Focus on: The use of logit and probit models in business cycle analysis

October 2009
INDEX

INTRODUCTION .......................................................................................................................... 5

1 WORKING PAPERS AND ARTICLES ................................................................................. 7

1.1 Anas, J., Billio, M., Ferrara L., and Mazzi, G.L. 2008, “A system for dating and detecting turning points in the euro area”, in The Manchester School, Volume 76, No. 5. .............................. 7


1.5 Camacho, M. and Perez-Quiros, G. 2000, “This is what the US leading indicators lead”, European Central Bank, Working Paper No 27 .............................................................................................................. 9


Selected Readings – October 2009


Selected Readings – October 2009


2 BOOKS

Binary response models, such as logit and probit models, are well known statistical models and are widely used in the empirical statistical literature, in several fields of application. Those models aim at establishing a relationship between one or several explanatory variables and a binary dependent variable. As an output the model delivers a probability of being in one of the two states according to the values of the explanatory variables. In view of the binary structure of the dependent variable, the classical statistical theory on linear modelling does not apply and needs therefore further improvements.

In business cycle analysis, logit and probit models are generally used to assess the probability of being in a given phase of the economic cycle assuming that two regimes are sufficient to describe fluctuations of the cycle. The explanatory variables are chosen among a wide range of financial and macroeconomics time series and the dependent variable, denoted \( r_t \), describes the occurrence of a given phase of the cycle supposed to be represented by the succession of low and high economic activity. For example, a lot of econometric recession predictions are constructed by using a dichotomous logit or probit model. That is, for all \( t \), the dependent time series \( r_t \) takes the value 1 if the economy is in recession, and takes the value 0 otherwise. If the analysis of the growth cycle (deviation to trend) is privileged, then \( r_t = 1 \) if the economy belongs to the low phase of the growth cycle (growth rate below its tendencial growth rate) and \( r_t = 0 \) otherwise (growth rate over its tendencial growth rate).

An important aspect of logit and probit models in business cycle analysis is that the phases of the cycle have to be known \textit{a priori}, before the analysis. Thus, the practitioner has to identify the turning points of the cycle along the sample path, that is the dates where there is a switch between phases. Generally, the chosen dates are those stemming from reference dating. When dealing with the US business cycle, the reference chronology is given by the National Bureau of Economic Research (NBER). When dealing with the euro area aggregated economic cycles, Eurostat provides with a dating chronology for both business and growth cycles (see Mazzi and Savio, 2007, or Anas et al., 2008). The OECD provides also with a dating of the euro area growth
cycle. The European Cycle Research Institute (ECRI) proposes a dating chronology of the acceleration cycle for the most important European countries, but not for the euro area as a whole. The euro area acceleration cycle is considered for example in Harding (2004) or Darné and Ferrara (2009).

The following list is a non-exhaustive, subjective selection of publications on “the use of logit and probit models in business cycle analysis”.

Contact point: GianLuigi Mazzi, "Responsible for Euro-indicators and statistical methodology", Estat – D5 "Key Indicators for European Policies" gianluigi.mazzi@ec.europa.eu.
1 WORKING PAPERS AND ARTICLES


In the paper we aim to introduce a statistical dating and detection of turning points giving them a first economic interpretation. The main advantage of the proposed approach is represented by the fact that classical and growth cycles are jointly considered both in the dating and in the detecting stage. A key result of this choice is a better description of different economic phases as well as a more accurate investigation of the economic cyclical behaviour. The proposed approach considerably improves the relevance of information delivered to users in comparison with a standard analysis based only on classical or growth cycle component.

*Full text available on-line at:*


No abstract available.

*Available on-line at:*


This paper seeks to elaborate econometric models that can be used to forecast the turning points of the Belgian business cycle. We begin by suggesting three reference cycles, which we hope will fill the void of an official reference chronology for Belgium. We then construct two different types of model to estimate the probabilities of recession: Markov-switching models, and logit models. We apply each approach to a limited set of data, which are a good representation of the economy, are available early and are subject to only minor revisions. We then select the best performing model for each chronology and type of approach. The out-of-sample results show that the models provide useful indicators of business cycle turning points. They are however far from perfect forecasting tools, especially when it comes to forecasting periods of classical recession.

*Full text available on-line at:*


The aim of the present article is to examine the information content of the Italian term spread as for real economic growth rates and recession probabilities and to test its predictive power in forecasting regime probabilities. To this end the relationship between the term spread and economic growth rates is modelled as a nonlinear one and specifically the Logistic Smooth Transition model is used, while a probit model is implemented to forecast recession probabilities. Specific to this article is the use of the OECD business cycle chronology, which was never used before to this end for the Italian case. Overall evidence supports the informative content of the spread in Italy over the whole period (1984-2005) although results are more satisfactory as from
1992. In particular, recession forecasts are generally better than those obtained with other chronologies previously adopted for the Italian case (ISAE and ECRI).

Full text available on-line at:

http://www.informaworld.com/smpp/content~db=all?content=10.1080/0003684070122512


We propose an optimal filter to transform the Conference Board Composite Leading Index (CLI) into recession probabilities in the US economy. We also analyze the CLI's accuracy at anticipating US output growth. We compare the predictive performance of linear, VAR extensions of smooth transition regression and switching regimes, probit, nonparametric models and conclude that a combination of the switching regimes and nonparametric forecasts is the best strategy at predicting both the NBER business cycle schedule and GDP growth. This confirms the usefulness of CLI, even in a real-time analysis.

Full text available on-line at:


We use a probit model of the term structure to examine the stability of recession forecasts under the presence of a structural break. We find strong evidence of a break, but with very uncertain location, which affects considerably recession predictions.

We compare forecasts of recessions using four different specifications of the probit model: a time invariant conditionally independent version; a business cycle specific conditionally independent model; a time invariant probit with autocorrelated errors; and a business cycle specific probit with autocorrelated errors. The more sophisticated versions of the model take into account some of the potential underlying causes of the documented predictive instability of the yield curve. We find strong evidence in favour of the more sophisticated specification, which allows for multiple breakpoints across business cycles and autocorrelation. We also develop a new approach to the construction of real time forecasting of recession probabilities.


This paper examines the predictive content of coincident variables for monitoring U.S. recessions in the presence of instabilities. We propose several specifications of a probit model for classifying phases of the business cycle. We find strong evidence in favour of the ones that allow for the possibility that the economy has experienced recurrent breaks. The recession probabilities of these models provide a clearer classification of the business cycle into expansion and recession periods, and superior performance in the ability to correctly call recessions and to avoid false recession signals. Overall, the sensitivity, specificity, and accuracy of these models are far
superior as well as their ability to timely signal recessions. The results indicate the importance of considering recurrent breaks for monitoring business cycles.

*Full text available on-line at:*

http://mpra.ub.uni-muenchen.de/15097/1/MPRA_paper_15097.pdf


Housing wealth is a large component of total wealth and plays an important role in aggregate business cycles. In this paper, we explore data on real house price cycles at the aggregate level and city level for the United States and Canada. Using a panel of 137 cities, we examine the duration, size, and correlations of housing market cycles in North America. We find that North American housing cycles are long, averaging five years of expansion and four years of contraction, and there is a fairly high degree of correlation in house price cycles between U.S. and Canadian cities. We estimate a discrete time survival model with a probit specification for house price expansions and contractions. This model allows us to test for duration dependence. We find that housing market expansions have positive duration dependence since their exit probabilities increase with duration, while contractions seem to have no duration dependence. Standard determinants of house prices (interest rates, income and population growth) are included as controls.

*Full text available on-line at:*

In addition to quantitative assessment of economic growth using econometric models, business cycle analyses have been proved to be helpful to practitioners in order to assess current economic conditions or to anticipate upcoming fluctuations. In this paper, we focus on the acceleration cycle in the euro area, namely the peaks and troughs of the growth rate which delimitate the slowdown and acceleration phases of the economy. Our aim is twofold: First, we put forward a reference turning point chronology of this cycle on a monthly basis, based on gross domestic product and industrial production index. We consider both euro area aggregate level and country specific cycles for the six main countries of the zone. Second, we come up with a new turning point indicator, based on business surveys carefully watched by central banks and short-term analysts, in order to follow in real-time the fluctuations of the acceleration cycle.

Full text available on-line at:


Although the spread has been established as a leading indicator of economic activity, recent studies on US and EU countries have documented, theoretically and empirically, that the term spread-output growth relationship may not be stable over time and it may be subjected to nonlinearities. Using aggregate data for the Euro area over the period 1970:1 - 2000:4, we applied linear regression as well as nonlinear models to examine the predictive accuracy of the term spread-output growth relationship. Our results confirm the ability of the yield curve as a leading indicator. Moreover, significant nonlinearity with respect to time and past annual growth is detected outperforming the linear model in out-of-sample forecasts of one-year-ahead
annual growth. Furthermore probit models that use the EMU and US yield spreads are successful in predicting EMU recessions.

Full text available on-line at:


This article presents a new type of business-cycle index that allows for cycle-to-cycle comparisons of the depth of recessions within a country, cross-country comparisons of business-cycle correlation and simple aggregation to arrive at a measure of a European business cycle. The paper examines probit-type specifications of binary recession/expansion variables in a Gibbs-sampling framework, wherein it is possible to incorporate time-series features to the model, such as serial correlation, heteroskedasticity and regime switching. The data-augmentation implied by Gibbs sampling generates posterior distributions for a latent coincident business-cycle index and extracts information from indicator variables, such as the slope of the yield curve. Sub-sample correlations between an aggregated `Europe' index and the national business-cycle indices from France, Germany, Italy are consistent with the claim that the European economies are becoming more harmonized over time, but there is no guarantee that this pattern will hold in the future.

Full text available on-line at:


One criticism of VAR forecasting is that macroeconomic variables tend not to behave as linear functions of their own past around business cycle turning points. This article
investigates the methods and efficacy of forecasting with a VAR that expands the information set to include dynamic forecasts of a qualitative variable - business cycle turning points. We apply this Qual VAR model to five of the G7 economies and find that the Qual VAR improves on forecasts from standard models, both for the qualitative variable and for macroeconomic data, such as industrial production. The improvement in the forecasts of the qualitative variable, relative to the standard probit model, is especially pronounced in recessionary periods. (earlier title: Forecasting output with information from business cycle turning points: a qualitative variable VAR).

Full text available on-line at:


Empirical research over the last decade has uncovered predictive relationships between the slope of the yield curve and subsequent real activity and inflation. Some of these relationships are highly significant, but their theoretical motivations suggest that they may not be stable over time. We use recent econometric techniques for break testing to examine whether the empirical relationships are in fact stable. We consider continuous models, which predict either economic growth or inflation, and binary models, which predict either recessions or inflationary pressure. In each case, we draw on evidence from Germany and the United States. Models that predict real activity are somewhat more stable than those that predict inflation, and binary models are more stable than continuous models. The model that predicts recessions is stable over our full sample period in both Germany and the United States.

Full text available on-line at:

http://www.newyorkfed.org/research/staff_reports/sr113.pdf
Since the 1980s, economists have argued that the slope of the yield curve - the spread between long- and short-term interest rates - is a good predictor of future economic activity. While much of the existing research has documented how consistently movements in the curve have signaled past recessions, considerably less attention has been paid to the use of the yield curve as a forecasting tool in real time. This analysis seeks to fill that gap by offering practical guidelines on how best to construct the yield curve indicator and to interpret the measure in real time.

Full text available on-line at:


How predictable was the recent US recession? This paper evaluates the accuracy of several recession prediction models. In particular, traditional rule-of-thumb models using the composite index of leading indicators (CLI), Neftçi's sequential probability model, a probit model, and Stock and Watson's experimental recession indexes are compared. Despite the relatively mild depth of the recession, the models using the CLI performed particularly well. The results are robust across different types of models and with respect to the use of real-time data. The strong real-time performance stands at odds with earlier sceptical claims about the marginal usefulness of the CLI in predicting cyclical turning points, and complements the results in the earlier research of Filardo (1999). At a more conceptual level, the paper provides general support to the classical business cycle view that turning points of business cycles from expansion to recession are complex, possibly endogenous and nonlinear, phenomena. The results also suggest that the impressive insights of Geoffrey Moore into the theory and construction of the CLI will continue to shape our understanding of business cycles well into the future.

In this paper we used a data set constructed for a companion paper (Fritsche/Stephan, 2000) where we explored the leading indicator properties of different time series for the German business cycle. Now we test for the ability of different indicator series to forecast recessions by using a probit approach as proposed by Estrella/Mishkin (1997). The dating procedure refers to the study by Artis et. al. (1997). We took into consideration the criticism made by Dueker (1997) who stated that in the probit model the fact that the economy is already in a state of recession must be controlled for. The results of our estimate are unsatisfactory on the whole. Only the IFO Institute's business expectation of producers of intermediate inputs, the interest rate spread, the long-term interest rate, and money supply M2 show satisfactory leading properties.

Full text available on-line at:

http://129.3.20.41/eps/mac/papers/0012/0012022.pdf


The paper analyses the reasons for departures from strong rationality of German business cycle forecasts based on annual observations from 1963 to 2004. We rely on forecasts from the joint forecast of the so-called "six leading" forecasting institutions in Germany. We test for a non-linear relation between forecast errors and macroeconomic fundamentals and find evidence for such a non-linearity for inflation forecasts. Evidence from probit models further suggests that some macroeconomic
fundamentals - especially monetary factors - correlate to large positive or negative forecast growth and inflation forecast errors.

Full text available on-line at:


Procedures are developed to compute the proportion of turning points located in the sample path of time series data. It is shown that the proportion of turning points can be directly related to the data generating process. Methods for estimating model parameters are developed using counts of turning points. It is shown that the proposed method has the advantages of tractability and robustness. The later feature arises as it does not require that any of the moments of the series Y(t) exist. Tests of model specification are developed using these counts of turning points. These tests are applied to several models one including the issue of whether GDP is better modelled as trend stationary or difference stationary. Monte carlo results are presented for both the estimation and testing procedures.

Full text available on-line at:

http://repec.org/esAUSM04/up.10680.1077839458.pdf


This paper considers the panel probit model with spatial dependency from a Bayesian point of view.

We consider Markov chain Monte Carlo methods to estimate the parameters of the model. Our approach is illustrated with simulated data set. Furthermore, we explore
the spatial interaction of business cycle across 47 prefectures from the period 1991 to 2000 in Japan. Spatial dependency can be found in business cycle in Japan.

Full text available on-line at:


We develop dynamic binary probit models and apply them for predicting U.S. recessions using the interest rate spread as the driving predictor. The new models use lags of the binary response (a recession dummy) to forecast its future values and allow for the potential forecast power of lags of the underlying conditional probability. We show how multiperiod-ahead forecasts are computed iteratively using the same one-period-ahead model. Iterated forecasts that apply specific lags supported by statistical model selection procedures turn out to be more accurate than previously used direct forecasts based on horizon-specific model specifications.

Full text available on-line at:

http://www.mitpressjournals.org/doi/abs/10.1162/rest.90.4.777


This paper examines the significance of widely used leading indicators of the UK economy for predicting the cyclical pattern of commercial real estate performance. The analysis uses monthly capital value data for UK industrials, offices and retail from the Investment Property Databank (IPD). Prospective economic indicators are drawn from three sources namely, the series used by the US Conference Board to construct their UK leading indicator and the series deployed by two private
organisations, Lombard Street Research and NTC Research, to predict UK economic activity. We first identify turning points in the capital value series adopting techniques employed in the classical business cycle literature. Probit models are then estimated using the leading economic indicators as independent variables and forecast the probability of different phases of capital values, that is, periods of declining and rising capital values. The forecast performance of the models is tested and found to be satisfactory. The predictability of lasting directional changes in property performance represents a useful tool for real estate investment decision-making.

*Full text available on-line at:*

http://www.informaworld.com/smpp/content~content=a714022419~db=all


We have evaluated the Commerce Department's Composite Index of Leading Indicators as a predictor of business cycle turning points using the two-state Markov switching model as the filter. Contrary to some recent studies, we found that the predictive performance of CLI is quite good and, with an exception of the 1973:11 peak, it made very little difference to the prediction of turning points whether real-time data are used instead of the revised series. We found, however, that imposing any degree of autoregression in the errors on the simple regime-shift model caused the filter to signal turning points inappropriately. Also, we found no evidence of duration dependence in post-war U.S. business cycles.

*Full text available on-line at:*

http://www3.interscience.wiley.com/journal/113453279/abstract

Three non-linear model specifications are tested for their efficacy in dating and forecasting US business cycles, viz. a probit specification, a logit specification — both binomial and multinomial alternatives — and a Markov, regime-switching specification. The models employ leading indicators compiled by the Economic Cycle Research Institute as putative explanators. They are tested within sample to determine their relative abilities to produce a business cycle chronology similar to the official NBER chronology. They are also tested in a post-sample context to test their relative abilities in anticipating future turning points with the result that the regime-switching model with time-varying transition probabilities performs the best.

Full text available on-line at:
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V92-43K9T25-6&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=951217685&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=243c3c3541bfead2bb76a0163cbf4687


expansions were not. In this paper, we explicitly incorporate the widely-accepted US business cycle phase change dates as determined by the NBER, and use a state-dependent multinomial logit modelling framework. The model incorporates both duration and movements in two leading indexes - one designed to have a short lead (SLI) and the other designed to have a longer lead (LLI) - as potential explanatory variables. We find that doing so suggests that current duration is not only a significant determinant of transition out of recessions, but that there is some evidence that it is also weakly significant in the case of expansions. Furthermore, we find that SLI has more informational content for the termination of recessions whilst LLI does so for expansions.

Full text available on-line at:


Durland and McCurdy (1994) investigated the issue of duration dependence in US business cycle phases using a Markov regime switching approach, introduced by Hamilton (1989) and extended to the case of variable transition parameters by Filardo (1994). In Durland and McCurdy’s model duration alone was used as an explanatory of the transition probabilities. They found that recessions were duration dependent whilst expansions were not. In this paper, we explicitly incorporate the widely-accepted US business cycle phase change dates as determined by the NBER, and use a state-dependent multinomial logit (and probit) modelling framework. The model incorporates both duration and movements in two leading indexes - one designed to have a short lead (SLI) and the other designed to have a longer lead (LLI) - as potential explanators. We find that doing so suggests that current duration is not only a significant determinant of transition out of recessions, but that there is some evidence that it is also weakly significant in the case of expansions. Furthermore, we find that SLI has more informational content for the termination of recessions whilst LLI does so for expansions.

This paper studies the informational content of the slope of the yield curve as a predictor of recessions in the euro area. In particular, the historical predictive power of ten yield spreads, for different segments of the yield curve, is tested using a probit model. The yield spread between the ten-year government bond rate and the three-month interbank rate outperforms all the other spreads in predicting recessions in the euro area. The result is confirmed when the autoregressive series of the state of the economy is added in the same model. The forecast accuracy of the spread between 10-year and 3-month interest rates is explored in an exercise of out-of-sample forecasting. This yield spread appears to contain information which goes beyond the information already available in the history of output, providing further evidence of the potential usefulness of this indicator for monetary policy purposes.

Full text available on-line at:


Leading indicators are a popular way to predict turning points in the business cycle. However, since the lead time of these indicators differ, those with a longer lead could potentially also be used to predict turning points in other leading indicators. This paper empirically explores the viability of using leading indicators to predict the
turning points of an index of commercial shares on the JSE Securities Exchange. Although share prices are leading the business cycle, other leading indicators that lead the business cycle by a longer period should lead share prices and, therefore, could potentially be useful in predicting the direction of share price movements.

The objective of this study is to evaluate and compare the performance of different leading indicators in leading the commercial share price index and in predicting turning points in the commercial share price index. In addition, a multivariate logit model is developed and estimated using these leading indicators in an attempt to improve the accuracy of forecasting the direction of the commercial share index.

Full text available on-line at:

http://www3.interscience.wiley.com/journal/118736847/abstract


Several empirical studies have documented that the signs of excess stock returns are, to some extent, predictable. In this paper, we consider the predictive ability of the binary dependent dynamic probit model in predicting the direction of monthly excess stock returns. The recession forecast obtained from the model for a binary recession indicator appears to be the most useful predictive variable and once it is employed, the sign of the excess return is predictable in-sample. A new dynamic "error correction" probit model proposed in the paper yields the best out-of-sample forecasts with the average trading strategy returns higher than in the buy-and-hold strategy or in the ARMAX models.

Full text available on-line at:

In this paper various financial variables are examined as predictors in new dynamic probit models to predict the probability of a recession in the United States and Germany. Following the findings of previous studies, the domestic term spread proved to be an important predictive variable, but several lagged values of stock returns and the foreign term spread are also statistically significant predictive variables for both countries. The interest rate differential between the U.S. and Germany is also a useful predictor in the case of Germany. Examined dynamic probit models outperform the traditional static model giving accurate out-of-sample forecasts for the latest recession period that began in both countries in 2001.

*Full text available on-line at:*


We propose new bivariate binary time series models to predict the current state of the U.S. business and growth rate cycles. The proposed bivariate autoregressive probit model outperforms the independent univariate models built for both cycle indicators. It is shown that business cycle recessions, and also growth rate cycle recessions can be predicted with financial variables, especially with the changes in the Federal funds rate and stock market returns.

*Full text available on-line at:*

http://www.socialsciences.manchester.ac.uk/cgbcr/conferences/papers/documents/Bivariate_CGBCR_final.pdf

This paper presents a logit model for dating business-cycle turning points. The regressors are monthly series from the Business Cycle Indicators database of the Conference Board. Dividing the sample period into a subset for model initialization (1959/9–1970/12) and a subset for testing (1971/1–2003/12) yields a chronology that is nearly identical to that established by the National Bureau of Economic Research (NBER). However, the recognition lag is less than four months, in contrast to an average of more than eleven months for the official chronology.

Full text available on-line at:

http://www.springerlink.com/content/t0q12g2058873512/fulltext.pdf


The slope of the Treasury yield curve has often been cited as a leading economic indicator, with inversion of the curve being thought of as a harbinger of a recession. In this paper, I consider a number of probit models using the yield curve to forecast recessions. Models that use both the level of the federal funds rate and the term spread give better in-sample fit, and better out-of-sample predictive performance, than models with the term spread alone. There is some evidence that controlling for a term premium proxy as well may also help. I discuss the implications of the current shape of the yield curve in the light of these results, and report results of some tests for structural stability and an evaluation of out-of-sample predictive performance.

Full text available on-line at:

2 Books


This book discusses recent developments in theoretical and empirical business cycle analysis, identifying possible applications of sophisticated tools by private and public institutions involved in the analysis of economic fluctuations and facilitating interaction between academics, researchers and institutions in the area of business cycle. The volume features recent methodological advances in several important areas for business cycle analysis, such as multivariate statistical methods, synchronization and convergence, composite indicators, turning points dating and detection, output gap measurement, as well as innovative applications of the existing theories and methods to the economy of the Euro-zone.

Ordering information at:

http://www.alibris.co.uk/search/books/isbn/9780230007901