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Do probit models help in forecasting turning points in German business cycles?

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Abstract

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.

Kurzfassung

In diesem Artikel wird ein Datensatz benutzt, mit dem auch in einer begleitenden Untersuchung die Frühindikatoreigenschaften verschiedener Reihen für den deutschen Konjunkturzyklus getestet wurden. Um die Fähigkeit, Rezessionen zu prognostizieren, zu testen, wird der von Estrella/Mishkin vorgeschlagene Ansatz benutzt. Für die Einteilung der Konjunkturphasen wurde auf Artis et. al. (1997) zurückgegriffen. Der Einwand von Dueker (1997), dass es wichtig ist, zu kontrollieren, ob die Wirtschaft sich schon in einer Rezession befindet, wurde berücksichtigt. Die Resultate der Schätzung sind insgesamt unbefriedigend. Nur die Ifo-Geschäftserwartungen von Vorleistungsgüterproduzenten, die Zinsdifferenz, die langfristigen Zinsen sowie die Geldmenge M2 zeigen befriedigende Vorlaufeigenschaften.

Descriptors: business cycle, probit model, modified McFadden's R^2, recession

JEL Classification: E 32, L 60, L 70

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Introduction

In a companion paper[1] business cycles' leading indicators for Germany were assessed according to specific requirements.

Therefore a reliable leading indicator should possess the following properties: (1) movements in the indicator series should resemble those in the business cycle reference series; (2) the relationship between the reference series and the indicator should be statistically significant and stable over time; (3) the inclusion of the indicator in out-of-sample forecasting procedures should improve the predictive power (compared to a "naive" prognosis).

Unfortunately the first paper did not give an answer to an important unmentioned fourth question of forecasting turning points, especially recessions. This is of very practical importance because in most cases, forecasters did not forecast recessions. There are two main reasons for this: first, most collections of "stylised facts" from business cycle research mention that recessions happen suddenly and unexpectedly and are characterised by a sudden decrease in the level of economic activity.[2] This seems to be quite difficult to measure. Second, most forecasters hesitate in forecasting recessions because they do not want to be blamed for creating some kind of self-fulfilling panic. The mixed quality of forecasting by the German research institutes and the joint diagnosis can be partly explained by missing the turning points of the cycle (which in turn leads to wrong annual growth rates for important variables, as figure 1 shows).[3]

The figure shows that missing the turning point (t-1 instead of t, called second scenario instead of first scenario in the figure) leads to a completely different average growth rate. This is of great practical importance because the users of professional forecasts such as stock traders, for example, quite often notice only the annual growth rate of GDP (which in fact is a result of the business cycle movement). Missing the turning points therefore biases the forecast and has negative consequences for the reputation of the forecasting institution.

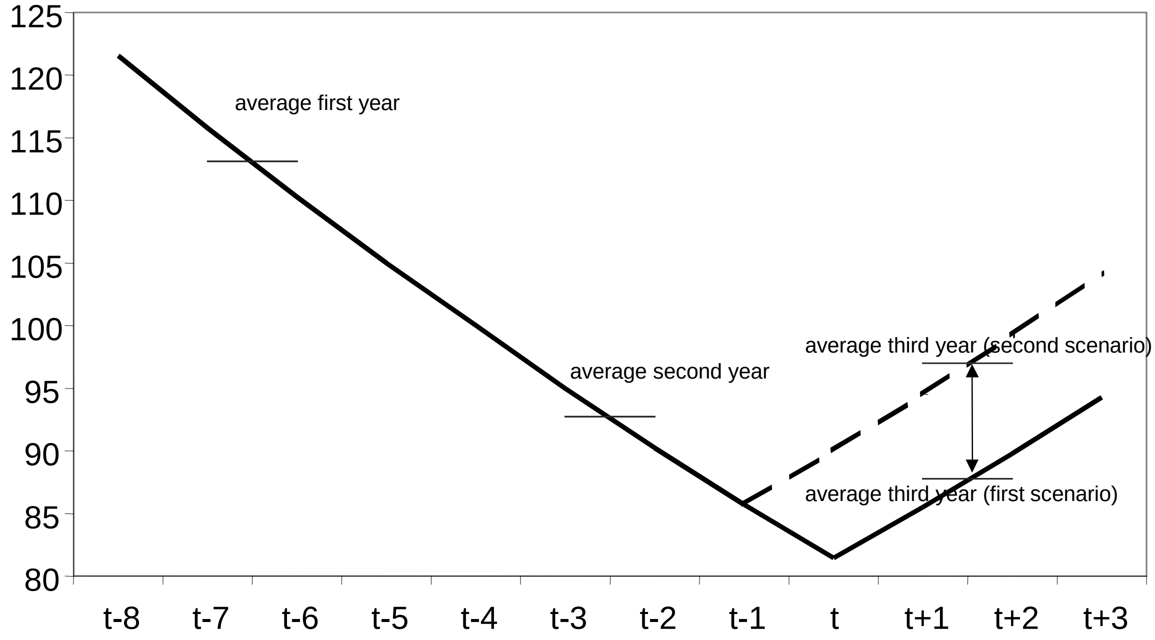
[1] Cf. Fritsche/Stephan (2000).

[2] Cf. Tichy (1994).

[3] Cf. Döpke/ Langfeldt (1994).

Figure 1

Turning Points and Annual Growth Rates



In the traditional approaches to investigation of the properties of indicators, research concentrates on behaviour over the whole cycle. To test for turning points, binary approaches have to be used. Therefore, during the last several years, probit models have been attracting attention. This is especially true of the approach developed by Estrella and Mishkin.[4]

What is Estrella/Mishkin's research program?

First a binary time series for recession/boom periods has to be constructed. There is some degree of freedom in how to date the beginning of the events. Second, indicator variables have to be regressed at different lags on the binary time series and a measure has to be estimated comparable to the well-known R^2 for each lag structure [a version of McFaddens R^2 as proposed by Estrella (1998)]. The possible local maximum on the x-axis of this measure (lags of indicator) can be interpreted as sign of the highest probability of forecasting a turning point.

Unfortunately the original approach – as proposed by Estrella and Mishkin – does not take into consideration the inherent information in the binary time series. Significant autocorellation can bias the information content of the results. Therefore we expanded the original idea – taking into account the papers by Dueker (1997) and Döpke (1999) – to test

[4] Cf. Estrella/Mishkin (1997), Döpke (1999), Bernard/Gerlach (1996).

whether or not there is further information in the lagged indicator which goes beyond the information inherent in the binary time series.

Data and Properties

To guarantee the comparability with the companion paper, we have used mainly the same data set here.[5] There are several reasons for our choice of indicators. One group, the order inflows, was chosen on the grounds of production technology, since on the macroeconomic (aggregate) level we expect a relatively stable relationship between the inflow of orders and production. The choice of other indicators is justified by the fact that these indicators contain information about market expectations. Furthermore, we included the spread between government bond yields (assumed to carry no risk) and private bond yields (which can reflect uncertainty regarding future economic activity).[6] This measure should provide information on confidence in the economy. For a number of indicators, namely the ifo indicators, order inflows and production indices, we have used indicators which refer to the manufacturing industry, to producers of investment goods and to producers of intermediate inputs. This reflects the idea that some sectors of the economy are leading or lagging compared with the overall business cycle. The use of monetary indicators can be justified in several ways. On the one hand, some business cycle theories emphasise the role of monetary developments in determining business cycle movements. In particular, this is the case in so-called "monetary over-production theories".[7] The argument that monetary developments influence business cycle movements can likewise be applied to the role of interest rates in determining economic decisions (for instance investment decisions) - especially in Keynesian business cycle theories. On the other hand, it can be assumed that all monetary indicators reflect expectations regarding the future path of economic activity.[8]

Because most time series under investigation are not stationary in levels – tested by Augmented Dickey-Fuller (ADF)-tests – these time series were transformed into annual growth rates. This simple kind of detrending eliminates a lot of variance at high frequencies.[9] Tests of stationarity of the transformed time series showed that the annual growth rates are stationary at least at the ten per cent significance level. Nominal credit supply was excluded from further analysis because the annual growth rate remained I(1). An overview of the time series under investigation can be found in the appendix (table 1).

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[5] Cf. Fritsche/Stephan (2000).

[6] We calculated the difference between the *Umlaufsrendite öffentlicher Anleihen* and the *Umlaufsrendite der Industrieobligationen*, cf. Friedman/Kuttner (1992) for theoretical arguments.

[7] Cf. Hayek (1931), Haberler (1948[2]).

[8] For the monetary aggregate indicators we calculated "real" monetary aggregates, taking the contemporary consumer price index as the deflator.

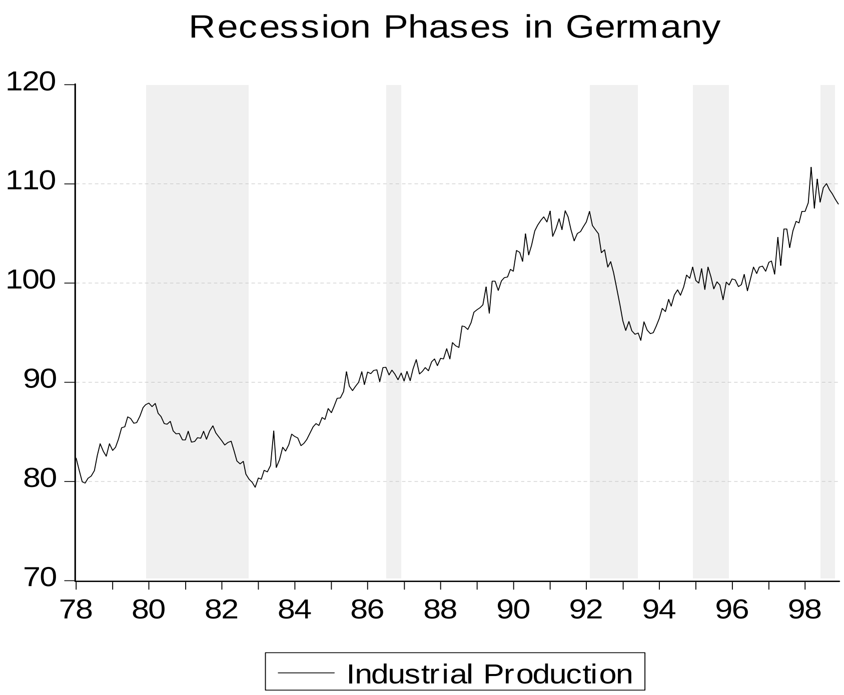
[9] Cf. Wolters/Kuhbier/Buscher (1980).

Dating Recessions

The dating of recession periods is not invariant against the used method. The often-used detrending procedures have major theoretical and practical weaknesses.[10] We decided to use a procedure developed by Artis et.al. (1997) to specify the recession periods. This procedure has its drawbacks as well, but was used for other studies for G-7 countries and the results are therefore easily comparable.[11] The idea behind the procedure goes back to the NBER approach to dating business cycles.[12] The reference series is industrial production as in the other tests in our companion paper. After determination and elimination of extreme values, possible turning points (points lower or higher, 12 months forward or backward) in a seven-month moving average were compared with those of the original series. To be qualified as a turning point, some conditions have to be met.[13]

This produces the following picture (shaded areas show the recessions).

Figure 2



Visually, the dating procedure seems to fit downswings in the reference cycle as used in the companion paper quite well.

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[10] From a methodological point of view, detrending procedures are based on strong assumptions about the data-generating process and the kind of association between trend and fluctuations; from a practical point of view the generated trends and business cycle components often miss some "stylised facts" such as the often-cited business cycle asymmetry. Cf. Canova (1998a,b); Tichy (1994).

[11] Cf. Bernard/Gerlach (1996).

[12] Burns/Mitchell (1947), Stock/Watson (1989).

[13] Cf. Artis et.al (1997).

Methodological Approach

Following Estrella and Mishkin, we constructed a binary time series where the value one stands for recession periods and the value zero for non-recession.

$$\text{Recession}_t = R_t = \begin{cases} 1 \text{ if the economy is in a recession} \\ 0 \text{ else} \end{cases}$$

Then we estimated a probit equation and explained the probability of the binary variable by lagged indicator variables.

Model (1) $$\Pr ob(R_t = 1) = \Phi(\beta_0 + \beta_1 I_{t-k})$$

Estrella (1998) proposed a modified McFadden's Pseudo-R^2 for the test of how well (and at which lag) an indicator can predict recessions.[14]

$$\text{Pseudo}-R^2 = 1 - \left[\frac{L_u}{L_c}\right]^{-\left(\frac{2}{n}\right)L_c}$$

where L_u...unconstrained Log-Likelihood (of the above mentioned function)
L_c...constrained Log-Likelihood ($\beta_1 = 0$)
n...number of observations

The unconstrained Log-Likelihood is a calculated by a regression on the constant. The local maximum of the modified McFaddens R^2 is interpreted as the lead of the indicator.

The main shortcoming of this approach – as mentioned by Dueker and Döpke in their papers – is the fact that the traditional probit estimation can be mis-specified if there is information content in the autocorrelation structure of the binary time series. Or, as Dueker described it, *"...it is implausible to assume that the conditional mean of u_t is zero without reference to whether the economy has actually been in recession in recent periods."* (Dueker 1997: 45). In traditional time series approaches we fix this problem by taking into account an autoregressive moving average filter. Here we had to use another technique.

Therefore we expanded the approach and specified the equation as equation 2:

Model (2) $$\Pr ob(R_t = 1) = \Phi(\beta_0 + \beta_1 I_{t-k} + \beta_2 R_{t-k})$$

The pseudo R^2 is now calculated in the same manner as explained above with the exception that now the unrestricted (first) model yields L_u. The restricted model with $\beta_1 = 0$ yields L_c. So we tested for the information content which *goes beyond* that information already contained in the autoregressive structure of the binary time series at the moment when the indicator gave a signal.

[14] The original McFaddens R^2 is defined as $1-L_u/L_c$. The version proposed in Estrella (1998) furthermore adjusts for the number of regressors.

Results

The results are shown in the appendix; the model 1 is shown by the thick line, model 2 by a thin line. Note that the R^2-measures are not directly comparable because for the R^2 in the second model the first model gives the unconstrained Log-Likelihood. This is why the R^2 for model two captures *only* the information content which goes beyond the information given by model one (and can therefore be expected to be lower). However, to save space we put both graphs together.

To be honest, the results are not at all satisfactory. Only some indicators showed a local maximum – which indicates leading indicator properties for turning points. This is true for ifo business expectations of producers of intermediate input (lead: three months), for the long-term nominal interest rate (lead: eleven months) or the interest rate spread (lead: four months) as well as for the money base M2 (lead: eleven months). The result for the interest rate spread is in line with the often-cited literature on the forecasting quality based on this measure. The results are confirmed by both models. The value of the modified McFadden's-R^2 is generally lower for the second model. This is not very surprising because we tested for additional information which is not included in the binary time series itself. In the case of the interest rate spread as well as the long-term-interest rate, the lead changed significantly – it is longer for the restricted model (in the case of the ifo business expectations of producers of intermediate input, the second model shows a lead of seven months instead of three months, in case of the interest rate spread, the second model shows a lead of seven months instead of four months).

The overall results for ifo indicators could indicate that they perform better as coincident indicators – which is in line with some tests in our companion paper. They show a local maximum at the border (lag minus one).

Our results show clear limitations of this probit approach. In sum we find no clear evidence that any of the indicators under investigation can be solely used for the purpose of identifying turning points. Furthermore, the research suffers from a lack of observations of recession periods. For US time series, some authors have been able to show better results. On the other hand, our results could indicate that recessions in the past were caused mainly by (mostly unexpectedly) exogenous shocks which later drive the business cycle by different propagation mechanisms. If this is true, business cycle research – and especially the forecast of recessions – will remain an art and not a science.

Literature

Artis, M; Kontolemis, Z; Osborn, D. (1997), Business Cycles for G7 and European Countries In: Journal of Business, Vol. 70, No. 2, pp. 249-279.

Bernard, H.; Gerlach, S. (1996), Does the Term Structure Predict Recessions? The International Evidence, Basel 1996.

Burns, A. F.; Mitchell, W. C. (1946), Measuring Business Cycles, New York.

Canova, F. (1998a), Detrending and Business Cycle Facts. In: Journal of Monetary Economics, Vol. 41, pp. 475-512.

Canova, F. (1998b), Detrending and Business Cycles Facts: A User's Guide. In: Journal of Monetary Economics, Vol. 41, pp. 522-540.

Döpke, J. (1999), Predicting Germany's Recessions with Leading Indicators: Evidence from Probit Models, Kiel.

Döpke, J.; Langfeldt, E. (1995), Zur Qualität von Konjunkturprognosen für Westdeutschland 1976-1994, Kiel.

Dueker, M. (1997), Strengthening the Case for the Yield Curve as a Predictor of U.S. Recessions In: Federal Reserve Bank of St. Louis Review, No. 2, pp. 41-51.

Estrella, A. (1998), A new measure of fit for equations with dichotomous dependent variables, In: Journal of business & economic statistics, Vol. 16 No. 2, pp. 198-205.

Estrella, A.; Mishkin, F. S. (1997), The Predictive Power of the Term Structure of Interest Rates in Europa and the United States: Implications for the European Central Bank. In: European Economic Review, Vol. 41, pp. 1375-1401.

Friedman, B.; Kuttner, K. (1992), Money, Prices, and Interest Rates. In: American Economic Review, Vol. 83, No. 3, pp. 472-492.

Fritsche, U./Stephan, S. (2000), Leading Indicators of German Business Cycles: An Assessment of Properties, Berlin.

Haberler, G. (1948), Prosperität und Depression, 2nd edition, Bern.

Hayek, F. A. (1931), Prices and Production, London.

Stock, J.; Watson, M. (1989), New Indexes of Coincident and Leading Economic Indicators. In: Blanchard, O.; Fischer, St. (eds.), NBER Macroeconomics Annual, Cambridge Mass., pp. 351-394.

Tichy, G. (1994), Konjunktur: Stilisierte Fakten, Theorie, Prognose. Berlin et. al.

Wolters, J.; Kuhbier, P.; Buscher; H. S. (1990), Die konjunkturelle Entwicklung in der Bundesrepublik Deutschland: Ergebnisse von Schätzungen alternativer aggregierter Konjunkturmodelle. Frankfurt.

Appendix:

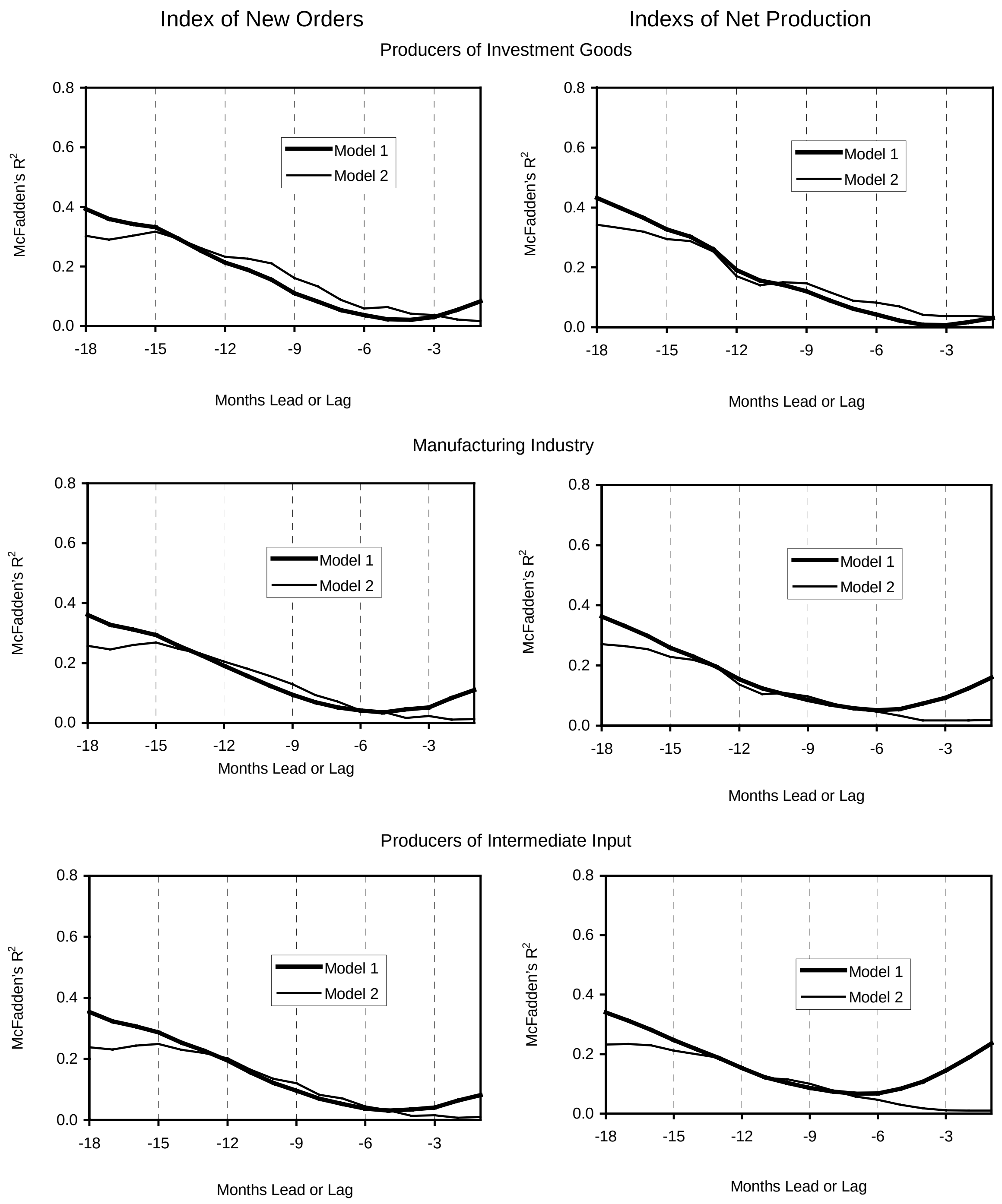
Table 1. Time series properties

Indicator	Integration	Transformation	Source
Index of New Order			
Producers of Investment Goods	I(1)	Annual growth rates[1)]	Eurostat
Manufacturing Industry	I(1)	Annual growth rates	Eurostat
Producers of Intermediate Input	I(1)	Annual growth rates	Eurostat
Index of Net Production			
Producers of Investment Goods	I(1)	Annual growth rates	Eurostat
Manufacturing Industry	I(1)	Annual growth rates	Eurostat
Producers of Intermediate Input	I(1)	Annual growth rates	Eurostat
Ifo Business Expectations			
Producers of Investment Goods	I(0)	Level	Ifo Institute Munich
Manufacturing Industry	I(0)	Level	Ifo Institute Munich
Producers of Intermediate Input	I(0)	Level	Ifo Institute Munich
Ifo Business Climate			
Producers of Investment Goods	I(0)	Level	Ifo Institute Munich
Manufacturing Industry	I(0)	Level	Ifo Institute Munich
Producers of Intermediate Input	I(0)	Level	Ifo Institute Munich
Nominal Money Supply			
M1	I(1)	Annual growth rates	Bundesbank
M2	I(1)	Annual growth rates	Bundesbank
M3	I(1)	Annual growth rates	Bundesbank
M3 enlarged	I(1)	Annual growth rates	Bundesbank
Real Money Supply			
M1	I(1)	Annual growth rates	Bundesbank
M2	I(1)	Annual growth rates	Bundesbank
M3	I(1)	Annual growth rates	Bundesbank
M3 enlarged	I(1)	Annual growth rates	Bundesbank
Real Credit Supply[2)]	I(1)	Annual growth rates	Bundesbank
Short-Term Interest Rate (3 month FIBOR)	I(1)	Annual growth rates	Bundesbank
Long-Term Interest Rate (Umlaufsrendite)	I(1)	Annual growth rates	Bundesbankk
Interest Rate Spread	I(0)	Level	Bundesbank
Real Effective Exchange Rate	I(0)	Level	OECD
Spread between Government and Private Bond Yields	I(0)	Level	Bundesbank
Consumer Sentiment Indicator	I(0)	Level	OECD

1) Annual growth rates = log(x)-log(x(-12)).- 2) Nominal credit supply was excluded from further analysis because the annual growth rate remained I(1).

Figure 3

Modified McFadden's R^2 in Probit Models to Predict German Recessions[1] with ...



[1] Modified McFadden's Pseudo-R-Squared = $1 - (L_u/L_c)^{\wedge}(-(2/n)L_c)$.

Source: Calculations of DIW.

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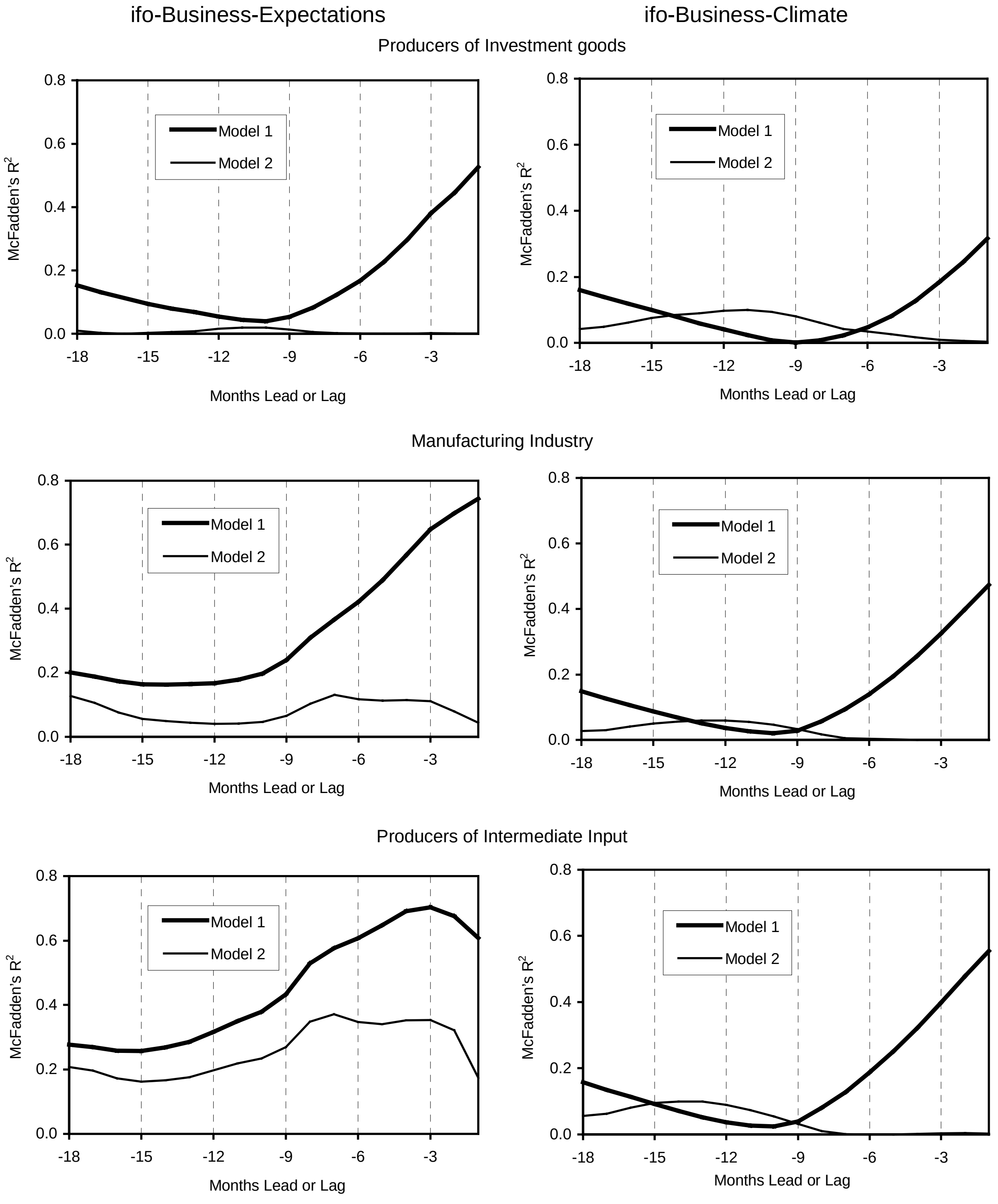
Figure 4

Modified McFadden's R^2 in Probit Models to Predict German Recessions[1)]



[1)] Modified McFadden's Pseudo-R-Squared = $1 - (L_u/L_c)^{\wedge}(-(2/n)L_c)$.

Source: Calculations of DIW.

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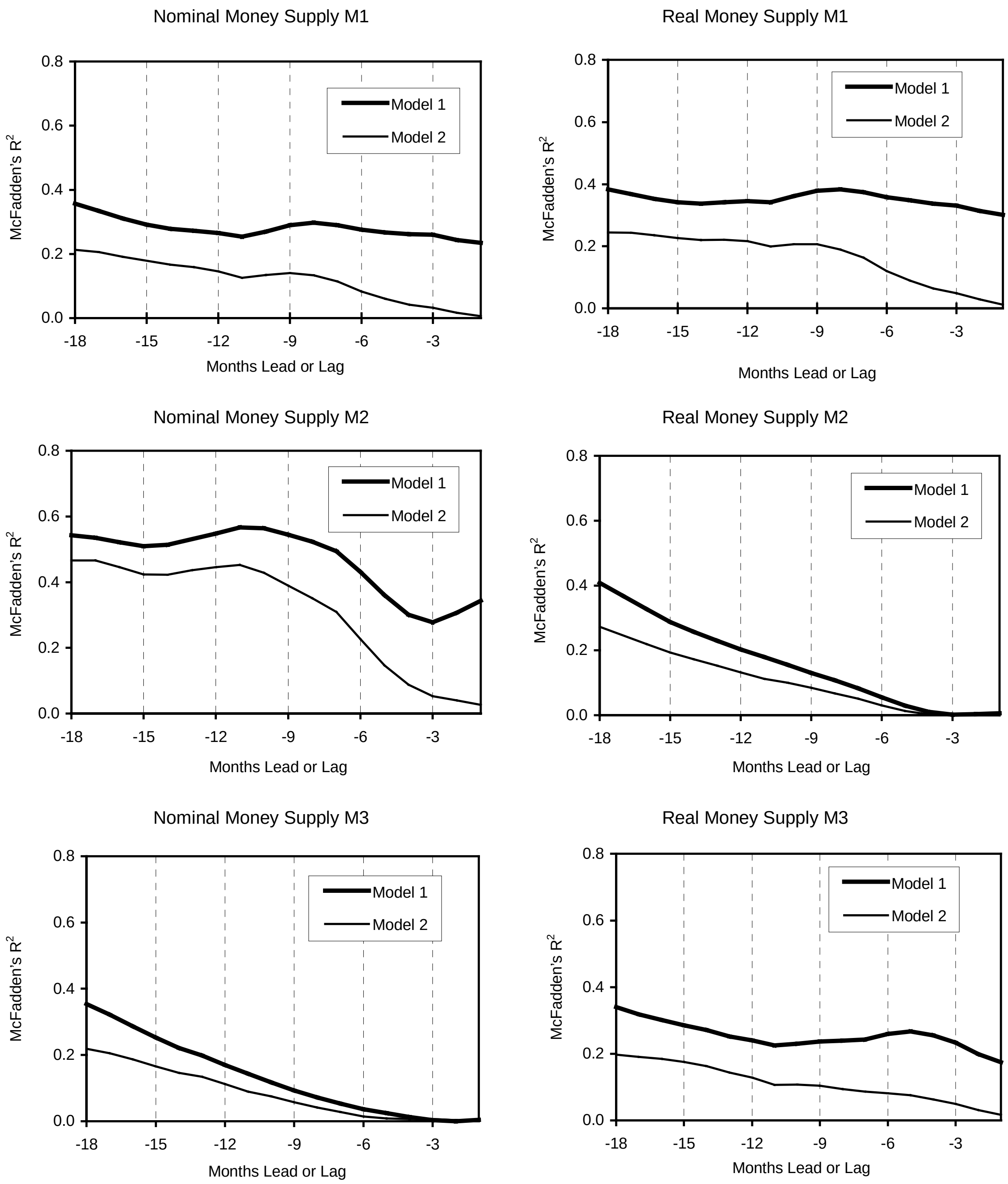
Figure 5

Modified McFadden's R^2 in Probit Models to Predict German Recessions[1)]



[1)] Modified McFadden's Pseudo-R-Squared = 1 - $(L_u/L_c)^{\wedge}(-(2/n)L_c)$.

Source: Calculations of DIW.

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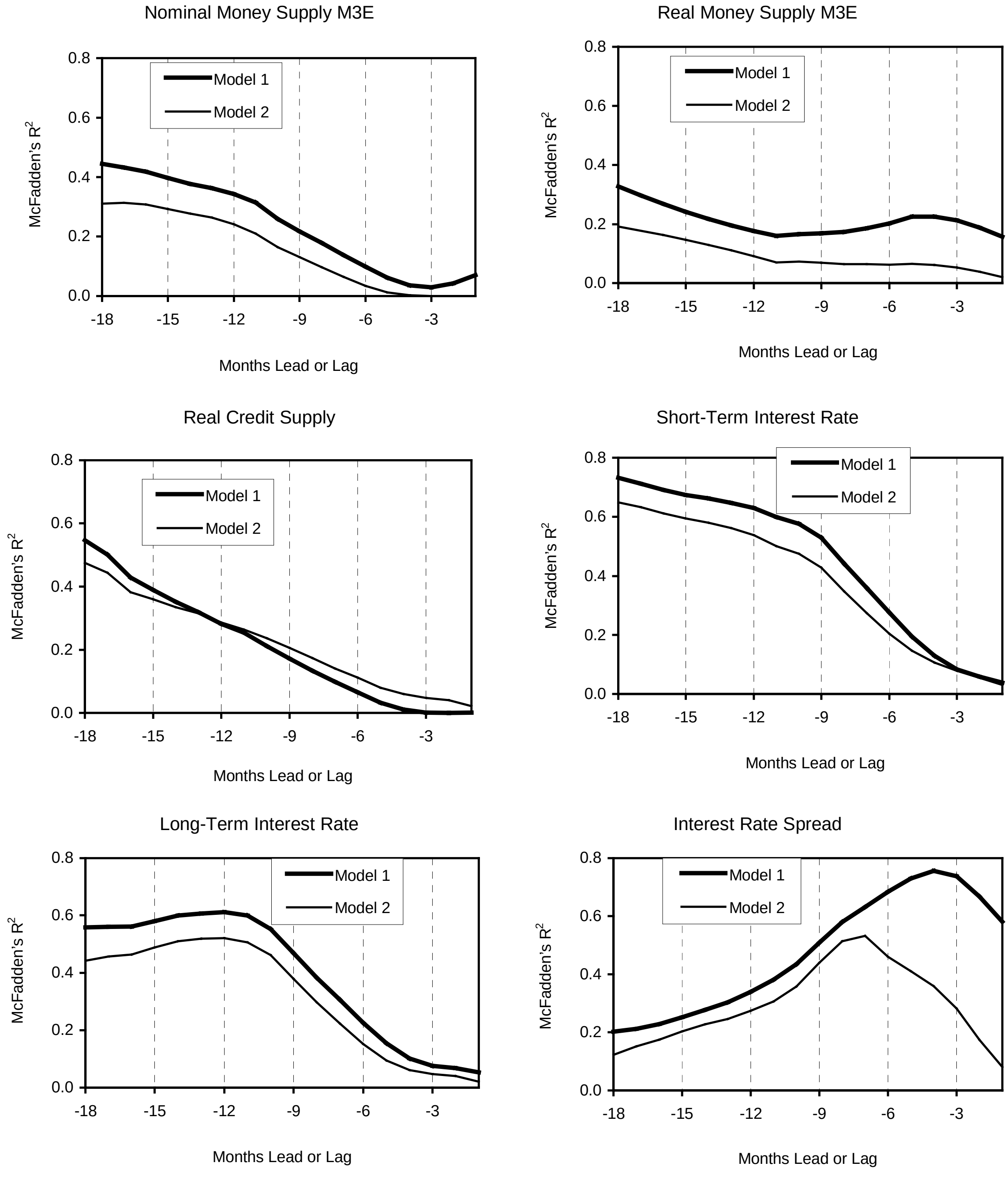
Figure 6

Modified McFadden's R^2 in Probit Models to Predict German Recessions[1)]

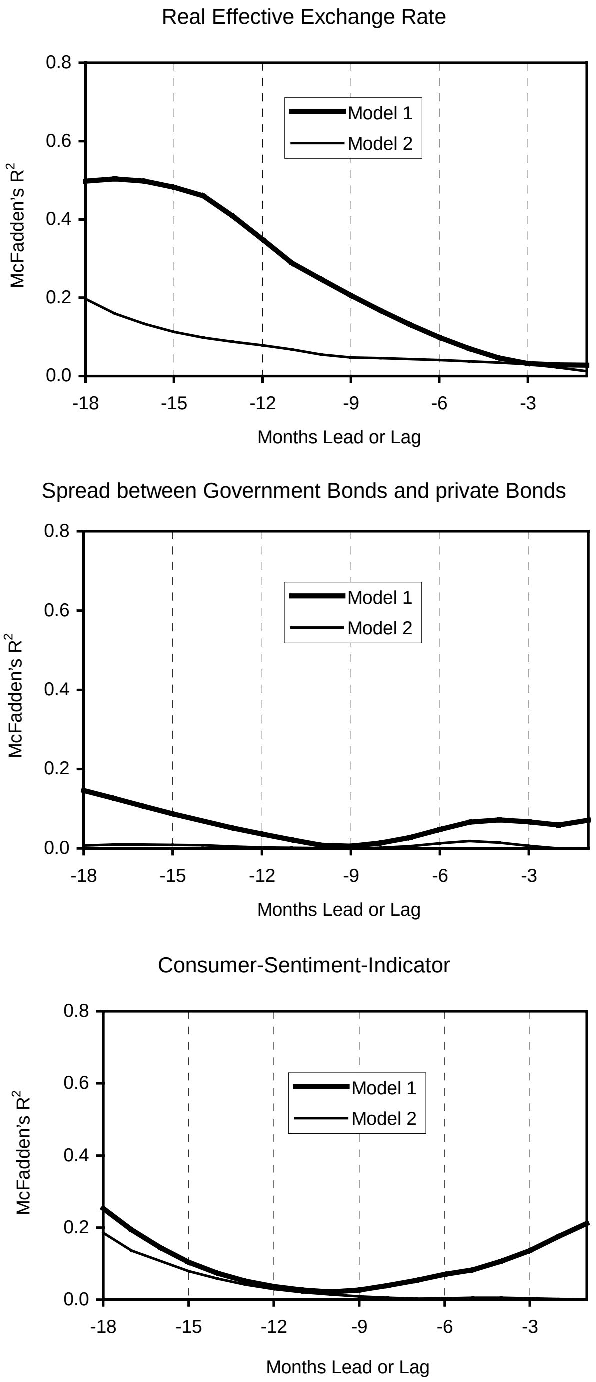


[1)] Modified McFadden's Pseudo-R-Squared = 1 - (L_u/L_c)^(-(2/n)L_c).

Source: Calculations of DIW.

Figure 7

Modified McFadden's R^2 in Probit Models to Predict German Recessions[1)]



1) Modified McFadden's Pseudo-R-Squared = $1 - (L_u/L_c)^\wedge(-(2/n)L_c)$.

Source: Calculations of DIW.

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