estimated probabilities of expansion in month *t*, calculated using information to month *t-3* using the models of Table 2.

Figure 3. Expansion Probabilities for France

Domestic Model



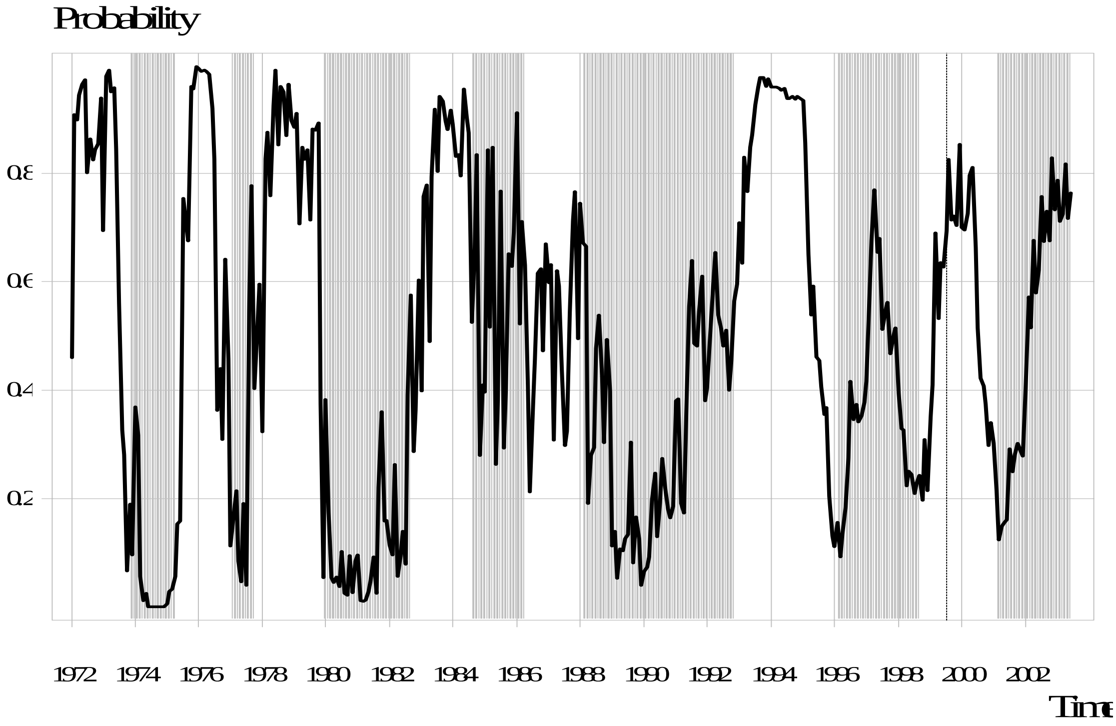
International Model



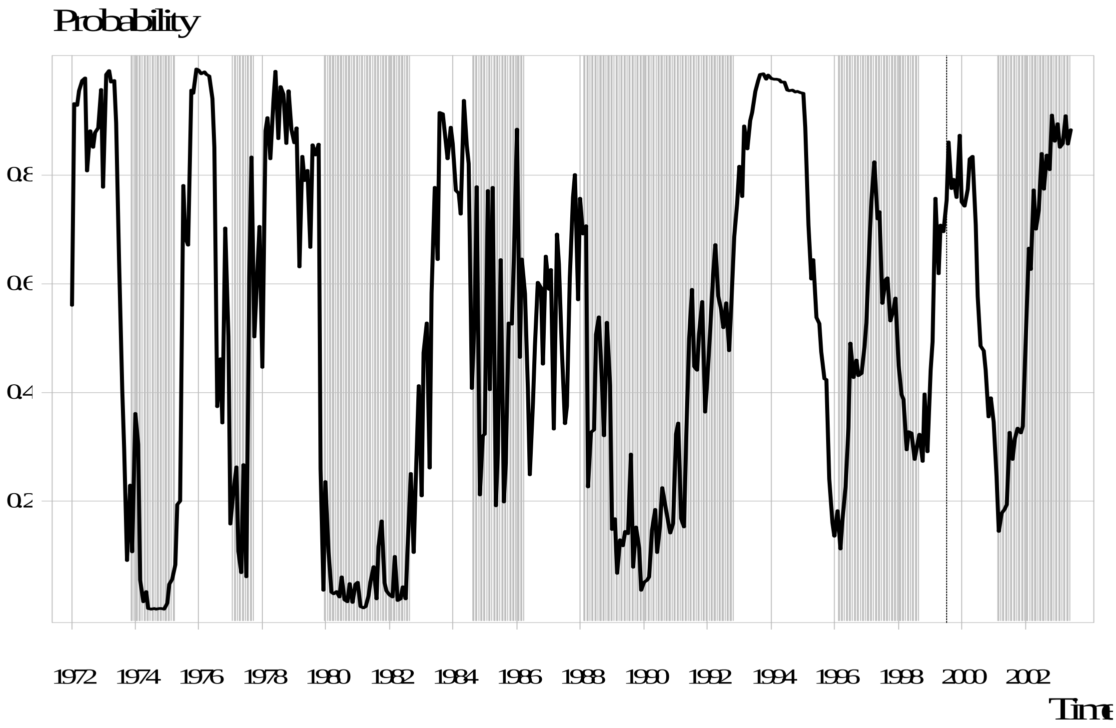
Notes: Shaded periods are growth cycle recessions for France as dated by ECRI. The values shown are estimated probabilities of expansion in month *t*, calculated using information to month *t-3* using the models of Table 3.

Figure 4. Expansion Probabilities for Italy

Domestic Model



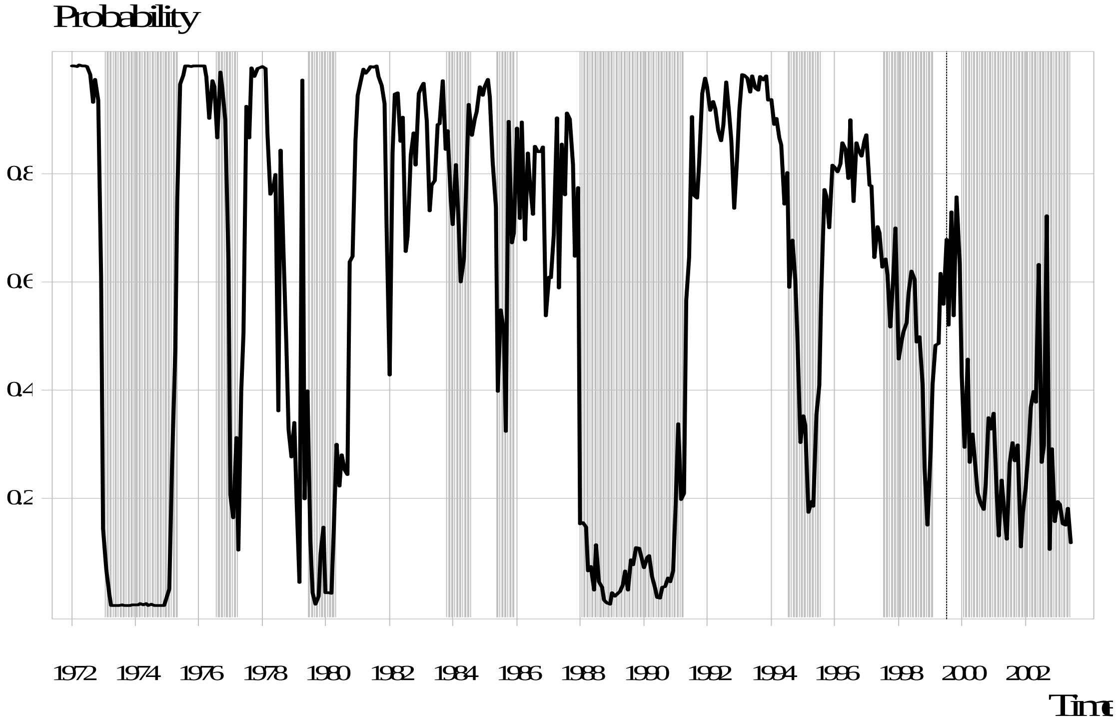
International Model



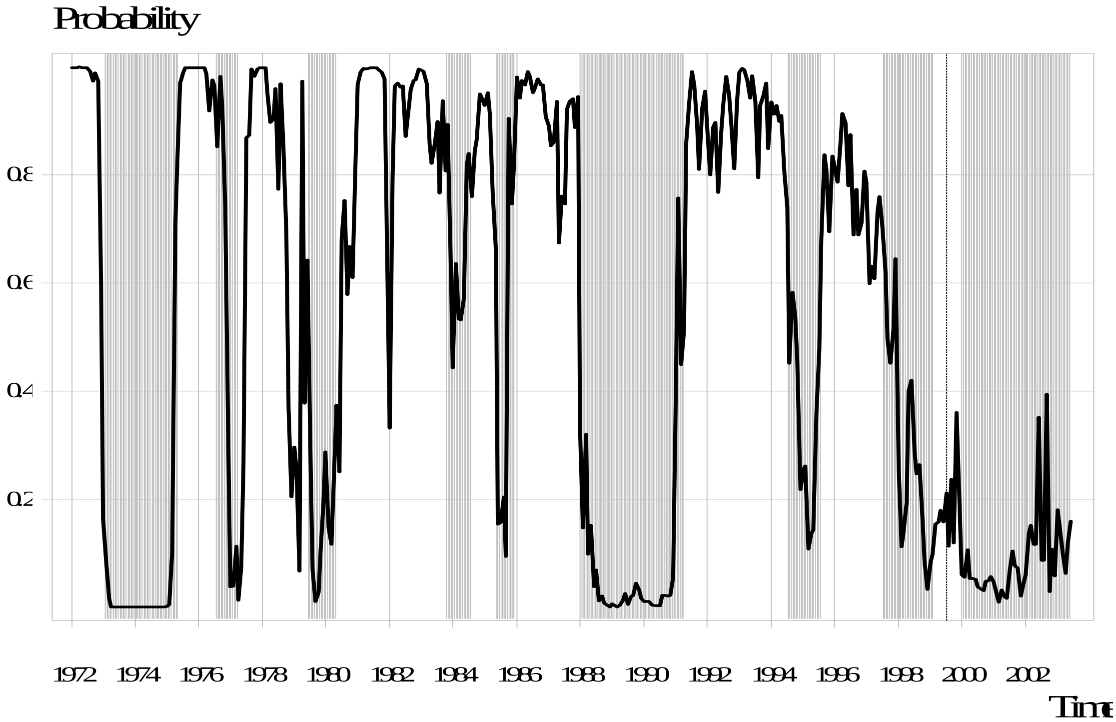
Notes: Shaded periods are growth cycle recessions for Italy as dated by ECRI. The values shown are estimated probabilities of expansion in month *t*, calculated using information to month *t-3* using the models of Table 4.

Figure 5. Expansion Probabilities for the UK

Domestic Model



International Model



Notes: Shaded periods are growth cycle recessions for the UK as dated by ECRI. The values shown are estimated probabilities of expansion in month *t*, calculated using information to month *t-3* using the models of Table 5.

Data Appendix

Table A.1: International Data

Description	**Source**	**Code**	**Transformation**
US composite leading indicator (amplitude adjusted)	OECD		None
US short interest rate (Treasury Bill Secondary Market Rate On Discount Basis-3 Month)	Datastream	USTRB3AV	None
E15 aggregate composite leading indicator (amplitude adjusted)	OECD		None
Euro-Zone aggregate composite leading indicator (amplitude adjusted)	OECD		None

Note: All composite leading indicators were obtained directly from the OECD.

Table A.2: German Data

Variable	**Source**	**Code**	**Transformation**
Industrial Production (excluding construction, volume index, seasonally adjusted)	Datastream	BDOCIPRDG	HP detrended (log series)
Retail Sales, volume index, SA	Datastream	BDOCRSALG	Difference of log
M1 Money Supply (Current prices, seasonally adjusted)	Datastream	BDM1C...B	
Consumer Price Index, all items	Datastream	BDCONPRCF	
Real M1 (M1 deflated by consumer price index)			Difference of log
Stock market prices (Index, DAX, end of period)	Datastream	BDSHRPRCF	Difference of log
Short interest rate (Frankfurt inter-bank offered rate, FIBOR, 3 Month, monthly average)	Datastream	BDINTER3	None
Long interest rate (Long Term Government Bond Yield, 9-10 Years Maturity)	Datastream	BDGBOND.	None
Exchange rate (US$ to German Mark, monthly average)	Datastream	BDXRUSD.	Difference of log)

Notes: HP detrended industrial production is used to measure the output gap. The series for German M1 has a break at re-unification in 1990m6. A series is created for M1 that takes account of the break.

Table A.3: French Data

Variable	Source	Code	Transformation
Industrial Production (excluding construction, volume index, seasonally adjusted)	Datastream	FROCIPRDG	HP detrended (log series)
Retail Sales (major outlets, index, seasonally adjusted)	Datastream	FROCRSLGE	Difference of log
Monetary Aggregate M1 (seasonally adjusted)	OECD	discontinued	
M1 Money Supply (French contribution to Euro Area M1, Current prices)	Datastream	FRM1....A	
Consumer price index	Datastream	FRCONPRCF	
Real M1 (M1 deflated by consumer price index)			Difference of log
Stock market prices (SBF 250)	Datastream	FRSHRPRCF	Difference of log
Short interest rate (PIBOR/ EURIBOR - 3-month, monthly average)	Datastream	FRINTER3	None
Long interest rate (Government Guaranteed Bond Yield, end of period)	Datastream	FRGBOND.	None
Exchange rate (US$ to French Franc)	Datastream	FRXRUSD.	Difference of log

Note: HP detrended industrial production is used to measure the output gap. The only available series available for French M1 after the introduction of the Euro in 1999 is a series that is not seasonally adjusted. The previously available M1 series is extended by adding the annual difference of the Euro M1 series to the natural log of the old series and taking the exponent.

Table A.4: Italian Data

Description	Source	Code	Transformation
Industrial Production (excluding construction, volume index, seasonally adjusted)	Datastream	ITOCIPRDG	HP detrended (log series)
Retail Sales(major outlets, index, seasonally adjusted)	Datastream	ITOCRSALG	Difference of log
M1 Monetary Aggregate (seasonally adjusted)	OECD	discontinued	
M1 Money Supply (Italian contribution to Euro Area M1, Current prices)	Datastream	ITM1....A	
Consumer price index (including Tobacco)	Datastream	ITCONPRCF	
Real M1 (M1 deflated by consumer price index)			Difference of log
Stock market prices (Milan Comit General share price index, end of period)	Datastream	ITSHRPRCF	Difference of log
Short interest rate (Interbank Deposit Rate-average on 3-Months Deposits)	Datastream	ITINTER3	None
Long interest rate (Treasury Bond Net Yield - Secondary Market, end of period)	Datastream	ITGBOND.	None
Exchange rate (US$ to Italian Lire)	Datastream	ITXRUSD.	Difference of log

Note: HP detrended industrial production is used to measure the output gap. See the above description for French M,1 as the same procedure was used here.

Table A.5: UK Data

Variable	Source	Code	Transformation
Gross domestic product monthly estimate (see Salazar *et al*., 1997)	NIESR		HP detrended (log series)
Retail Sales (volume index, seasonally adjusted)	Datastream	UKRETTOTG	Difference of log
M0 wide monetary base (Current prices, end of period, seasonally adjusted)	Datastream	UKAVAE..	
Retail Price Index (all items)	Datastream	UKCONPRCF	
Real M0 (M0 deflated by the retail price index)			Difference of log
Stock market prices (FT all share index, end of period)	Datastream	UKFTALL.	Difference of log
Short interest rate (Bank Bill Rate - Discount, 3 Month, seasonally adjusted, monthly average)	Datastream	UK3MTHINE	None
Long interest rate (Gross Redemption Yield on 20 Year Gilts, Period Average)	Datastream	UKAJLX..	None
Exchange rate (US $ to £1)	Datastream	UKXRUSD.	Difference of log

Note: HP detrended monthly GDP is used to measure the output gap.

Table A.6: Outliers Removed

Country	Money	Industrial Production	Retail Sales
Germany	1990m6, 1990m12	1984m6	-
France	1977m12	-	1971m1
Italy	1984m2; 1988m2; 1992m2; 1996m2;	1972m12	-
UK	1971m2-3; 1999m12; 2000m1	-	1975m4, 1979m6

Note: Outliers are identified in the first difference of the log of the series as events beyond 3.5 standard deviations of the mean. These are then removed by linear interpolation from the level of the series.