

Baumann, Ursel; Gómez Salvador, Ramón; Seitz, Franz

Working Paper

Global recessions and booms: What do probit models tell us?

Weidener Diskussionspapiere, No. 61

Provided in Cooperation with:

University of Applied Sciences Amberg-Weiden (OTH)

Suggested Citation: Baumann, Ursel; Gómez Salvador, Ramón; Seitz, Franz (2018) : Global recessions and booms: What do probit models tell us?, Weidener Diskussionspapiere, No. 61, ISBN 978-3-937804-63-7, Ostbayerische Technische Hochschule Amberg-Weiden (OTH), Weiden i.d.OPf.

This Version is available at:

<http://hdl.handle.net/10419/180214>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



Die Hochschule im Dialog:

Global Recessions and Booms: What do Probit models tell us?

Ursel Baumann
Ramón Gómez Salvador
Franz Seitz

Global Recessions and Booms: What do Probit models tell us?*

Ursel Baumann[§], Ramón Gómez Salvador[‡] & Franz Seitz[†]

June 2018

Abstract

We present non-linear binary Probit models to capture the turning points in global economic activity as well as in advanced and emerging economies from 1980 to 2016. For that purpose, we use four different business cycle dating methods to identify the regimes (upswings, downswings). We find that especially activity-driven variables are important indicators for the turning points. Moreover, we identify similarities and differences between the different regions in this respect.

Deutsche Zusammenfassung:

Das Papier analysiert nicht-lineare binäre Probit-Modelle, um Wendepunkte der Weltkonjunktur sowie in fortgeschrittenen und aufstrebenden Volkswirtschaften von 1980 bis 2016 zu bestimmen. Zur Identifikation der Regime (Auf- und Abschwung), verwenden wir vier verschiedene Konjunkturzyklusbestimmungsmethoden. Als Ergebnis ergibt sich, dass vor allem aktivitätsgetriebene Variablen wichtige Indikatoren der Wendepunkte sind. Die Determinanten der Wendepunkte lassen Unterschiede und Gemeinsamkeiten in den unterschiedlichen Regionen erkennen.

Keywords: Global GDP, Probit, turning points

JEL Classification: C34, C35, E32,

* We thank A. Loukas for excellent research assistance. The opinions expressed in the paper are those of the authors and do not necessarily reflect the views of the ECB. All errors and omissions remain the authors' responsibility.

[§] European Central Bank, Sonnemannstrasse 20, 60314 Frankfurt am Main, Germany; e-mail: ursel.baumann@ecb.europa.eu.

[‡] European Central Bank, Sonnemannstrasse 20, 60314 Frankfurt am Main, Germany; e-mail: ramon.gomezsalvador@ecb.europa.eu.

[†] Weiden Technical University of Applied Sciences, Hetzenrichter Weg 15, D-92637 Weiden, Germany; e-mail: f.seitz@oth-aw.de.

1. Introduction

One of the greatest challenges of empirical business cycle research is the timely detection and modelling of business cycle turning points. In the US and the euro area, there are the Business Cycle Dating Committees of the NBER and the CEPR, respectively, which date the turning points in the dynamics of economic activity. However, at a global level - be it world-wide, advanced economies, emerging market economies - such dating does not exist and the business cycle analysis is quite limited. To detect as well as model the turning points in a global context, we make use of the dynamic and non-linear bivariate Probit models.

Dynamic Probit models estimate a multi-regime variable directly with the help of one or more economic variables (e.g. Haltmaier 2008, Christiansen et al. 2014 for the US, Boysen-Hogrefe 2012 for the euro area, Abberger & Nierhaus 2010 for Germany, Fornari & Lemke 2010 for a set of countries).¹ The application of probit models requires the definition of a binary variable that distinguishes expansions from recessions. There are various ways to specify the upswings and downswings to construct the binary variable. These include simple rules of thumb (e.g., two consecutive declines in quarterly GDP growth as indicative of a recession) or more formal rules like the Bry-Boschan-algorithm (e.g. Harding 2008).

There are only few papers on turning points in global economic activity. Ferrara & Marsilli's (2014) approach builds on a Factor-Augmented Mixed Data Sampling model of various countries and sectors worldwide. Ravazzolo & Vespignani (2015) also concentrate on growth rates and evaluate the quality of world steel production compared to Kilian's index of global economic activity and the index of OECD world industrial production. Stratford (2013) uses *linear* models to investigate several global indicators' ability to nowcast world trade and world GDP. He finds that the indicators are most helpful during periods of large swings in world growth. However, their usefulness fluctuates greatly over time. The only paper which addresses turning points directly and on a global level within a non-linear framework is Camacho & Martinez-Martin (2015). They propose a two-state *Markov-switching* dynamic factor model to produce short-term forecasts of world GDP and to compute business cycle probabilities.

¹ An alternative would be Markov Switching models which define and estimate two or more regimes where the evolution of economic activity is regime-dependent (see, e.g., Hamilton 1989). A comparison of both model types with regard to business cycles may be found in Layton & Katsuura (2001).

Our analysis differs in several aspects from these papers. First, and in contrast to Ferrara & Marsilli (2014), Ravazzolo & Vespignani (2015) and Stratford (2013), we concentrate solely and directly on turning points of global GDP growth. Second, we use Probit models to capture the turning points on a global level. So far, these methods have been predominantly applied to a national level. Third, we use several business cycle turning point dating methods to evaluate the models. Fourth, the indicator variables are included individually, not as factors as in Camacho & Martinez-Martin (2015) and Ferrara & Marsilli (2014).

Our results reveal that lagged GDP growth rates and activity-based variables are the best indicators of upswing and downswing periods. The emerging market economies are the hardest to model. The remainder of the paper is structured as follows. Section 2 describes the independent and dependent variables used. Following this, section 3 introduces the Probit models and presents their results. Section 4 summarises and concludes.

2. Data

We use seasonally-adjusted quarterly data for the sample 1980Q1-2016Q4. World activity is measured by real quarterly world GDP, derived from a PPP-weighted aggregation of national GDP data based on national sources. We also distinguish between real quarterly GDP for advanced economies and emerging economies (see Appendix A for details).

The independent variables considered can be grouped as follows:

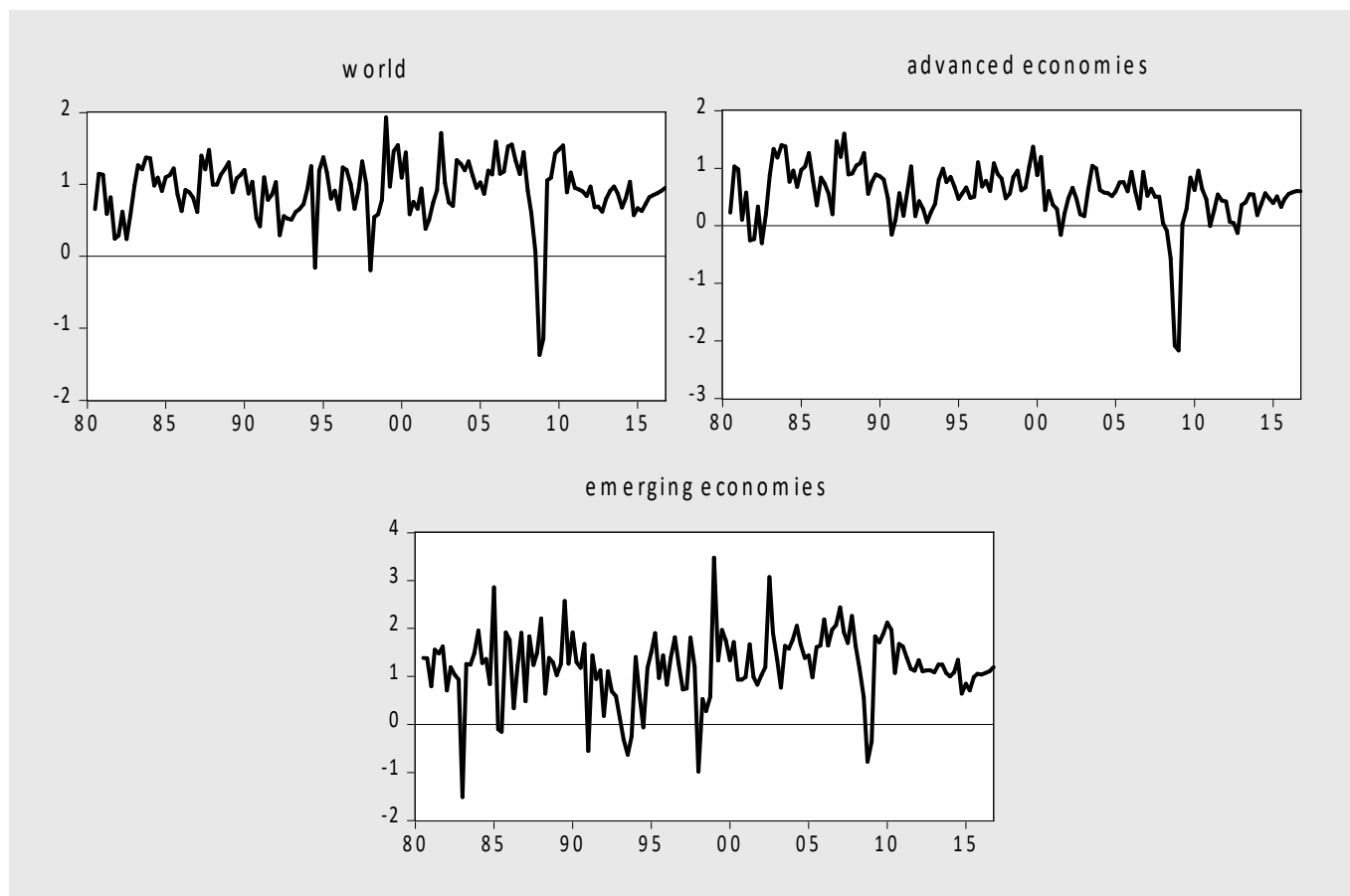
- *Activity data*: industrial production in OECD countries and emerging market economies, world steel production (see Ravazzolo and Vespignani, 2015), the Kilian index of real world economic activity, the Goldman Sachs Global Leading Indicator, the Composite Leading Indicator by the OECD, a global factor derived by Delle Chiaie, Ferrara and Giannone (2017) and the Conference Board US Leading Economic Index.
- *Survey data*: consumer confidence in OECD countries and the US.
- *Financial data*: the US term spread (10years minus 3 month), the US BBB bond spread, S&P500, M1 and M3 for OECD countries.
- *Commodity prices*: oil prices in USD and indices of metal prices and non-oil commodity prices.

The results reported in section 3 concentrate, however, on those independent variables that turned out to be statistically significant in the various specifications selected and in line with economic reasoning.

Chart 1 plots quarterly world, advanced economy and emerging economy real GDP growth from 1980Q1 to 2016Q4. We distinguish two types of periods with different mean growth rates: (i) negative or slightly positive, but low growth rates; (ii) periods of robust growth (either briefly following recessions or on a more prolonged basis). The only common recession in all three country groupings is the great recession 2009 which affected global economies, AEs as well as EMEs, although the latter to a lesser extent.

In what follows, our aim is to use model-based techniques and judgmental approaches to detect these alternative episodes, and thereafter to estimate probabilities of staying in a regime or moving to a different one.

Chart 1: Real GDP – world, advanced and emerging economies
(quarter-on-quarter percentage change)



Sources: IMF, ECB and author's calculations.

3. Probit models

3.1. Methodology

One methodology commonly used to analyse turning points in economic activity is the Probit method. A textbook treatment may be found in Verbeek (2012). Recent business cycle applications are, inter alia, Chauvet & Potter (2010), Christiansen et al. (2014), Nyberg (2014), Fossati (2015), Hsu (2016), and Proaño (2017). In our case, a value of the binary variable of "0 signals a "downswing" whereas the value "1" indicates an "upswing". The objective of the analysis is to assess with what probability the variable changes its value at a specific date.

Formally, the probit method can be represented as follows:

$$(1) \quad P_i = \Pr(Y_i = 1 | X_i, \beta) = \int_{-\infty}^{X_i' \beta} \frac{1}{\sqrt{2\pi}} e^{-0.5u^2} du = \Phi(X_i', \beta),$$

where P_i represents the probability that a specific event (e.g. an upswing) will occur; $\Phi(\cdot)$ is the distribution function of the standard normal distribution (the so-called probit function); u stands for the normally distributed residuals. X_i is the vector of the independent variables, in our analysis specifically the potential variables that explain an upswing or a downswing or, more specifically, a turning point. The β coefficients of the independent variables of this non-linear estimation approach can only be determined by iteration. To estimate these coefficients, we use the Newton-Raphson method with Marquardt steps to obtain parameter estimates. The standard errors are estimated by the inverse of the estimated information matrix. The latter is computed with the help of the observed Hessian.

A precondition for the empirical application of probit models is the specification of the binary variable. As there is neither an official business cycle dating available at the global level nor for advanced or emerging economies as a whole (as, for example, for the US from the NBER), we rely on our own dating. For that purpose, we use four variants in what follows:

- "Acceleration" is defined as 1 if there is an acceleration in year-on-year real GDP growth in at least three out of five quarters (measured on a centred rolling basis), and 0 otherwise (p_yoy),
- "High growth" is 1 in any period if the centred five-quarter moving average quarterly growth rate in real GDP is above the 40th (35th) percentile of the series, and 0 otherwise ($p_pct40(35)$),

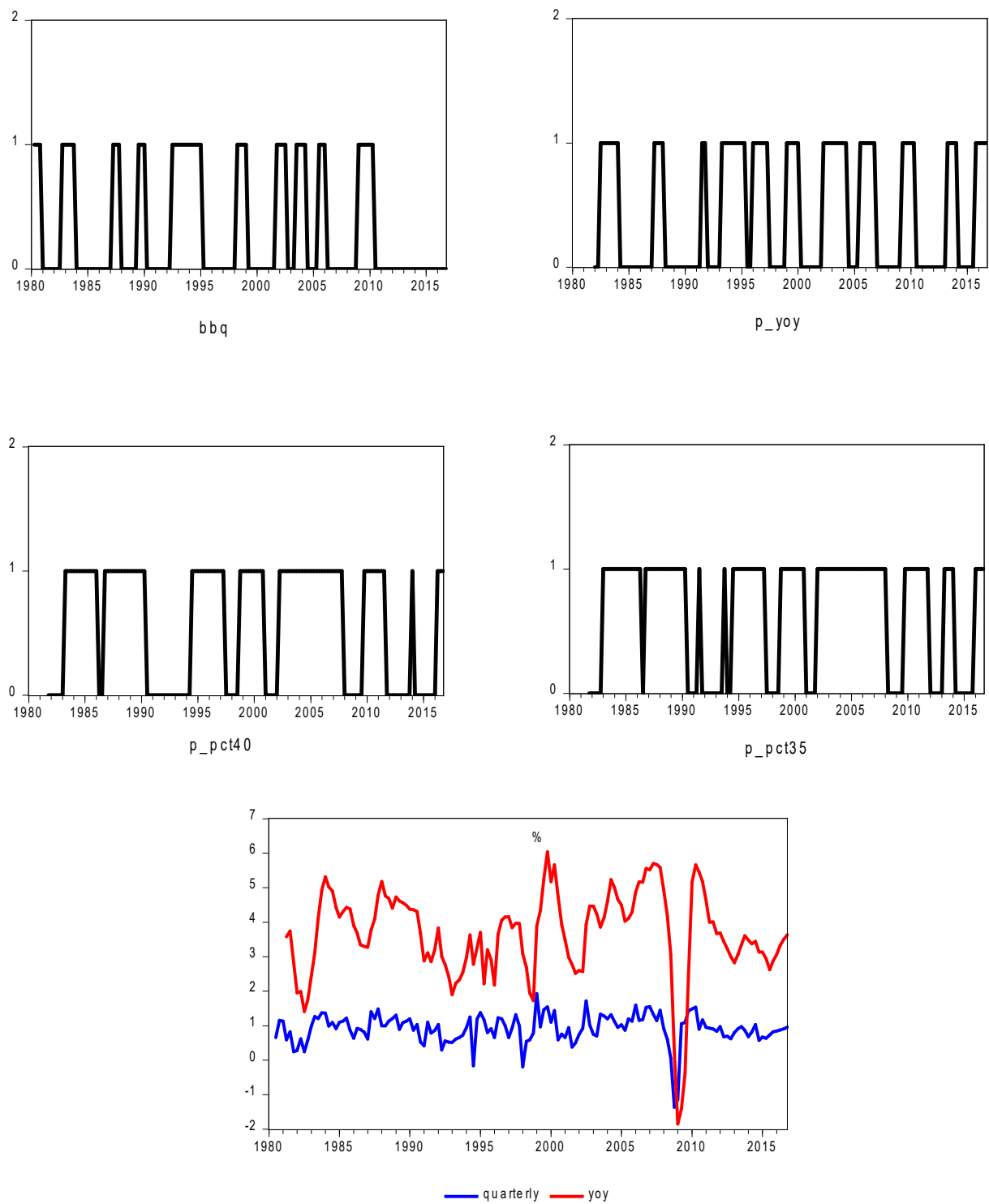
- "Bry/Boschan" is a quarterly analogue to the Bry-Boschan algorithm to detect turning points in time series (*bbq*) (see Bry & Boschan, 1971; Harding & Pagan, 2002). This methodology identifies a turning point by using the definition that a peak happens at time t if $y(t-k), \dots, y(t-k+1) < y(t) > y(t+1), \dots, y(t+k)$, where k is the so-called symmetric window parameter (turnphase). It needs to be set. For quarterly data, usually $k=2$.

Chart 2 shows the four binary variables together with the quarterly and year-over-year growth rates for the world economy. The chart illustrates that all indicators capture the worldwide recession in 2009 quite well. Since then, however, the picture is mixed. Whereas the Bry-Boschan index does not show signs of an upswing, the other three variables indicate some, but no clear-cut, hints of an acceleration in growth since about 2013. The problem in getting an unambiguous assignment is evident in the growth figure in the lower right part of the chart. It shows that after 2010 the growth rates declined in the first years (until 2013). Afterwards they exhibit ups and downs, but increased on a quarterly and annual basis since 2015.

Charts 2a and 2b in Appendix B contain the same information for the advanced and emerging economies. All binary indicators point to an improved economic situation in the advanced economies in the last few years. This pattern is also apparent in the rising annual growth rates. In contrast, two out of the four indicators for the emerging countries do not show any signs of a turning point in the direction of an upswing. The year-over-year method and the one where we calculate the cut-off rate with the 35th percentile present evidence of a turning point in 2016. What is also evident is that the year-over-year growth rates in the advanced economies declined to a lesser extent compared to the emerging world in the Great Recession. In the former, growth rates declined to around -5%, while they did not turn into negative territory in the latter.

In what follows, we describe in detail the results for the best model(s) of one indicator and refer to similarities and differences of the others in footnotes and separate paragraphs. Our preferred indicator is the year-over-year procedure as it looks especially at turning points and yields in most of the cases – economically and statistically – the most promising results.

Chart 2: Global GDP growth and the binary variables



Note: quarterly: quarterly growth rate of real GDP; yoy: year-over-year growth rate of real GDP. p_yoy: 1 if there is an acceleration in year-on-year real GDP growth in at least three out of five quarters, and 0 otherwise; p_pct40(35): 1 in any period if the centred five-quarter moving average quarterly growth rate in real GDP is above the 40th (35th) percentile of the series, and 0 otherwise; bbq: quarterly analogue to the Bry-Boschan algorithm.

3.2. Results

3.2.1. Global GDP

The explanatory variables in the best Probit model include the contemporaneous and lagged Goldman Sachs Global Leading Indicator.² This is also true for the other binary variables.

The equation reads as

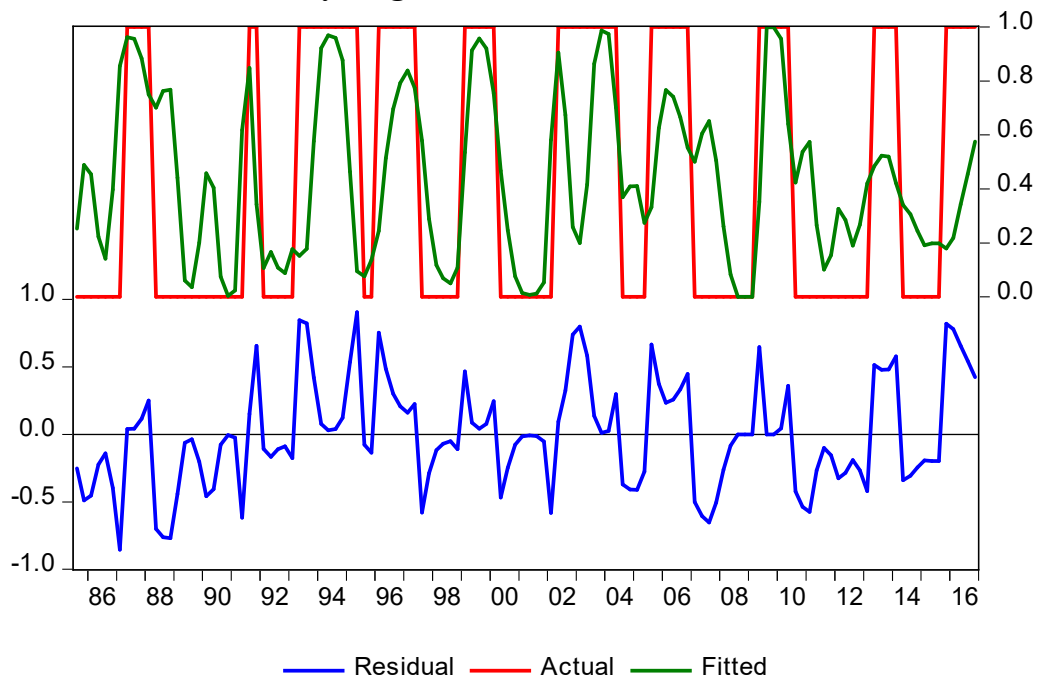
$$(2) \quad p_yoy = -1.16 + 0.66 gs_gli_t + 0.51 gs_gli_{t-1}$$

(5.2) (3.7) (3.0)

Note: Sample: 1985q3-2016q4; observations with dependent variable = 0: 71; observations with dependent variable = 1: 55; absolute z-statistic in parentheses below coefficients; McFadden R² = 0.31; SE = 0.40; SSR = 20.1; LR = 53.5 (0.0).³

As can be seen from the residual analysis (see Chart 3), the model is quite a good predictor of the turning points. Most residual fluctuations are located at the regime edges, i.e. the model becomes restless around the turning points and, therefore, signals that a regime change is approaching. One "unpleasant" aspect is, however, the false signals during the downswing phases in the beginning and the middle of the 1990s and during the upswing phase at the beginning of the new century. Here, the model user would have erroneously suspected a regime change, even though none materialized (type-2 error).

Chart 3: Residual analysis: global



² Alternative models which do, however, not perform as good, only include lagged GDP growth rates or OECD consumer confidence (results available upon request).

³ SE: standard error of regression; SSR: sum of squared residuals; LR: Likelihood Ratio statistic on the overall significance of the model (p-value in parentheses).

Table 1 highlights once again the model's goodness of fit and its uncertainty. In this table, the 126 total observations are broken down by deciles. The columns labeled “Risk deciles” depict the high and low value of the predicted probability for each decile. Also depicted is the actual and expected number of observations in each group, as well as the contribution of each group to the overall Hosmer-Lemeshow (H-L) statistic—large values indicate large differences between the actual and predicted values for that decile. If the predicted values for the binary value are in the 1st-5th or the 8th-10th decile, the model performs rather well in discriminating between the two different regimes (upswing or downswing). Most of the forecast errors are in the 7th decile. In this decile, if the model user were to assume that a predicted value of greater than 0.5 signals an upswing or a value of smaller than 0.5 a downswing, he would achieve a hit probability of only about 50 %, i.e. in this decile he could basically toss a coin and then decide based on the outcome which regime is present. However, overall, the null that the observed and expected values are the same across all the deciles cannot be rejected, as indicated by the Hosmer-Lemeshow test (p-value > 90 %). This test groups observations on the basis of the predicted probability that $y = 1$.

Table 1: Forecast quality: global

Risk deciles	Dep=0		Dep=1		Total obs.	H-L value		
	Low	High	Actual	Expect			Actual	Expect
1	0.00	0.06	12	11.74	0	0.26	12	0.27
2	0.07	0.14	12	11.76	1	1.24	13	0.05
3	0.14	0.20	8	9.87	4	2.13	12	2.01
4	0.20	0.29	10	9.75	3	3.25	13	0.03
5	0.29	0.41	9	8.37	4	4.63	13	0.13
6	0.42	0.49	7	6.60	5	5.40	12	0.05
7	0.50	0.58	6	5.93	7	7.07	13	0.00
8	0.61	0.75	4	3.92	8	8.08	12	0.00
9	0.75	0.91	3	2.30	10	10.70	13	0.26
10	0.91	1.00	0	0.52	13	12.48	13	0.54
Total			71	70.77	55	55.23	126	3.34 (0.91)

Note: Hosmer-Lemeshow test whether the observed and expected proportions are the same across the deciles; p-value in parentheses.

These conclusions are underscored by Table 2. Here, an assessment based on the model is correct if the predicted probability is below the cut-off value of $C = 0.5$ in the case of $y = 0$ or above 0.5 in the case of $y = 1$. It is obvious that in 76.2 % of the cases the model prediction is correct (the specificity, i.e. the correct $y = 0$ observations, is 81.7 %; the sensitivity, i.e. the correct $y = 1$ observations, is 69.1 %). For comparative purposes, the right part of Table 2

shows the results of a model with a constant probability, which arises when one estimates the model only with a constant. It reveals that our preferred model is over 49 % better (calculated as the percent of incorrect predictions corrected by the equation, i.e. $(0.778-0.563)/(1-0.563)$) than the model with constant probability, which generates 56.3% correct values.

Table 2: Classification table: global

	Estimated equation		Constant probability	
	Dep = 0	Dep = 1	Dep = 0	Dep = 1
p(Dep=1) ≤ 0.5	59	16	71	55
p(Dep=1) > 0.5	12	39	0	0
% correct	77.8		56.3	

Note: White cells indicate correct forecasts, grey cells indicate incorrect predictions. Correct: predicted probability ≤ C = 0.5 and act. y=0 or predicted probability > C = 0.5 and act. y=1.

For the other classification schemes of upswings and downswings, the statistical properties and the economic interpretation are not as good as for p-yoy.⁴ However, they all lead to an improvement compared to a model with constant probability.

3.2.2. Advanced economies

For the advanced economies, the optimal Probit model consists of lagged GDP growth rates and the Goldman Sachs Global Leading indicator (see Equation 3).⁵ This is also true for the other binary variables. The inclusion of a leading indicator in the detection of turning points is in line with Haltmaier (2008) who finds that in six of the eight considered OECD countries at least one (monthly) lag of the leading indicator is significant. Moreover, it is also significant in her panel setup. Financial variables, especially the yield spread, and narrow monetary aggregates which often are found helpful in this respect for (individual) advanced economies and within the Probit methodology (see, e.g., Fornari & Lemke, 2010; Boysen-Hogrefe, 2012) do not enter our preferred specification. Our best equation reads as

$$(3) \quad p_yoy_ae = -1.07 + 2.00 gdp_ae_{t-1} - 1.59 gdp_ae_{t-2} + 0.84 gs_gli_t$$

(3.5) (3.6) (3.0) (4.8)

Note: Sample: 1985q2-2016q4; observations with dependent variable = 0: 68; observations with dependent variable = 1: 59; absolute z-statistic in parentheses below coefficients; McFadden R² = 0.33; SE = 0.40; SSR = 19.7; LR = 58.2 (0.0). Explanations see Equation 4.

⁴ Results available upon request.

⁵ A model with only three lags of GDP growth performs slightly worse than the one presented (results available upon request).

The residual analysis in Chart 4 shows a slightly better behaviour compared to the results for the global economy. The model reveals again the problems during the downswing at the end of the 1980s and beginning of the 1990s, but behaves quite well in the other episodes.⁶ At the end of the sample (2015/16) our preferred model indicates a steadily improving economic situation.

Chart 4: Residual analysis: advanced economies

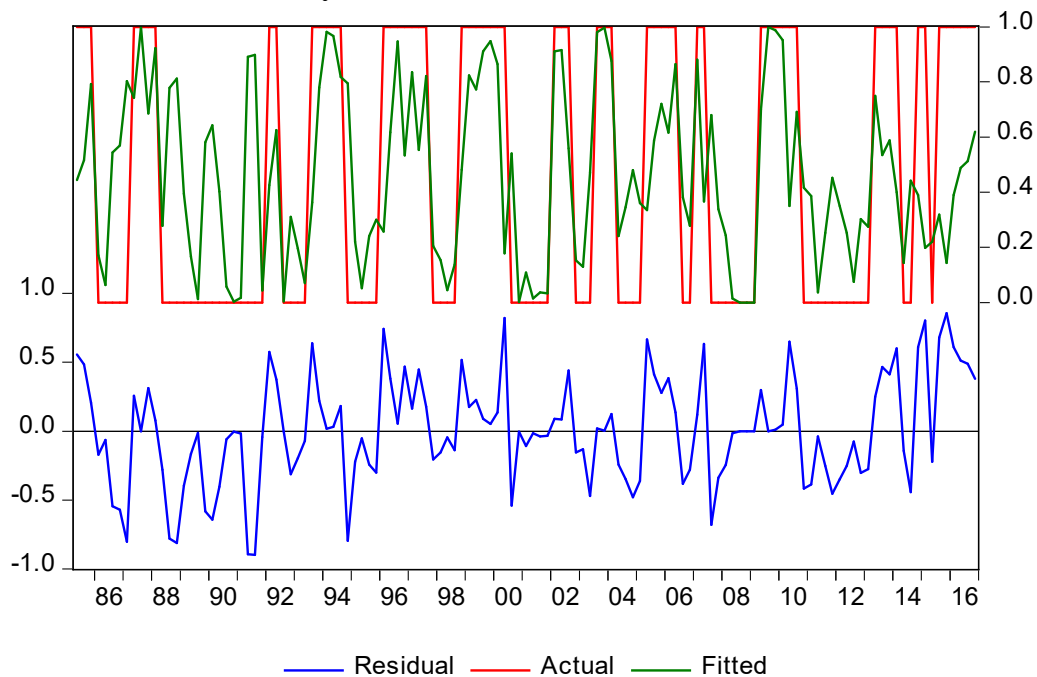


Table 3 compares the fitted expected to the actual values by group (ten deciles) and calculates the Hosmer-Lemeshow test statistic. This test of goodness-of-fit shows that, in general, the model behaviour is quite good. There are some problems in the 5th decile in which the accuracy is only slightly above 50 %. In general, however, differences between "actual" and "expected" are not too large. Therefore, we do not reject the model as providing a sufficient fit to the data.

⁶ The latter is also true for the Bry-Boschan model. The "High growth" specification, in contrast, exhibits problems at the end of the 1990s and beginning of the new century (results available upon request).

Table 3: Forecast quality: advanced economies

	Risk deciles		Dep=0		Dep=1		Total obs.	H-L value
	Low	High	Actual	Expect	Actual	Expect		
1	0.00	0.04	12	11.86	0	0.14	12	0.14
2	0.04	0.14	12	11.89	1	1.11	13	0.01
3	0.15	0.24	12	10.41	2	2.60	13	0.17
4	0.25	0.34	9	8.50	3	3.50	12	0.10
5	0.35	0.40	7	8.12	6	4.88	13	0.41
6	0.42	0.53	5	6.80	8	6.20	13	1.00
7	0.54	0.63	4	5.00	8	7.00	12	0.34
8	0.64	0.79	4	3.47	9	9.53	13	0.11
9	0.80	0.91	4	1.90	9	11.10	13	2.73
10	0.91	1.00	0	0.49	13	12.51	13	0.51
	Total		68	68.44	59	58.56	127	5.5 (0.70)

Note: Hosmer-Lemeshow test statistic that the observed and expected proportions are the same across the deciles; p-value in parentheses.

Table 4 reveals that in 78 % of all cases our model delivers the right classification (specificity: 82 %; sensitivity: 73 %). Compared to a model with constant probability which has 53 % correct values, this is an improvement of more than 50 %.

Table 4: Classification table: advanced economies

	Estimated equation		Constant probability	
	Dep = 0	Dep = 1	Dep = 0	Dep = 1
p(Dep=1) ≤ 0.5	56	16	68	59
p(Dep=1) > 0.5	12	43	0	0
% correct	78.0		53.5	

Note: White cells indicate correct forecasts, grey cells indicate incorrect predictions. Correct: predicted probability ≤ C = 0.5 and act. y=0 or predicted probability > C = 0.5 and act. y=1.

The model with the binary variable specified by "High growth (40)" performs slightly better in discriminating between regimes and with regard to the overall fit of the model. In contrast, the results of all others binary variable specifications are worse than the one presented.

3.2.3. Emerging markets

All in all, the emerging market economies were the hardest to model. As with the advanced economies, the best model includes lagged quarterly GDP growth rates, but in the emerging market case together with industrial production in emerging markets (see Equation 4). This result is in line with Baumann et al. (2018) who use a three regime classification to analyse emerging market economies with a Markov Switching framework. Overall, we have 140

observations, of which 77 belong to regime 0 and 63 to regime 1. The model has the lowest R² and the highest standard error of all the regional models considered.

$$(4) \quad p_yoy_ee = -1.47 + 0.42 gdp_ee_{t-1} + 0.17 ip_ee_t + 0.16 ip_ee_{t-1}$$

(4.6) (2.6) (1.9) (1.8)

Note: Sample: 1982q1-2016q4; observations with dependent variable = 0: 77; observations with dependent variable = 1: 63; absolute z-statistic in parentheses below coefficients; McFadden R² = 0.12; SE = 0.50; SSR = 28.7; LR = 23.9 (0.0). Explanations see Equation 4.

Chart 5 and Tables 5 and 6 summarize the statistical properties of the model. At the sample end (2016), the model indicates a slow movement in the direction of a possible regime turning point from downswing to upswing. The Hosmer-Lemeshow test on the equality of observed and expected values is significant (p-value: 0.13). With more than 70% correct predictions, our model is better than the one with constant probability which in turn does only forecast correctly in 55 % of all cases.

The "Bry-Boschan" and the "high growth" regime classifications include the Goldman Sachs global leading indicator instead of industrial production. This corresponds to the preferred model in the multinomial logit case of Baumann et al. (2018). In terms of predictive accuracy, the best model is "high growth" which, in both cases (cut-off of 35 or 40) has about 80 % of correct classifications (specificity: between 50 % and 60 %; sensitivity: > 90 %). The improvement relative to the model with only a constant (which has 70 % of correct predictions) is between 32 % and 41 %.

Chart 5: Residual analysis: emerging markets

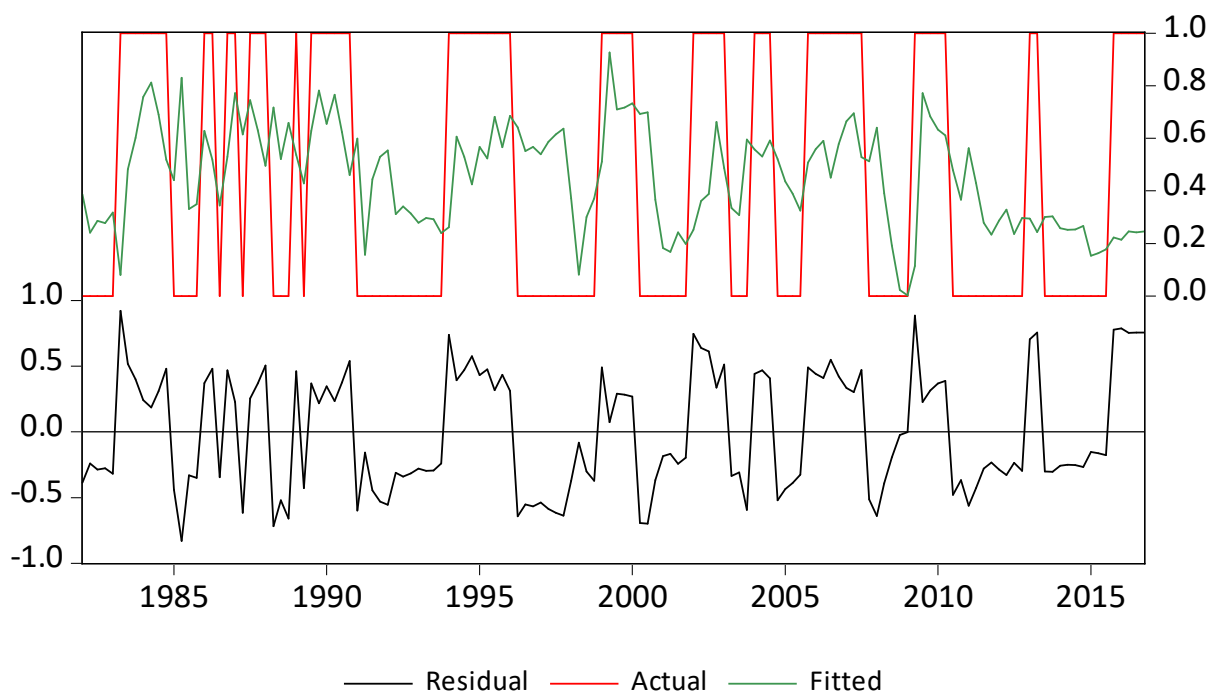


Table 5: Forecast quality: emerging markets

	Risk deciles		Dep=0		Dep=1		Total obs.	H-L value
	Low	High	Actual	Expect	Actual	Expect		
1	0.00	0.21	11	12.10	3	1.90	14	0.73
2	0.22	0.26	8	10.60	6	3.40	14	2.61
3	0.26	0.30	12	9.98	2	4.02	14	1.42
4	0.31	0.37	13	9.30	1	4.70	14	4.38
5	0.37	0.46	10	8.18	4	5.82	14	0.97
6	0.48	0.53	4	6.86	10	7.14	14	2.35
7	0.53	0.58	6	6.27	8	7.73	14	0.02
8	0.59	0.63	5	5.47	9	8.53	14	0.07
9	0.63	0.70	5	4.68	9	9.32	14	0.03
10	0.70	0.93	3	3.26	11	10.74	14	0.03
	Total		77	76.69	63	63.31	140	12.6 (0.13)

Note: Hosmer-Lemeshow test statistic that the observed and expected proportions are the same across the deciles; p-value in parentheses.

Table 6: Classification table: emerging markets

	Estimated equation		Constant probability	
	Dep = 0	Dep = 1	Dep = 0	Dep = 1
$p(\text{Dep}=1) \leq 0.5$	55	19	77	63
$p(\text{Dep}=1) > 0.5$	22	44	0	0
% correct	70.7		55.0	

Note: White cells indicate correct forecasts, grey cells indicate incorrect predictions. Correct: predicted probability $\leq C = 0.5$ and act. $y=0$ or predicted probability $> C = 0.5$ and act. $y=1$.

4. Summary, conclusions

In this paper, we tried to shed light on the question what determines the turning points of world GDP on the one side and advanced as well as emerging economies on the other from the beginning of the 1980s onwards. For that purpose, we constructed different binary variables to capture upswings and downswings to integrate and explain them with the help of Probit models. It seems that world and advanced economy activity can be captured better than that in emerging markets. This could be due to the poor data quality. The most important variables in these exercises are lagged GDP growth rates and activity-based indicators.

Interestingly, the yield spread does not yield significant results in detecting turning points. However, against the background that we neither have yield data on a global level nor for advanced and emerging economies as a whole, this is not too surprising.

It might be interesting to combine our approach with the Markov-Switching methodology to identify the turning points. These models might also be helpful to decide whether the two-regime case is really the correct one or whether we should take more than two regimes into account. This is left to a separate paper, see Baumann et al. (2018).

Appendix A: Data used

Activity data:

- real GDP growth, national accounts at country level weighted using PPP shares of world total, ECB and WEO databases
- the EME GDP aggregate is based on ECB data after 1995, which are linked up to IMF International Financial Statistics data (in year-on-year growth rates) before 1995
- industrial production in OECD countries, index excluding construction, OECD
- industrial production in emerging market economies (EMEs) excluding construction weighted using PPP shares of EMEs total, country statistical offices
- world crude steel production in thousand tonnes, World Steel Association
- index of world economic activity, based on Kilian (2009)
- composite leading indicator, OECD total, OECD
- global leading indicator from Goldman Sachs. This leading indicator is derived from ten component series, namely (i) Korean exports, (ii) GS industrial metals index; (iii) US initial jobless claims, (iv) G4 consumer confidence, (v) Japanese inventory-to-sales ratio, (vi) AUD and CAD trade weighted index, (vii) Belgian and Dutch manufacturing confidence survey, (viii) Global PMI new orders less inventories, (ix) Baltic Dry Index, (x) Global PMI. The aggregate cyclical series is constructed by weighting the double-smoothed components with equal (10%) weight, see also O'Neill et al (2002) and Stupnytska et al (2010).
- global factor of economic activity, based on Delle Chiaie, Ferrara & Giannone (2017)
- leading economic index for the US, Conference Board

Survey data:

- consumer confidence, OECD total, OECD
- consumer confidence, US, OECD

Financial data:

- term spread US, the 10-year Treasury Note yield minus the 3-month Treasury Bill yield, Federal Reserve Board
- bond spread US, the Baa corporate bond yield minus the 10-year Treasury Note yield, Federal Reserve Board
- stock price index, S&P500 composite, Standard & Poor's
- monetary aggregates, OECD M1 and M3, OECD

Commodity prices:

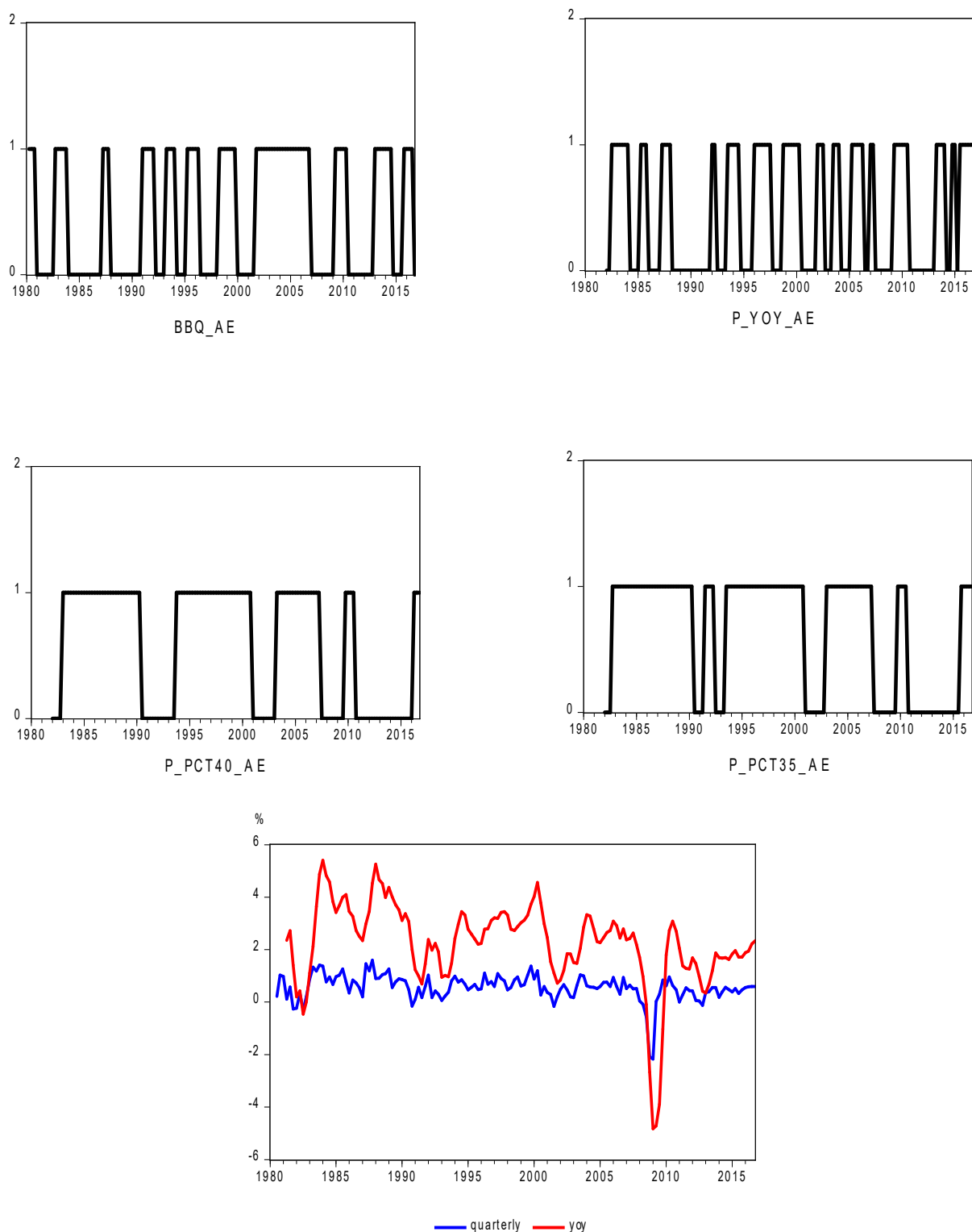
- Brent crude oil prices in US-dollars, IMF
- metal price index, IMF
- non-oil commodity prices, IMF

Classification of advanced (AEs) and EMEs:

- AEs include: US, Japan, UK, Canada, euro area, Switzerland, Sweden, Denmark, Poland, Czech Republic, Romania, Hungary
- EMEs include: China, India, South Korea, Russia, Brazil, Mexico, Argentina, Turkey

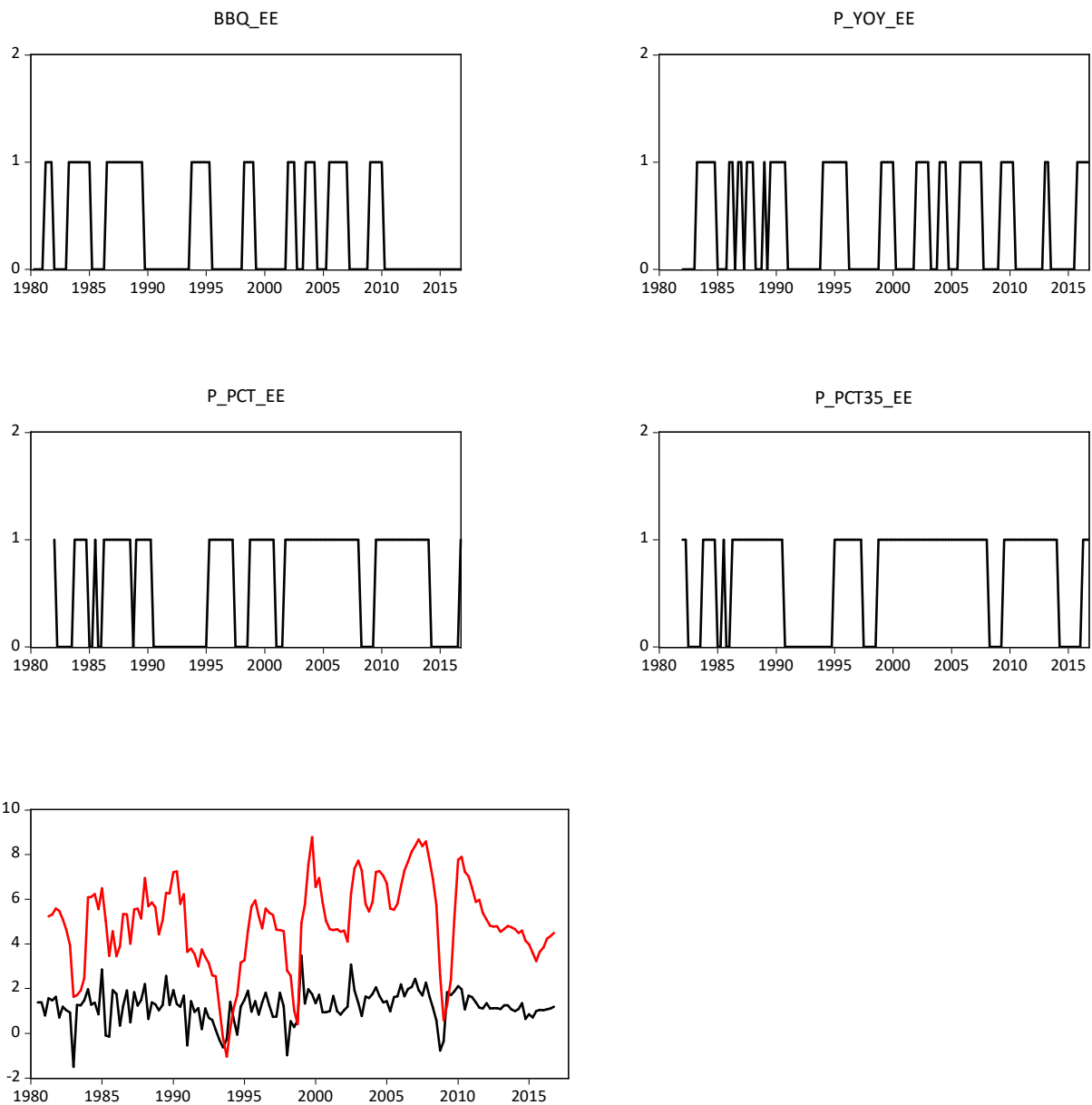
Appendix B: Additional charts

Chart 2a: GDP growth and the binary variables: advanced economies



Note: quarterly: quarterly growth rate of real GDP; yoy: year-over-year growth rate of real GDP. ae: advanced economies; p_yoy: 1, if there is an acceleration in year-on-year real GDP growth in at least three out of five quarters, and 0 otherwise; p_pct40(35): 1 in any period if the centred five-quarter moving average quarterly growth rate in real GDP is above the 40th (35th) percentile of the series, and 0 otherwise; bbq: quarterly analogue to the Bry-Boschan algorithm.

Chart 2b: GDP growth and the binary variables: emerging economies



Note: quarterly: quarterly growth rate of real GDP; yoy: year-over-year growth rate of real GDP. ee: emerging economies; p_yoy: 1 if there is an acceleration in year-on-year real GDP growth in at least three out of five quarters, and 0 otherwise; p_pct40(35): 1 in any period if the centred five-quarter moving average quarterly growth rate in real GDP is above the 40th (35th) percentile of the series, and 0 otherwise; bbq: quarterly analogue to the Bry-Boschan algorithm.

References

- Abberger, K. & W. Nierhaus, (2010), Markov-Switching and the Ifo Business Climate, *Journal: Journal of Business Cycle Measurement and Analysis*, 1-13.
- Baumann, U., R. Gómez Salvador and F. Seitz (2018), Detecting turning points in global economic activity, European Central Bank, mimeo.
- Boysen-Hogrefe, J. (2012), A Note on Prediction Recessions in the Euro Area Using Real MI, *Economics Bulletin* 32, 1291-1301.
- Bry, G. & C. Boschan (1971), Programmed Selection Of Cyclical Turning Points, in: Bry, G. & C. Boschan (eds.), *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*, UMI, 7-63.
- Camacho, M., & J. Martinez-Martin (2015), Monitoring the world business cycle, *Economic Modelling* 51, 617-625.
- Chauvet, M. & S. Potter (2010), Business Cycle Monitoring with Structural Change, *International Journal of Forecasting* 6, 777-793.
- Christiansen, C., J.N. Eriksen & S.V. Møller (2014), Forecasting US recessions: The role of sentiment, *Journal of Banking & Finance* 49, 459-468.
- Ferrara, L. & C. Marsilli (2014), Nowcasting global economic growth: A factor-augmented mixed-frequency approach, Banque de France, Working Paper No. 515, October.
- Fornari, F. & W. Lemke (2010), Predicting Recession Probabilities with Financial Variables, ECB Working Paper Series NO 1255, October.
- Fossati, S. (2015), Forecasting US recessions with macro factors, *Applied Economics* 47, 5726-5738.
- Haltmaier, J. (2008), Predicting Cycles in Economic Activity, Board of Governors of the Federal Reserve System, *International Finance Discussion Papers Number 926*, April
- Hamilton, J. D. (1989), A new approach to the economic analysis of nonstationary time series and the business cycle, *Econometrica* 57, 357–384.
- Harding, D. (2008), Detecting and forecasting business cycle turning points, MPRA Paper No. 33583, September.
- Harding, D. & A. Pagan (2002), Dissecting the cycle: A methodological investigation, *Journal of Monetary Economics* 49, 365-381.
- Hsu, T. (2016), U.S. recession forecasting using probit models with asset index predictor variables, Economics Department, The University of Maryland Baltimore County, November.
- Layton, A. P. & M. Katsuura (2001), Comparison of regime switching, probit and logit models in dating and forecasting US business cycles, *International Journal of Forecasting* 17, 403–417.
- Nyberg, H. (2014), A bivariate autoregressive Probit model: Business cycle linkages and transmission of recession probabilities, *Macroeconomic Dynamics* 18, 838-862.
- Proaño, C. R. (2017), Detecting and Predicting Economic Accelerations, Recessions, and Normal Growth Periods in Real-Time, *Journal of Forecasting* 36, 26–42.

Ravazzolo, F. & J.L. Vespignani (2015), A new monthly indicator of global real economic activity, Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute, Working Paper No. 244, June.

Stratford, K. (2013), Nowcasting world GDP and trade using global indicators, Bank of England, Quarterly Bulletin 2013 Q3, 233-243.

Verbeek, M. (2012), A Guide to Modern Econometrics, 4th ed., Wiley

Bisher erschienene Weidener Diskussionspapiere

- 1** „Warum gehen die Leute in die Fußballstadien? Eine empirische Analyse der Fußball-Bundesliga“
von Horst Rottmann und Franz Seitz
- 2** „Explaining the US Bond Yield Conundrum“
von Harm Bandholz, Jörg Clostermann und Franz Seitz
- 3** „Employment Effects of Innovation at the Firm Level“
von Horst Rottmann und Stefan Lachenmaier
- 4** „Financial Benefits of Business Process Management“
von Helmut Pirzer, Christian Forstner, Wolfgang Kotschenreuther und Wolfgang Renninger
- 5** „Die Performance Deutscher Aktienfonds“
von Horst Rottmann und Thomas Franz
- 6** „Bilanzzweck der öffentlichen Verwaltung im Kontext zu HGB, ISAS und IPSAS“
von Bärbel Stein
- 7** Fallstudie: „Pathologie der Organisation“ – Fehlentwicklungen in Organisationen, ihre Bedeutung und Ansätze zur Vermeidung
von Helmut Klein
- 8** „Kürzung der Vorsorgeaufwendungen nach dem Jahressteuergesetz 2008 bei betrieblicher Altersversorgung für den GGF.“
von Thomas Dommermuth
- 9** „Zur Entwicklung von E-Learning an bayerischen Fachhochschulen-
Auf dem Weg zum nachhaltigen Einsatz?“
von Heribert Popp und Wolfgang Renninger
- 10** „Wie viele ausländische Euro-Münzen fließen nach Deutschland?“
von Dietrich Stoyan und Franz Seitz
- 11** Modell zur Losgrößenoptimierung am Beispiel der Blechteilindustrie für Automobilzulieferer
von Bärbel Stein und Christian Voith
- 12** Performancemessung
Theoretische Maße und empirische Umsetzung mit VBA
von Franz Seitz und Benjamin R. Auer
- 13** Sovereign Wealth Funds – Size, Economic Effects and Policy Reactions
von Thomas Jost

- 14 The Polish Investor Compensation System Versus EU – 15 Systems and Model Solutions
von Bogna Janik**
- 15 Controlling in virtuellen Unternehmen -eine Studie-
Teil 1: State of the art
von Bärbel Stein, Alexander Herzner, Matthias Riedl**
- 16 Modell zur Ermittlung des Erhaltungsaufwandes von Kunst- und Kulturgütern in
kommunalen Bilanzen
von Bärbel Held**
- 17 Arbeitsmarktinstitutionen und die langfristige Entwicklung der Arbeitslosigkeit –
Empirische Ergebnisse für 19 OECD-Länder
von Horst Rottmann und Gebhard Flaig**
- 18 Controlling in virtuellen Unternehmen -eine Studie-
Teil 2: Auswertung
von Bärbel Held, Alexander Herzner, Matthias Riedl**
- 19 DIAKONIE und DRG's –antagonistisch oder vereinbar?
von Bärbel Held und Claus-Peter Held**
- 20 Traditionelle Budgetierung versus Beyond Budgeting-
Darstellung und Wertung anhand eines Praxisbeispiels
von Bärbel Held**
- 21 Ein Factor Augmented Stepwise Probit Prognosemodell
für den ifo-Geschäftserwartungsindex
von Jörg Clostermann, Alexander Koch, Andreas Rees und Franz Seitz**
- 22 Bewertungsmodell der musealen Kunstgegenstände von Kommunen
von Bärbel Held**
- 23 An Empirical Study on Paths of Creating Harmonious Corporate Culture
von Lianke Song und Bernt Mayer**
- 24 A Micro Data Approach to the Identification of Credit Crunches
von Timo Wollmershäuser und Horst Rottmann**
- 25 Strategies and possible directions to improve Technology
Scouting in China
von Wolfgang Renninger und Mirjam Riesemann**
- 26 Wohn-Riester-Konstruktion, Effizienz und Reformbedarf
von Thomas Dommermuth**
- 27 Sorting on the Labour Market: A Literature Overview and Theoretical Framework
von Stephan O. Hornig, Horst Rottmann und Rüdiger Wapler**
- 28 Der Beitrag der Kirche zur Demokratisierungsgestaltung der Wirtschaft
von Bärbel Held**

- 29 Lebenslanges Lernen auf Basis Neurowissenschaftlicher Erkenntnisse
-Schlussfolgerungen für Didaktik und Personalentwicklung-
von Sarah Brückner und Bernt Mayer**
- 30 Currency Movements Within and Outside a Currency Union: The case of Germany
and the euro area
von Franz Seitz, Gerhard Rösl und Nikolaus Bartsch**
- 31 Labour Market Institutions and Unemployment. An International Comparison
von Horst Rottmann und Gebhard Flaig**
- 32 The Rule of the IMF in the European Debt Crisis
von Franz Seitz und Thomas Jost**
- 33 Die Rolle monetärer Variablen für die Geldpolitik vor, während und nach der Krise:
Nicht nur für die EWU geltende Überlegungen
von Franz Seitz**
- 34 Managementansätze sozialer, ökologischer und ökonomischer Nachhaltigkeit:
State of the Art
von Alexander Herzner**
- 35 Is there a Friday the 13th effect in emerging Asian stock markets?
von Benjamin R. Auer und Horst Rottmann**
- 36 Fiscal Policy During Business Cycles in Developing Countries: The Case of Africa
von Willi Leibfritz und Horst Rottmann**
- 37 MONEY IN MODERN MACRO MODELS: A review of the arguments
von Markus A. Schmidt und Franz Seitz**
- 38 Wie erzielen Unternehmen herausragende Serviceleistungen mit höheren Gewinnen?
von Johann Strassl und Günter Schicker**
- 39 Let's Blame Germany for its Current Account Surplus!?
von Thomas Jost**
- 40 Geldpolitik und Behavioural Finance
von Franz Seitz**
- 41 Rechtliche Überlegungen zu den Euro-Rettungsschirmprogrammen und den
jüngsten geldpolitischen Maßnahmen der EZB
von Ralph Hirdina**
- 42 DO UNEMPLOYMENT BENEFITS AND EMPLOYMENT PROTECTION INFLUENCE
SUICIDE MORTALITY? AN INTERNATIONAL PANEL DATA ANALYSIS
von Horst Rottmann**
- 43 Die neuen europäischen Regeln zur Sanierung und Abwicklung von Kreditinstituten:
Ordnungspolitisch und rechtlich angreifbar?
von Ralph Hirdina**

- 44 Vermögensumverteilung in der Eurozone durch die EZB ohne rechtliche Legitimation?
von Ralph Hirdina**
- 45 Die Haftung des Steuerzahlers für etwaige Verluste der EZB auf dem rechtlichen Prüfstand
von Ralph Hirdina**
- 46 Die Frage nach dem Verhältnis von Nachhaltigkeit und Ökonomie
von Alexander Herzner**
- 47 Giving ideas a chance - systematic development of services in manufacturing industry
von Johann Strassl, Günter Schicker und Christian Grasser**
- 48 Risikoorientierte Kundenbewertung: Eine Fallstudie
von Thorsten Hock**
- 49 Rechtliche Überlegungen zur Position der Sparer und institutionellen Anleger mit Blick auf
die Niedrigzins- bzw. Negativzinspolitik der Europäischen Zentralbank
von Ralph Hirdina**
- 50 Determinanten des Studienerfolgs: Eine empirische Untersuchung für die Studiengänge
Maschinenbau, Medienproduktion und -technik sowie Umwelttechnik
von Bernd Rager und Horst Rottmann**
- 51 Cash Holdings in Germany and the Demand for "German" Banknotes:
What role for cashless payments
von Nikolaus Bartzsch und Franz Seitz**
- 52 Europäische Union und Euro – Wie geht es weiter? – Rechtliche Überlegungen
von Ralph Hirdina**
- 53 A Call for Action – Warum sich das professionelle Management des Service Portfolios in der
Industrie auszahlt
von Günter Schicker und Johann Strassl**
- 54 Der Studienerfolg an der OTH Amberg-Weiden – Eine empirische Analyse der Studiengänge
Maschinenbau, Medienproduktion und Medientechnik sowie Umwelttechnik
von Bernd Rager und Horst Rottmann**
- 55 Die Bewertung von Aktienanleihen mit Barriere – Eine Fallstudie für die Easy-Aktienanleihe
der Deutschen Bank
von Maurice Hofmann und Horst Rottmann**
- 56 Studie: Die Generation Y und deren organisatorische Implikationen
von Helmut Klein**
- 57 Die gesetzliche Einschränkung von Bargeldzahlungen und die Abschaffung von Bargeld auf
dem rechtlichen Prüfstand
von Ralph Hirdina**
- 58 Besser ohne Bargeld? Gesamtwirtschaftliche Wohlfahrtsverluste der Bargeldabschaffung
von Gerhard Rösl, Franz Seitz, Karl-Heinz Tödter**

- 59 Nowcasting des deutschen BIP
von Jens Doll, Beatrice Rosenthal, Jonas Volkenand, Sandra Hamella**
- 60 Herausforderungen und Erfolgsfaktoren bei der Einführung Cloud-basierter
Unternehmenssoftware – Erfahrungen aus der Praxis
von Thomas Dobat, Stefanie Hertel, Wolfgang Renninger**
- 61 Global Recessions and Booms: What do Probit models tell us?
von Ursel Baumann, Ramón Gómez Salvador, Franz Seitz**



Ostbayerische Technische Hochschule
Amberg-Weiden

Die Weidener Diskussionspapiere erscheinen in unregelmäßigen Abständen und sollen Erkenntnisse aus Forschung und Wissenschaft an der Hochschule in Weiden insbesondere zu volks- und betriebswirtschaftlichen Themen an Wirtschaft und Gesellschaft vermitteln und den fachlichen Dialog fördern.

Herausgeber:

Ostbayerische Technische Hochschule (OTH) Amberg-Weiden
Prof. Dr. Horst Rottmann und Prof. Dr. Franz Seitz
Fakultät Betriebswirtschaft

Presserechtliche Verantwortung:

Sonja Wiesel, Hochschulkommunikation und Öffentlichkeitsarbeit
Telefon +49 (9621) 482-3135
Fax +49 (9621) 482-4135
s.wiesel@oth-aw.de

Bestellungen schriftlich erbeten an:

Ostbayerische Technische Hochschule Amberg-Weiden
Abt. Weiden, Bibliothek
Hetzenrichter Weg 15,
D – 92637 Weiden i.d.Opf.

Die Diskussionsbeiträge können elektronisch abgerufen werden unter
http://www.oth-aw.de/aktuelles/veroeffentlichungen/weidener_diskussionspapiere/

Alle Rechte, insbesondere das Recht der Vervielfältigung und Verbreitung sowie Übersetzung vorbehalten.
Nachdruck nur mit Quellenangabe gestattet.

ISBN 978-3-937804-63-7

- **Abteilung Amberg:** Kaiser-Wilhelm-Ring 23, 92224 Amberg,
Tel.: (09621) 482-0, Fax: (09621) 482-4991
- **Abteilung Weiden:** Hetzenrichter Weg 15, 92637 Weiden i. d. OPf.,
Tel.: (0961) 382-0, Fax: (0961) 382-2991
- **E-Mail:** info@oth-aw.de | **Internet:** <http://www.oth-aw.de>