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Modeling mechanism of economic growth using threshold autoregression models*

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Abstract

We propose to apply a time series-based nonlinear mechanism in the threshold autoregression form in order to examine the possible relationship between economic growth rate and its potential determinants included debt-to-GDP indicator. Our approach employs threshold variables instead of exogenous variables and time-series data instead of panel data to reveal the economic instruments that have determined the business cycle in European countries for the last 2 decades – starting from 1995. The purpose of the study is to reveal the mechanism of growth (measured in terms of GDP growth rate and industrial production growth rate) given different macroeconomic indicators, such as public debt, rate of inflation, interest rate, and rate of unemployment with the level of growth itself serving as the threshold variables. We identify that the monetary mechanism played an important role in diagnosing the phases of business cycle in most European economies which is in line with liberal economic policy dominating in the observed period. The initial level of debt-to-GDP ratio as its increase within the recession period was of no value for the economic growth pattern.

Keywords: Economic growth; Economic potential; Threshold models; Economic policy; Recession
JEL: C24; C87; E32

1 Introduction

The relationship between economic growth and public debt has been the subject of numerous studies and publications in recent years. There is ongoing debate among economists about whether there should be specified levels of public debt in both developed and emerging economies. The academic debate even has entered the political arena, particularly in the European Union (EU), where criteria for economic convergence were established in the early 1990s. The problem is not easy to solve systematically because there is evidence that supports both positions: those who consider that public debt positively stimulates economic growth and those who consider the opposite. The recession of 2007–2009 has re-opened the debate on the limits of public debt in the economy and the impact of its magnitude on economic growth (Krugman, 2012). The recession itself as well as a long stagnation period thereafter experienced by both developed and emerging economies caused increasing debt-to-GDP ratios; this has become common knowledge and has been perceived as a way to maintain prevailing levels of growth. Economists widely discussed and evaluated this phenomenon after the recession (e.g. Saleh and Harvie (2005), Schclarek (2005), Misztal (2011)). Woo and Kumar (2015) examined the impact of high public debt on economic growth in the long run. Their analysis, based on a panel of developed and emerging economies over almost 4 decades, took into account a broad range of determinants of growth. The empirical results suggest an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth. On average, a 10-percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in annual real per capita GDP growth of around 0.2 percentage points per year, with the impact being somewhat smaller in advanced economies. Furthermore, there is some evidence of nonlinearity with higher levels of initial debt having a proportionately larger negative effect on subsequent growth. Panizza and Presbitero (2014) provided an interesting survey on the latest literature related to this topic. An

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analysis of the components of growth suggests that the adverse effect largely reflects a slowdown in labor productivity growth, mainly due to reduced investment and slower growth of capital stock.

Direct motivation of our research was the paper of Reinhart and Rogoff (2010) who concluded that high levels of debt-to-GDP ratio (90% and above) are associated with notably lower growth outcomes. On the other hand, much lower levels of the external debt-to-GDP ratio (60%) are associated with adverse outcomes for emerging market growth. Reinhart and Rogoff's results were questioned by Herndon et al. (2014), who repeated the research and found that the GDP growth rate in countries whose debt-to-GDP ratios exceeded 90% did not differ from that in countries with lower values of the indicator. Mota et al. (2012) considered the problem of debt-to-GDP ratio dynamics in 2000–2011 across the EU countries. They applied a fixed-effect panel model for 27 EU countries and found no support for the view that when monetary policy effectiveness is constrained (when short-term interest rates reached or are close to the lower zero bound), contractionary fiscal policy is expansionary. The broad explanation of this fact is, among others, related to changes introduced in the EU labor market, such as increasing flexibility in working time, making wages and labor costs more responsive to market pressures, and weakening unemployment benefit systems. The authors rejected any association between the initial fiscal policy response to the crisis and the subsequent debt crisis. Panizza and Presbitero (2013) used a panel-data modeling approach for OECD countries in the period 1982–2008 and concluded that the case still needs to be made for a causal effect from high debt to low growth. In addition, they showed that the evidence of a common debt threshold above which growth collapses is far from being robust. Moreover, their next study (Panizza and Presbitero, 2014) revealed that negative correlation between debt and growth disappears once the model is corrected for endogeneity. On the other hand, the findings by Ilzetzki (2011) for a sample of developing countries could not reject that in most countries, inclusion of a debt feedback effect does not change the size of fiscal multipliers significantly. Eyraud and Weber (2013) examined the effect of fiscal consolidation on the debt ratio and concluded, among others, that using the debt ratio as an operational fiscal target is risky. In other words, if country authorities focus on the short-term behavior of the debt ratio, they may engage in repeated rounds of tightening in an effort to make the debt ratio converge with the official target, thereby undermining confidence and setting off a vicious circle of slow growth, deflation, and further tightening. Finally Mendieta-Muñoz (2014) showed that short-run fluctuations may affect the rate of growth. He studied 13 Latin American and 18 OECD economies during the period 1981–2011 and found evidence that business cycle fluctuations have significant impact on the rate of growth for the majority of studied economies. In addition, he stated that research on the interaction between business cycle fluctuations and economic growth requires implementation of various modeling approaches in order to describe specific mechanisms for each particular country in a more detailed way. Interesting analysis of dependence between public debt and growth is provided in Kourtellos et al. (2013). The authors examined a wide range of countries using cross-sectional data. They rely on the structural threshold Solow growth model including many economic and non-economic variables. They found that one of the important factors determining the impact of debt on growth is level of democracy, that mean the level of development of institutional order. In lower democracies increasing the debt has negative impact on economic growth.

In this study, we are in line with the studies of Panizza and Presbitero (2013), Panizza and Presbitero (2014), Herndon et al. (2014), Mota et al. (2012), Kourtellos et al. (2013) in that a high level of debt-to-GDP ratio does not necessarily mean a decrease in the growth rate in subsequent periods, although we do not concentrate solely on debt. We extended the approach represented in the literature in such sense that we examine the dynamics of the growth rate in EU countries with respect to the level of selected economic indicators. The aim of the study is analyzing economic growth patterns within mentioned economies given different macroeconomic indicators, such as external debt-to-GDP ratio, long- and short-term interest rates, real estate cost indicators, consumer price index (CPI), exchange rate in levels and first differences. The hypothesis of the research is that there are significant relationships between the levels of indicators and economic growth dynamics. Durlauf et al. (2005) argued that modeling economic growth based on time series is limited owing to short series of data, sensitivity of growth to business cycles, and other short-run instabilities. A multi-regime approach in growth patterns was very important from their viewpoint. The rationale of the threshold autoregression (TAR) model lies in the assumption that the regime is determined by a certain variable relative to a threshold value. Given a threshold value one can observe asymmetric reaction of the variable in interest in one regime when compared to another. Recently, the empirical existence of a threshold has been widely analyzed in various economic settings, for example in agriculture Zapata and Gauthier (2003), in finance Chen et al. (2011) and macroeconomics Gnegne and Jawadi (2013). Its particular assessment to economic growth has been determined in the publications by Tong (1983, 1990) who analyzed business cycle in the USA, Funke and

Niebuhr (2005) who shed the light on the regional perspective of growth in Germany and Kremer et al. (2013) who introduced a dynamic panel threshold model to estimate inflation thresholds for long-term economic growth, to mention only a few. Thus, we propose to employ a nonlinear mechanism to reveal possible types of the mentioned relationships. Threshold models of the threshold autoregression and self-exciting threshold autoregression (SETAR) type are to be used to distinguish among: (1) threshold variable(s) and its (their) level(s) in the state of prosperity and the state of recession, (2) the number of states of economic growth, and (3) differences in business cycle between developed and emerging European economies. The threshold model seems to be the right tool of analysis for cyclical patterns when a certain number of regimes can be distinguished. In the analyzed period of time, several phases of economic cycles were observed with the strongest recession of 2007–2009 (in Europe, 2008–2009). The data (quarterly and monthly) applied in the research cover the time period from the beginning of 1995 to the end of 2013. Such a long period is interesting from yet another viewpoint, that is, it allows investigating the mechanism of growth under two different economic policy models. From the beginning of that period up to the outbreak of the financial crisis in 2007, policies based on the Washington consensus were dominant. Starting from 2007–2008, the situation has changed and there has been a great comeback of state interventionism, although in some countries, tightening of financial policy was continuous. For this reason, an interesting problem has arisen: whether the applied models are able to show any differences between the two types of economic policy.

There is a numerous literature on how to measure the economic growth and what variables are related with the economic growth, for example Fell and Greenfield (1983), Barro (1991, 1999) and Sala-I-Martin (1997). Typically the aggregate GDP and GDP per capita have been used for direct measurement of economic growth due to the fact that there is a common methodology of the GDP computing approved by many international organizations like Eurostat and OECD. That is why relatively long time series data are available for different economies. We use the aggregate GDP for several reasons. Firstly, we identify the mechanism of economic growth using stationary threshold autoregression models focusing on finding the thresholds that potentially determine the growth phases. Secondly, we extend and deepen the analysis related with business cycles synchronization in the EU during the recession of the first decade of XXI century Osińska et al. (2016). Thirdly, we focus on the two groups of countries: those well-developed and emerging after the years of following of non-market economic rules. In the perspective of our research, the GDP aggregate growth rate is the first important measure that shows economic ability of the country to grow its potential implementing contemporary know-how. Furthermore it has been widely used in many publications so if one is going to refer to the existing results using the GDP is a necessity.

Examples of the use of the aggregate seasonally adjusted quarterly GDP can be found in many researches, including the newest ones. Ahlborn and Wortmann (2018) use aggregated GDP to analyze the synchronization of business cycles in 27 European countries. In order to extract cyclical components from the time series, they use a band-pass filter developed by Christopher and Fitzgerald and high pass filter by Hodrick and Prescott. The filtered data is used to create a classification of economies due to similarities in the course of the cycle. Araújo (2015) uses Bayesian approach to estimate dynamic stochastic general equilibrium models (DSGE) to model real the GDP as a measure of the real output for the US economy. Schreiber and Soldatenkova (2016) use the monthly real industry production index to forecast turning points in the business cycle using the (sub)VAR approach. In the paper Benhabib and Spiegel (2000) have used the GDP levels in cross-country panel regressions to illustrate correlation between financial development and total factor productivity growth and investment. Madsen (2008) proposed application of GDP, measured in purchasing power parity units, for 21 OECD countries in research related to semi-endogenous and Schumpeterian growth models. Other examples of the use of aggregate GDP can be found in Enders and Li (2015), Razzu and Singleton (2016) or Horvath (2018).

In this paper the most convincing argument for using the GDP is such that there exists a well-defined methodology for business cycle identification through filtration and it is commonly observed with quarterly frequency which is required for the purpose of our research. Alternatively, we used the Industrial Production Index (IPI) for monthly observed data.

The remains of the paper is organized as follows. In Section 2 a classification of European economies is given and in Section 3 the model and methodology are described. Sections 4 and 5 contain description of the time-series and the empirical results respectively, while in Section 6 robustness analysis via Monte Carlo experiments is presented. Finally in Section 7 we conclude.

2 Classification of economies

One of the most popular perspectives of classification of economies is the criterion of initial wealth measured by GDP per inhabitant. The initial wealth is crucial for understanding the individual process of developing an economy. According to this, the group of developing EU countries consists of Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, and Slovak Republic. In the beginning of the analyzed period, that is, in 1995, the GDP per inhabitant of all these countries was far less than 10,000 USD, while at the end of this period in 2013, only Bulgaria and Romania's GDP per capita remained below this threshold. This means that the newest EU countries that entered EU in 2004 managed to make successful progress in the process of economic convergence measured by dispersion from the average level. This process was interrupted by the recession of 2007–2009 when each country had to bring its economic decisions more or less in line with EU economic policy (Osińska and Kluth, 2011). However both developed and emerging countries have suffered from the recession, and some of them, like Greece, were even forced to ask for financial assistance from international institutions. Facing the recession and the threat of deep crisis, governments made resolutions about financing economic recovery by increasing public debt. It is worth noting that EU member states had different levels of public debt-to-GDP ratios before entering the Eurozone. For example, in the first quarter of 2000, the public debt-to-GDP ratio of the EU15 was 65.6%, while in Belgium and Italy, the values were 115.7% and 112.8%, respectively. The lowest values were observed in Luxembourg (6%) and in Norway (23.9%). During the last 14 years, the public debt-to-GDP ratio has increased and exceeded 90% in many countries. In the last quarter of 2013, in the Eurozone, the ratio was 92.6%. In Belgium, France, Italy, Portugal, Spain, and the United Kingdom, the public debt-to-GDP ratio was higher than 90% and in Austria, Germany, Hungary, the Netherlands, and Slovenia, it was close to 80%. The only exception to this trend is Sweden, where public debt significantly decreased in the analyzed period from more than 60% to 35–40% of GDP. In Luxembourg and Norway, the public debt-to-GDP ratio increased, but remained at low levels of 23.1% and 29.5%, respectively.

The common increase of public debt has resulted from the changing economic paradigm during the last great recession. When financial policy instruments failed and interest rates could not be reduced any longer due to a liquidity trap, fiscal policy instruments became more important. The paradigm of economic liberalization was replaced by the paradigm of interventionism of governments in economies. Billions of dollars or euros were pumped into the EU economies, mainly into their financial sectors, in order to aid recovery from the deep recession. According to public debt-to-GDP ratio dynamics, it is possible to indicate three types of economies. The first group comprises countries where initial public debt-to-GDP ratios were low and remained relatively low (e.g., Luxembourg, Norway, and Switzerland). The second group comprises those countries where initial public debt-to-GDP ratios were very high (more than 100%), then lowered, and increased again during the crisis (e.g., Belgium and Italy). The third group comprises economies where initial public debt-to-GDP ratios were at acceptable levels of about 40% and then increased; this is the biggest group comprising most European countries (e.g., the Czech Republic, France, Germany, Poland, and the United Kingdom). In this study, we do not consider the debt-to-GDP ratio as a cause of all economic difficulties but rather as an instrument of fiscal policy that is often accompanied by worse values of other economic variables, such as GDP, long- and short-term interest rates, CPI, cost of new residential buildings index, and exchange rates (currency/USD) (Eyraud and Weber, 2013). Looking at long-term and short-term interest rates, the following features are observed.

1. Interest rates were in general lowered systematically, which was in accordance with the Washington Consensus (e.g., Austria, Belgium, Norway, and Poland)
2. In the case of Hungary and Portugal, interest rates were decreasing but increased in 2011.
3. In some cases, interest rates had an overall tendency to decrease but increased and decreased in the short run (e.g., Germany, Luxembourg, and Norway).

These facts motivated the subsequent parts of this study, in which we check whether the mentioned variables can significantly diversify the path of the growth rate over time into separate regimes. The cases of Japan and the USA were considered for comparison, the former because it is driven by different economic policy and the latter because it experienced the crisis and implemented the policy of economic loosing as the first economy in the world (Krugman, 2012).

3 Model

The problem described in Section 2 can be modeled by a wide class of switching models, such as TAR/SETAR models (Tong, 1990) and (Tsay, 1989), STR models (Granger and Teräsvirta, 1993), and Markov switching models (Hamilton, 1994). The models reveal different mechanisms of endogenous variable dynamics taking into account the way in which the dynamics change over time. As the threshold variable is to be verified and is assumed *a priori*, we found the threshold class of the models the most useful. Here the mechanism of growth is apparent due to the explicit threshold.

Let Y_t denote a k-dimensional random vector. The general model is

$$Y_t = B^{J_t} Y_t + A^{J_t} Y_{t-1} + H^{J_t} \varepsilon_t + C^{J_t} \tag{1}$$

where J_t is a random variable taking values of a finite set of natural numbers $\{1, 2, 3, ..., p\}$, B^{J_t}, A^{J_t}, H^{J_t} are $k \times k$-dimensional matrixes of the coefficients, ε_t is the k-dimensional white noise, and C^{J_t} is a constant vector, which is called a canonical form of the threshold model. This defines a wide class of the models, depending on the choice of J_t. When J_t is a function of Y_t, then we obtain a SETAR model. The TAR/SETAR($p; k_1, k_2, \ldots, k_p$) model is defined as follows:

$$Y_t = \alpha_0^j + \sum_{i=1}^{k_j} \alpha_i^j Y_{t-i} + h^j \varepsilon_t \tag{2}$$

conditionally on X_{t-d}, where $X_{t-d} = \{X_{i,t-d}, Y_{t-d}\} \in R_j, j = 1, ..., p$. It is useful to present the two-regime model with $I(y)$ function.

$$I(y) = \begin{cases} 0 & \text{when} \quad Y_{t-d} \leq 0 \\ 1 & \text{when} \quad Y_{t-d} > 0 \end{cases}, \tag{3}$$

and the corresponding SETAR($2, k, k$) model

$$Y_t = (\alpha_0 + \alpha_1 Y_{t-1} + \ldots + \alpha_k Y_{t-k}) + (\beta_0 + \beta_1 Y_{t-1} + \ldots + \beta_k Y_{t-k}) \cdot I\left(Y_{t-d}\right) + \varepsilon_t \tag{4}$$

If all $\beta_0, \beta_1, ..., \beta_k$ parameters are zeros, then (4) becomes the linear autoregressive model. When the autoregressive model is considered, its stationarity becomes the crucial point. For the linear autoregressive model, the conditions of stationarity are well known and easy to satisfy (see Box and Jenkins (1970)). In the case of the SETAR or TAR model, the problem is much more complicated. Even stationary models within the regimes do not guarantee stationarity of the whole system. Niglio et al. (2012) analyzed this problem, based on studies by Petruccelli and Woolford (1984) and Chan et al. (1985), among others. In the case of the two-regime SETAR model (5), when k is greater than 1, the following stationarity conditions must be satisfied (An and Huang (1996), Ling (1999)):

$$max_j \sum_{i=1}^{k} \left| \alpha_i^{(j)} \right| < 1$$

$$\sum_{i=1}^{k} max_j \left| \alpha_i^{(j)} \right| < 1$$

The SETAR model with more than two regimes and other cases of the TAR model are rarely the subject of analysis in the context of the whole system, because the formal conditions for SETAR(2) are difficult to generalize. Although ergodicity conditions as well as distribution stationarity are known (Chen and Tsay, 1991), formalization of the conditions for a given system is very rare. As Tong (2007) pointed out, one of the problems is the asymmetry of the probability density function in the case of threshold models, such as the skew-Gaussian and skew-t models. For further discussion, see Tong (2011). Another solution, taking into account statistical aspects, is testing for unit roots within a specified TAR/SETAR system. Kapetanios and Shin (2006) proposed and developed a test for unit roots in a three-regime SETAR model. Again, the situation is complicated when formulating a generalized procedure appropriate for any threshold model. The most popular—but not very elegant—approach applied in practice ensures stationarity, first, at the stage of standard procedure of testing a time series for a unit root and, second, within each regime of the TAR/SETAR model. This has been applied in the research reported in the remainder of the paper.

In our research, the following economic threshold model was applied:

$$GDP_t = \begin{cases} \alpha_0^1 + \alpha_1^1 GDP_{t-1} + \ldots + \alpha_{k_1}^1 GDP_{t-k_1} + \varepsilon_t & \text{for} \quad X_{t-d} \leq r_1 \\ \alpha_0^2 + \alpha_1^2 GDP_{t-1} + \ldots + \alpha_{k_2}^2 GDP_{t-k_2} + \varepsilon_t & \text{for} \quad r_1 < X_{t-d} \leq r_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & \ldots \quad \ldots\ldots\ldots\ldots\ldots \\ \alpha_0^p + \alpha_1^p GDP_{t-1} + \ldots + \alpha_{k_p}^p GDP_{t-k_p} + \varepsilon_t & \text{for} \quad X_{t-d} > r_p \end{cases} . \tag{5}$$

where X_{t-d} is a set of threshold variables that are described in Section 4. In SETAR model (5), the threshold variable is the lagged endogenous variable (here, GDP_t). In the case of monthly data, GDP was replaced by the industrial production index (IPI). When we consider other threshold variables from a set of lagged exogenous variables, say $\{X_t\}$, the resulting model is called a TAR model.

The analyzed time series cover the period of financial crisis of 2008–2010. To eliminate possible impact of changes resulting from the crisis, we included additional dummy variable $Crisis_t$, i.e.

$$Crisis_t = \begin{cases} 1, & \text{for period 2008:01} - \text{2010:12} \\ 0, & \text{in other cases} \end{cases} .$$

First signals of the crisis were observed in 2007 in United States and continued later in 2008. In 2008 the crisis expanded to other countries resulting in the global recession, which remained in the Eurozone till 2010. Including the variable $Crisis_t$ to the models was intended to check the robustness of proposed approach. We estimated both types of models: with and without dummy variable $Crisis_t$ in each regime. Sequent observations of the dummy variable were assigned to the regimes according to the threshold variable. As a consequence coefficients at the $Crisis_t$ indicated the magnitude of correction of the constant level within the regimes. This fact strengthened the effect of the crisis.

Obviously the statistical identification of the TAR/SETAR model may be limited by the data, but it is interesting to reveal the most likely differences for the mechanism's change within similar economic system. The level of economic development of particular EU countries remains still diversified that determines the expected results. For these reasons, we assumed the same set of threshold variables that were the subject of testing for both growth measures: GDP growth rate for quarterly data and IPI for monthly data.

4 Data

The data in the form of time series covered the period from the beginning of 1995 to the end of 2013. Time-series data were taken from official statistics of Eurostat. The research was organized into two separate panels, that is, time series observed quarterly and monthly. Quarterly data included (short names are given in brackets): the GDP growth rate (GDP), unemployment rate (UNEMP), public debt as a percentage of GDP (DEBT), interest rates (longIR and shortIR), CPI (CPI), cost of new residential buildings index (ESTATE), exchange rates denominated in USD (EXR), and their first differences. It was assumed that the GDP growth rate was the endogenous variable and the lagged remaining variables were supposed to be thresholds for regime changes. The regimes correspond to the phases of an economic cycle. In fact, what we examined was a business cycle across European countries. To eliminate non-stationarity, the original GDP series were detrended with a Hodrick–Prescott (HP) filter with $\lambda = 1600$.

Following this idea, we decided to check monthly data, which consist of industrial production index (IPI), interest rates (longIR, shortIR), CPI and first differences of CPI, exchange rates denominated in USD (EXR) and its first differences. Being in line with the previous panel we assumed that the IPI is the endogenous variable.

All the original data were seasonally adjusted and transformed into logs. Time series were filtered using the HP filter and tested for stationarity using Augmented Dickey–Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. The number of regimes was restricted to three for the following reasons: relatively short time series and reasonable interpretation of the business cycles in the cases of prosperity, recession, and the intermediary states of increasing and decreasing GDP.

The TAR/SETAR models are originally suitable for stationary time series. The results of testing for stationarity for detrended GDP and IPI series are presented in table 1. Data from the USA and Japan were taken for comparison.

It is noticeable that all the time series of interest are stationary when the KPSS test results are considered (Kwiatkowski et al., 1992). In the case of the ADF test (Dickey and Fuller, 1979), in five cases, the test statistics were higher than the 5% critical value, but due to the smaller power of the ADF test, the KPSS was preferred. When the threshold variables were considered, they were taken into

Table 1: Results of testing for unit roots

Frequency: quarterly			Frequency: monthly		
Variable	t_{ADF}	μ_{KPSS}	Variable	t_{ADF}	μ_{KPSS}
Austria_GDP	-3.602535	0.090413	Austria_IPI	-3.134454	0.091254
Belgium_GDP	-2.998182	0.084473	Belgium_IPI	-3.002986	0.096155
Czech_GDP	-3.666064	0.084655	Czech_IPI	-2.860445	0.094126
Denmark_GDP	-3.331706	0.073707	Denmark_IPI	-4.265872	0.057792
Finland_GDP	-3.985277	0.072443	Finland_IPI	-3.333381	0.077884
France_GDP	-3.132938	0.092853	France_IPI	-3.225340	0.089785
Germany_GDP	-3.529351	0.069103	Germany_IPI	-3.568179	0.065706
Hungary_GDP	-3.028876	0.082063	Hungary_IPI	-4.641119	0.069914
Italy_GDP	-3.092656	0.067824	Italy_IPI	-2.537608	0.120174
Japan_GDP	-3.426199	0.098099	Latvia_IPI	-2.856016	0.122569
Latvia_GDP	-2.717347	0.112239	Lithuania_IPI	-2.165379	0.088470
Lithuania_GDP	-2.425999	0.093371	Luxembourg_IPI	-3.682101	0.067238
Luxembourg_GDP	-2.814069	0.085169	Netherlands_IPI	-3.700299	0.082195
Netherlands_GDP	-2.703567	0.106519	Norway_IPI	-3.925349	0.083579
Norway_GDP	-4.013167	0.061905	Poland_IPI	-2.681694	0.104379
Poland_GDP	-3.553682	0.083245	Slovakia_IPI	-2.588174	0.156716
Slovakia_GDP	-2.496298	0.143578	Slovenia_IPI	-2.005931	0.128169
Slovenia_GDP	-3.309978	0.122970	Spain_IPI	-2.635801	0.114826
Spain_GDP	-2.671723	0.187489	Sweden_IPI	-3.601550	0.071867
Sweden_GDP	-3.731164	0.059687	Switzerland_IPI	-2.386782	0.139405
Switzerland_GDP	-3.002516	0.099492	UK_IPI	-3.824086	0.063443
UK_GDP	-2.906273	0.092184			
USA_GDP	-3.321318	0.099664			

The critical value for the ADF test at the $\alpha = 5\%$ significance level is $t_{50,5\%} = -2.0086$
The critical value for the KPSS test at the $\alpha = 5\%$ significance level is $\mu_{KPSS_{5\%}} = 0.462$

account in both ways: non-stationary levels and stationary first differences. This was in order to examine the level or dynamics of the threshold (switching) variable.

The dynamics of the level of GDP in comparison with the level of public debt-to-GDP ratio and the cost of new residential buildings index is shown in Figures 1 and 2.

In Figure 1, the original quarterly data before transformation are shown. The compared indicators are GDP and debt-to-GDP ratio, and GDP and real estate cost index. The figures show quite different patterns of dynamics of GDP and the possible thresholds. It is somewhat difficult to conclude that the public debt-to-GDP ratio in different periods dramatically changes to a positive trend in GDP growth. This can be explained in particular for the case of the United Kingdom. When the GDP growth collapsed in 2007–2008, the debt-to-GDP ratio was far below 50%. Starting from the lowest level of GDP in 2009, debt systematically increased, pulling GDP up to current levels. The case of the United States, presented in Figure 3, is similar to that of the United Kingdom.

In the case of monthly data, short-term interest rates are shown in Figure 4 together with the IPI for Spain and the United Kingdom. It can be observed that financial policy instruments are of lower efficiency in the term of recession and after, which supports the findings of (Leigh et al., 2010).

5 Empirical results

The procedure of the research was organized as follows. First, the regime's number was selected based on quantiles of threshold variables. Due to the relatively small numbers of observations, quartiles were used in computations. Minimum Bayesian information criterion (BIC) was the criterion of selection for both the number of regimes and the threshold variable. Two or three regimes were chosen in all cases. If threshold values within regimes were close, then the two-regime model was enforced instead of the three-regime model. Second, the threshold variables were analyzed and for the chosen threshold, the models of the form (5) were estimated using the conditional ordinary least squares method Tong (1983, 1990). The values of maximum lag in regimes and maximum delay of the threshold variable were limited up to value of 6, due to the limited numbers of observations. All the methodological aspects of the threshold model construction, including testing for the number of regimes, the choice of threshold variable, parameter estimation, and testing for stability of the results, were projected and carried out using `gretl` computer package. Stationarity of the autoregressive component within regimes was ensured at the stage of estimation. The procedures of selection and estimation of the threshold models was originally written by the authors of this paper and are available in `gretl` package. The results of

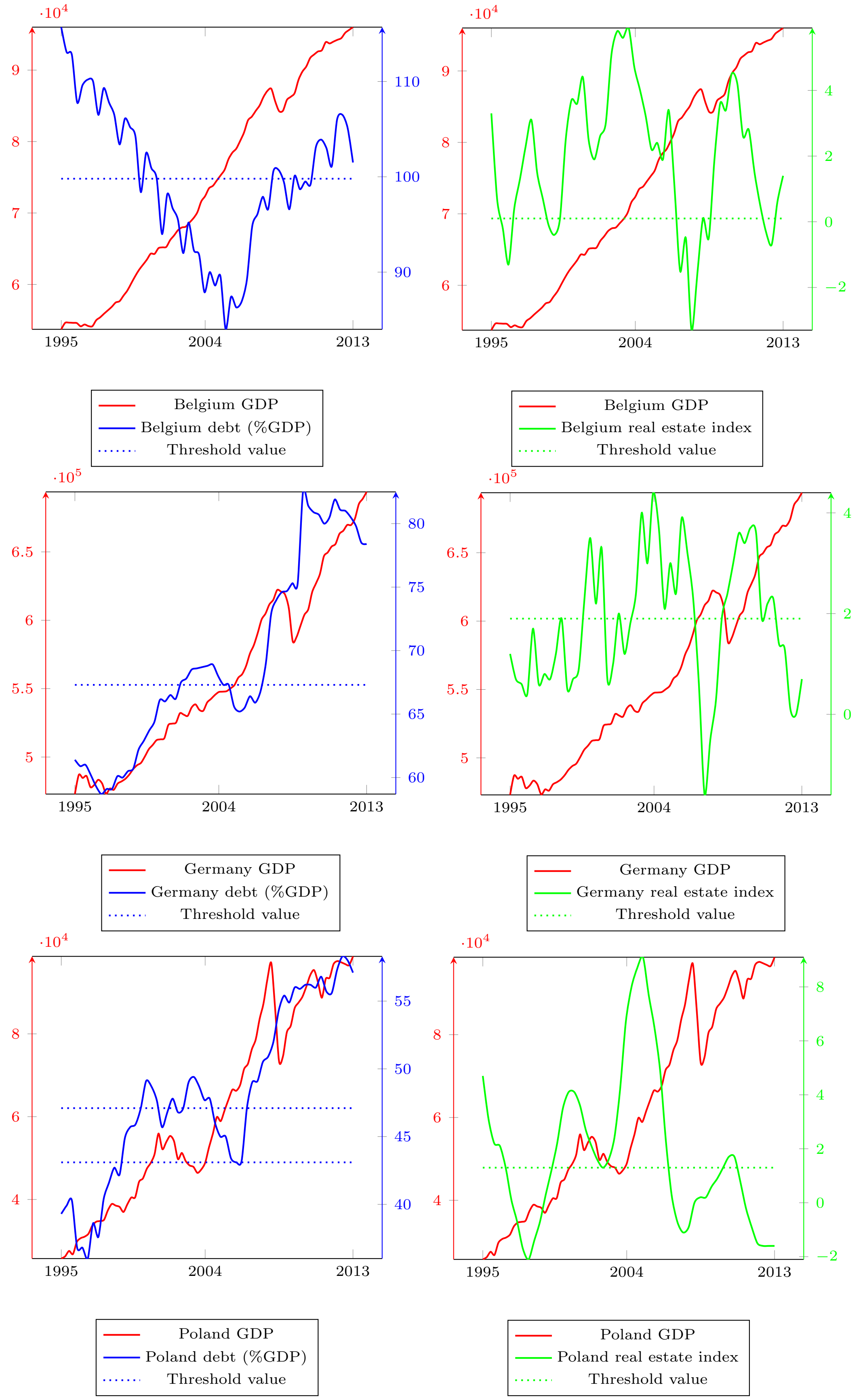

Figure 1: GDP in comparison to debt-to-GDP ratio and to real estate countries in selected European countries (Belgium, Germany and Poland)

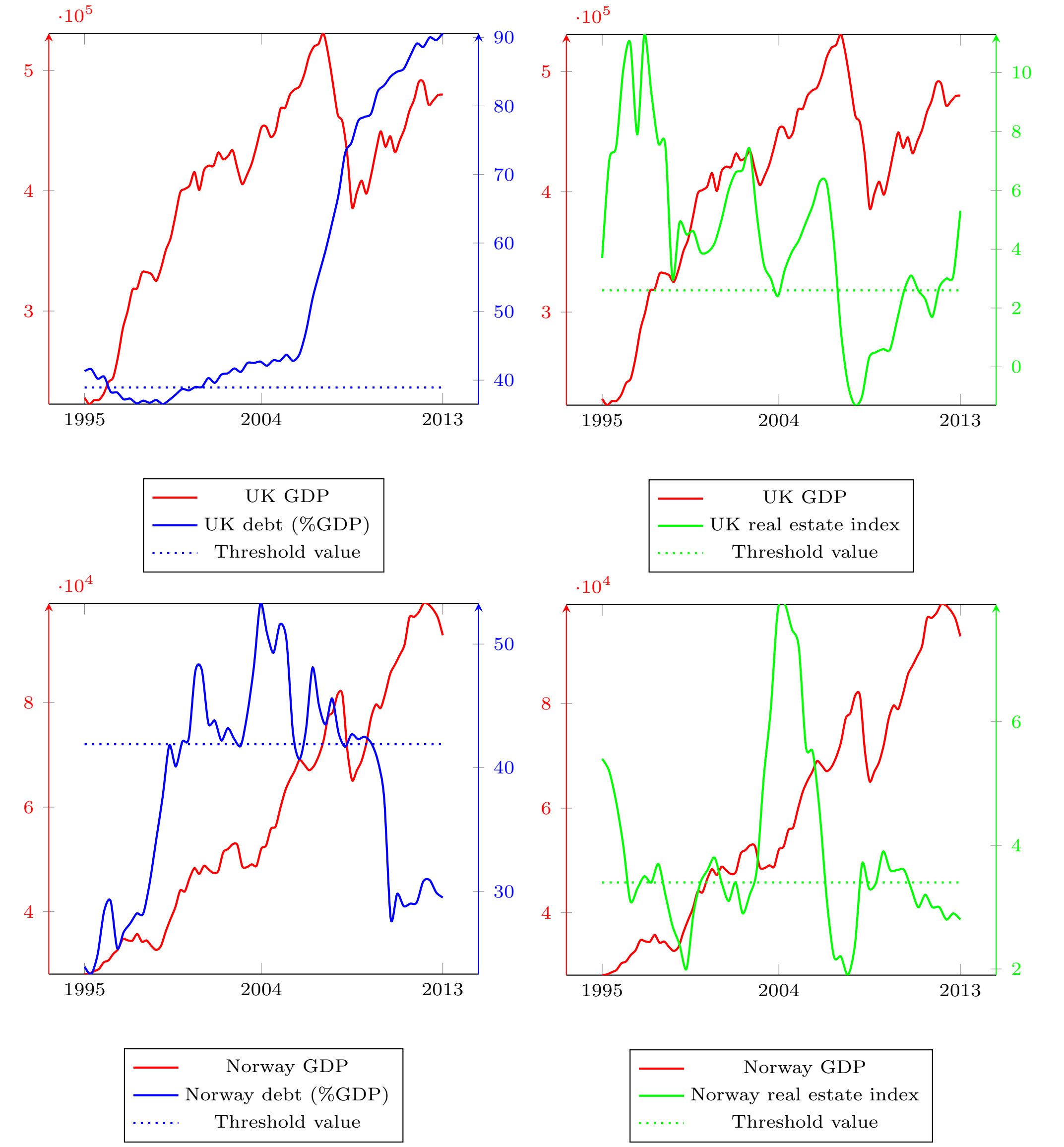

Figure 2: GDP in comparison to debt-to-GDP ratio and to real estate countries in selected European countries (United Kingdom and Norway)

selection of the threshold variable and the number of regimes are presented in Tables 2-4 (quarterly data), and 5-7 (monthly data).

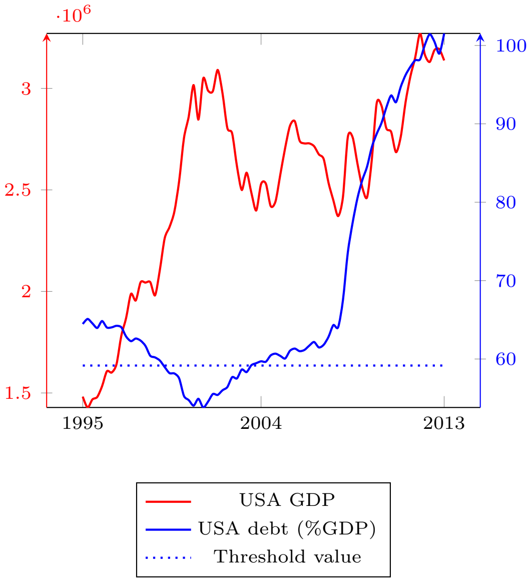

Figure 3: GDP in comparison to debt-to-GDP ratio in the USA

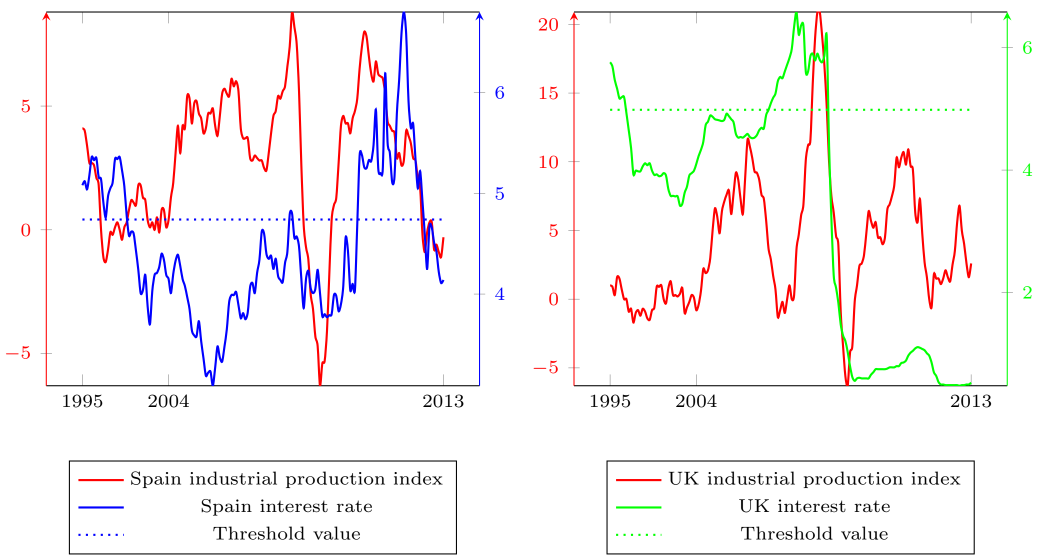

Figure 4: The industrial production index in Spain and United Kingdom in comparison to short term interest rate

Table 2: Threshold models selected for quarterly data (emerging economies)

Country		GDP	ΔGDP	UNEMP	ΔUNEMP	DEBT	ΔDEBT	ESTATE	ΔESTATE	CPI	ΔCPI	long IR	Δlong IR	short IR	Δshort IR	EXR	ΔEXR
Czech	BIC	-330.298	-330.469	-335.070	-329.250	-242.753	-231.715	-230.290	-214.012	**-339.443**	-333.404	-242.969	-234.251	-335.966	-324.958	-334.219	-320.899
	tr1	-0.031	0.003	1.629	-0.028	28.600	-0.008	1.200	-0.000	**1.800**	-0.001	4.145	-0.030	3.460	-0.345	19.780	-0.008
	tr2	0.023	0.039	NA	NA	NA	NA	3.800	NA	**6.700**	NA	5.090	NA	NA	0.080	NA	NA
	tr_lag	4	1	3	1	1	1	1	1	**2**	1	1	1	3	1	3	1
Czech $Crisis_t$	BIC	-325.501(*)	-324.311(*)	-330.150(*)	-328.836(*)	-240.870(*)	-224.353	-224.477(*)	-216.091(*)	-336.058	-324.932	-231.379	-245.235(*)	-327.545	-321.622(*)	-334.158(*)	-320.117(*)
	tr1	-0.007	0.023	1.946	-0.028	28.600	-0.005	2.200	-0.007	2.800	-0.001	4.145	-0.030	3.460	-0.345	20.420	-0.008
	tr2	NA	0.039	NA	NA	NA	NA	3.800	NA	6.500	NA	5.090	NA	NA	0.080	NA	NA
	tr_lag	2	1	7	1	1	2	2	1	1	1	1	1	3	1	5	1
Hungary	BIC	-299.195	-299.908	-277.731	-278.983	-204.881	-205.088	-197.825	-200.960	-298.219	-289.408	-236.536	-226.787			-306.182	-302.662
	tr1	-0.030	-0.002	2.022	0.000	59.300	-0.017	4.700	-0.009	6.700	-0.003	7.600	-0.070			182.130	-0.028
	tr2	NA	NA	NA	0.017	NA	NA	6.700	NA	NA	NA	NA	0.320			206.480	NA
	tr_lag	5	1	2	1	1	1	3	2	4	1	3	2			6	1
Hungary $Crisis_t$	BIC	-310.317[1]	-293.506	-274.768(*)	-272.105(*)	-214.526(*)	-200.615	-196.855(*)	-194.631(*)	-302.111(*)	-286.051(*)	-242.572(*)	-224.895			-302.862(*)	**-306.649**(*)
	tr1	-0.026	-0.002	2.028	-0.022	66.150	-0.017	4.700	-0.009	6.500	-0.011	7.600	-0.070			183.590	**-0.028**
	tr2	NA	NA	NA	NA	NA	NA	6.700	0.008	NA	NA	NA	0.320			NA	**NA**
	tr_lag	8	1	1	1	2	1	3	2	1	1	3	2			5	**1**
Poland	BIC	-254.430	-254.461	-224.316	-225.165	-179.891	-171.931	-167.560	-177.354	-260.997	-246.160	-173.560	-174.157	-261.815	-257.136	-261.471	-250.886
	tr1	-0.005	-0.003	2.272	-0.030	43.100	0.005	1.300	-0.001	4.100	-0.003	5.860	-0.135	4.760	-0.140	2.840	-0.040
	tr2	NA	NA	NA	NA	47.100	NA	NA	0.006	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	6	1	3	1	5	1	1	2	3	2	3	1	5	1	5	1
Poland $Crisis_t$	BIC	-254.739(*)	-253.851(*)	-216.961	-225.185(*)	-176.460(*)	-171.146(*)	-161.407	-173.282(*)	-256.709(*)	-241.778(*)	-171.332(*)	-173.430	**-271.865**(*)	-249.037	-266.659(*)	-256.399(*)
	tr1	-0.005	-0.003	2.272	-0.030	43.175	-0.010	1.300	0.000	2.300	-0.002	5.860	-0.135	**6.150**	-0.140	2.830	0.003
	tr2	0.029	NA	NA	NA	NA	0.005	NA	0.006	4.100	NA	NA	NA	**NA**	NA	NA	NA
	tr_lag	8	1	3	1	2	1	1	4	3	1	3	1	**2**	1	6	1
Slovenia	BIC	-448.753	-441.842	-426.068	-428.621	-332.005	-332.057	-352.537	-354.874	**-454.546**	-434.160	-287.220	-287.018	-308.681	-279.833	-451.044	-439.148
	tr1	-0.003	0.013	1.902	-0.028	27.500	0.004	5.300	-0.005	**5.500**	-0.007	4.680	-0.248	0.880	-0.020	0.800	0.000
	tr2	NA	NA	NA	0.000	NA	NA	NA	NA	**NA**	NA	NA	-0.050	4.850	NA	NA	NA
	tr_lag	6	1	1	3	1	1	1	1	**3**	1	1	1	1	1	8	1
Slovenia $Crisis_t$	BIC	-441.858	-441.918(*)	-419.004	-422.455	-328.080(*)	-324.623(*)	-347.194(*)	-346.808	-446.792	-433.112(*)	-284.977	-283.334	-304.443(*)	-273.227	-447.130(*)	-435.063
	tr1	-0.014	0.013	1.902	-0.028	26.300	0.004	5.400	-0.017	5.500	-0.007	4.680	-0.248	3.670	-0.020	0.760	0.000
	tr2	NA	NA	NA	0.000	NA	0.044	NA	NA	NA	NA	NA	NA	4.850	NA	NA	NA
	tr_lag	8	1	1	3	5	1	4	1	3	1	1	1	1	1	8	1
Slovakia	BIC	-356.492	-350.285	-299.877	-291.781	-269.972	-266.951	-324.293	-322.490	-357.909	-345.283	-258.906	-238.727			**-361.741**	-344.728
	tr1	-0.028	0.005	2.573	-0.005	34.024	-0.000	2.400	0.000	4.600	-0.008	4.680	-0.110			**0.760**	-0.028
	tr2	0.008	NA	NA	NA	NA	NA	NA	0.002	7.300	NA	NA	NA			**0.910**	NA
	tr_lag	4	1	1	5	2	1	1	1	1	1	2	2			**7**	2
Slovakia $Crisis_t$	BIC	-352.860	-347.187(*)	-292.306	-283.736	-262.199	-265.921(*)	-317.174	-332.164(*)	-352.088	-341.293	-252.590	-233.173			-356.566(*)	-338.404
	tr1	-0.009	0.021	2.573	-0.005	34.024	-0.024	2.400	0.000	3.400	-0.001	4.680	-0.110			0.760	-0.028
	tr2	0.008	NA	NA	NA	NA	NA	NA	0.002	NA	NA	NA	NA			NA	NA
	tr_lag	8	1	1	5	2	1	1	1	7	1	2	2			8	2

(*) This means that the $Crisis_t$ was significant.

[1] This was the best model but the $Crisis_t$ was insignificant so the second best model was selected.

Results for the best model for certain country are bolded.

Table 3: Threshold models selected for quarterly data

Country		GDP	ΔGDP	UNEMP	ΔUNEMP	DEBT	ΔDEBT	ESTATE	ΔESTATE	CPI	ΔCPI	long IR	Δlong IR	short IR	Δshort IR	EXR	ΔEXR
EU28	BIC	-491.378	-486.437	-335.335	-341.856			-489.313	-491.694								
	tr1	-0.010	0.005	2.152	-0.011			2.500	-0.004								
	tr2	0.007	NA	NA	NA			NA	0.004								
	tr_lag	1	1	1	1			6	1								
EU28 $Crisis_t$	BIC	**-497.906**$^{(*)}$	-488.508$^{(*)}$	-346.526$^{(*)}$	-341.586			-489.514$^{(*)}$	-484.662$^{(*)}$								
	tr1	**0.000**	0.005	2.152	0.000			2.200	-0.004								
	tr2	**0.007**	NA	NA	0.019			NA	0.004								
	tr_lag	**1**	1	1	1			2	1								
EURO18	BIC	-563.715	-564.954	-462.683	-471.180	-411.013	-396.980	-568.375	-558.191			-569.210	-557.835	-571.293	-566.913	-580.434	-555.473
	tr1	-0.008	0.004	2.125	0.000	69.100	-0.006	2.600	0.000			4.440	-0.110	3.390	-0.030	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	NA	NA			NA	NA	NA	0.105	NA	NA
	tr_lag	2	1	1	1	1	1	3	1			6	1	6	2	7	1
EURO18 $Crisis_t$	BIC	-584.986	-570.519$^{(*)}$	-455.326	-474.510$^{(*)}$	-403.627	-395.635	-565.768$^{(*)}$	-550.929			-577.794$^{(*)}$	-561.814$^{(*)}$	**-586.038**$^{(*)}$	-565.143$^{(*)}$	-576.842$^{(*)}$	-552.960$^{(*)}$
	tr1	-0.004	0.004	2.214	0.000	69.100	0.003	1.900	0.000			4.490	-0.110	**3.460**	-0.330	0.760	0.000
	tr2	0.006	NA	NA	0.019	NA	NA	3.500	NA			NA	NA	**NA**	0.102	NA	NA
	tr_lag	8	1	1	1	1	1	4	1			7	1	**8**	1	7	1
Austria	BIC	**-557.928**	-549.541	-553.448	-557.066	-425.762	-417.977	-553.418	-549.446	-554.165	-546.170	-551.344	-550.643	-557.792	-550.472	-556.260	-547.998
	tr1	**0.002**	0.009	1.459	-0.024	66.800	0.006	2.600	-0.005	2.000	-0.002	4.350	-0.330	3.340	0.005	0.800	0.000
	tr2	**NA**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	**1**	1	2	1	1	1	6	1	2	1	4	1	5	1	7	1
Austria $Crisis_t$	BIC	-555.955	-550.004$^{(*)}$	-554.576$^{(*)}$	-549.167	-429.135$^{(*)}$	-417.972$^{(*)}$	-549.228	-542.689	-553.811$^{(*)}$	-538.802	-548.853$^{(*)}$	-542.851	-553.552$^{(*)}$	-547.257$^{(*)}$	-552.290$^{(*)}$	-541.626
	tr1	0.003	0.009	1.459	-0.024	69.900	0.006	2.600	-0.005	2.000	0.000	4.410	-0.330	3.340	0.005	0.760	-0.028
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	8	1	2	1	1	1	6	1	3	1	6	1	6	1	6	1
Belgium	BIC	-526.922	-517.201	-532.815	-514.278	-371.070	-363.770	-341.536	-338.758	-523.902	-514.832	-529.454	-533.741	-529.437	-519.482	-528.221	-517.458
	tr1	0.001	0.009	2.001	-0.022	99.800	-0.007	0.100	-0.002	1.400	0.001	4.370	-0.315	3.270	0.000	0.760	0.000
	tr2	0.014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.080	NA	NA	NA	NA
	tr_lag	6	1	5	1	1	1	1	2	5	1	5	1	4	1	7	1
Belgium $Crisis_t$	BIC	-534.807$^{(*)}$	-515.020$^{(*)}$	**-545.637**$^{(*)}$	-511.314$^{(*)}$	-373.318$^{(*)}$	-357.104	-340.865$^{(*)}$	-328.708$^{(*)}$	-532.149$^{(*)}$	-521.841$^{(*)}$	-527.267$^{(*)}$	-522.487	-533.289$^{(*)}$	-512.298	-524.088$^{(*)}$	-517.785$^{(*)}$
	tr1	0.001	0.009	**2.001**	-0.022	94.800	-0.007	0.100	-0.002	1.800	0.001	4.400	-0.315	3.310	0.000	0.760	0.000
	tr2	0.015	NA	**NA**	NA	NA	NA	NA	0.009	NA	NA	NA	-0.080	4.450	NA	NA	NA
	tr_lag	7	1	**5**	1	1	1	1	2	4	1	6	1	8	1	6	1
Denmark	BIC	-437.342	-427.962	-438.418	-428.170	-308.252	-305.638	-412.121	-408.189	-440.143	-427.368	-434.986	-435.985	-435.614	-434.094	-442.190	-427.622
	tr1	-0.000	0.001	1.482	-0.039	37.800	-0.006	2.500	0.000	1.800	-0.004	4.530	-0.365	2.190	-0.025	5.630	-0.005
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	6	1	4	1	1	2	1	1	4	1	6	1	4	1	4	1
Denmark $Crisis_t$	BIC	-431.213	-423.980	-435.512	-424.812	-307.561$^{(*)}$	-294.379	-408.965$^{(*)}$	-401.325	**-443.078**$^{(*)}$	-429.847$^{(*)}$	-431.097$^{(*)}$	-428.885	-434.309$^{(*)}$	-425.992	-436.499$^{(*)}$	-423.787$^{(*)}$
	tr1	-0.008	0.001	1.482	0.000	37.800	-0.006	2.500	0.000	**1.800**	0.000	4.610	-0.365	3.680	-0.025	5.630	-0.005
	tr2	NA	NA	NA	NA	NA	0.029	NA	NA	**NA**	NA	NA	NA	4.960	NA	NA	NA
	tr_lag	5	1	4	1	1	2	1	1	**4**	1	7	1	8	1	7	1
Finland	BIC	-445.156	-455.132	-442.629	-451.281	-324.566	-316.422	-433.826	-432.045	-449.599	-437.213	-456.570	-444.691	-448.783	-446.147	-455.583	-442.181
	tr1	-0.002	0.003	2.079	-0.012	43.100	0.009	1.300	-0.005	0.800	-0.003	4.430	-0.355	3.280	-0.257	0.760	-0.028
	tr2	NA	0.011	NA	NA	NA	NA	3.100	NA	NA	NA	NA	NA	NA	0.157	NA	NA
	tr_lag	1	1	5	1	1	1	1	1	2	2	5	2	4	3	7	1
Finland $Crisis_t$	BIC	-441.840$^{(*)}$	-443.559$^{(*)}$	-435.710	**-457.217**$^{(*)}$	-322.119$^{(*)}$	-309.072$^{(*)}$	-433.112$^{(*)}$	-429.649$^{(*)}$	-444.264	-438.885$^{(*)}$	-444.167$^{(*)}$	-438.740	-454.582$^{(*)}$	-444.278$^{(*)}$	-452.298	-450.696$^{(*)}$
	tr1	-0.001	0.011	2.079	**-0.012**	39.600	-0.042	2.300	-0.005	0.800	-0.003	3.800	-0.355	3.340	-0.252	0.760	0.000
	tr2	NA	NA	NA	**NA**	NA	0.038	3.100	NA	NA	NA	NA	NA	4.540	0.153	NA	NA
	tr_lag	7	3	5	**2**	1	1	1	1	2	1	8	2	8	1	7	1
France	BIC	-571.138	-563.057	-574.010	-562.487	-410.989	-399.150	-561.562	-555.344	-576.973	-553.523	-564.943	-561.257	-567.644	-560.145	-567.130	-555.374
	tr1	-0.008	0.005	2.152	0.000	66.200	0.008	1.900	0.000	1.700	0.000	4.340	-0.105	1.640	-0.285	0.800	0.000
	tr2	0.007	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.890	0.125	NA	NA
	tr_lag	6	2	6	1	1	1	3	3	2	1	3	1	1	2	2	1
France $Crisis_t$	BIC	-577.530	-564.756$^{(*)}$	-573.959	-561.221$^{(*)}$	-402.221$^{(*)}$	-392.500	-561.326$^{(*)}$	-551.165$^{(*)}$	-579.185$^{(*)}$	**-562.921**$^{(*)}$	-561.762	-559.598$^{(*)}$	-568.879$^{(*)}$	-556.705$^{(*)}$	-561.851	-554.442$^{(*)}$
	tr1	0.002	0.005	2.152	0.000	66.150	0.008	1.800	0.000	1.700	**-0.003**	3.750	-0.105	3.390	-0.277	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA	NA	NA	0.117	NA	NA
	tr_lag	8	2	7	1	2	1	2	1	2	**1**	8	1	7	1	4	1
Germany	BIC	-493.049	-484.797	-494.935	-482.371	-347.275	-342.030	-316.426	-307.590	-488.380	-478.119	-489.765	-484.932	-487.798	-482.483	-489.044	-479.736
	tr1	-0.010	0.002	2.041	-0.027	67.300	0.001	1.900	-0.008	1.600	0.000	3.580	-0.347	3.290	0.005	0.760	-0.028
	tr2	0.008	NA	2.128	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	6	1	3	1	1	1	1	1	4	1	6	1	5	1	5	1
Germany $Crisis_t$	BIC	-493.863$^{(*)}$	-496.150$^{(*)}$	**-507.420**$^{(*)}$	-482.285$^{(*)}$	-341.846$^{(*)}$	-343.632$^{(*)}$	-320.009$^{(*)}$	-308.159$^{(*)}$	-504.477$^{(*)}$	-485.962$^{(*)}$	-497.752$^{(*)}$	-486.565$^{(*)}$	-505.728$^{(*)}$	-490.792$^{(*)}$	-494.103$^{(*)}$	-480.676$^{(*)}$
	tr1	-0.010	0.002	**2.128**	-0.027	67.300	0.001	1.900	-0.008	1.600	0.000	4.310	-0.347	1.640	-0.253	0.760	0.000
	tr2	0.008	NA	**NA**	NA	NA	NA	3.000	0.001	1.900	0.003	NA	NA	3.740	NA	NA	NA
	tr_lag	7	1	**3**	1	2	1	1	1	6	3	7	1	1	1	6	1
Ireland	BIC	-259.751	-250.299	-252.332	-243.906			-197.756	-191.889			-255.154	-245.830			-260.934	-240.974
	tr1	0.003	-0.029	5.100	-0.061			-99.259	-0.012			4.130	-0.310			0.760	0.000
	tr2	NA	0.032	NA	NA			NA	-0.001			NA	NA			0.850	NA
	tr_lag	4	1	1	1			1	1			2	1			8	1
Ireland $Crisis_t$	BIC	**-265.065**$^{(*)}$	-246.376$^{(*)}$	-257.174$^{(*)}$	-245.503$^{(*)}$			-205.213$^{(*)}$	-191.293$^{(*)}$			-255.642$^{(*)}$	-249.260$^{(*)}$			-254.084$^{(*)}$	-243.170$^{(*)}$
	tr1	**0.003**	-0.029	5.100	0.000			-97.883	-0.012			4.210	-0.310			0.760	0.000
	tr2	**NA**	NA	NA	NA			NA	NA			NA	NA			NA	NA
	tr_lag	**4**	2	3	2			1	1			5	1			8	1

Table 4: Threshold models selected for quarterly data

Country		GDP	ΔGDP	UNEMP	ΔUNEMP	DEBT	ΔDEBT	ESTATE	ΔESTATE	CPI	ΔCPI	long IR	Δlong IR	short IR	Δshort IR	EXR	ΔEXR
Italy	BIC	-505.011	-500.049	-502.484	-503.622	-372.948	-364.789	-506.520	-508.523	-512.660	**-516.382**	-506.488	-496.481	-504.931	-512.647	-514.475	-507.755
	tr1	-0.002	0.007	2.163	0.000	107.100	-0.009	1.900	-0.004	1.900	**0.000**	4.250	-0.100	3.290	-0.410	0.760	-0.028
	tr2	NA	NA	NA	NA	NA	NA	3.200	-0.001	NA	**0.002**	NA	NA	NA	0.145	0.800	0.034
	tr_lag	6	2	3	2	1	1	3	2	4	**1**	5	1	1	2	7	1
Italy $Crisis_t$	BIC	-506.118	-495.617$^{(*)}$	-490.479	-500.810$^{(*)}$	-365.904$^{(*)}$	-362.749$^{(*)}$	-507.114$^{(*)}$	-496.904	-504.876	-505.001	-503.134$^{(*)}$	-492.561$^{(*)}$	-500.295$^{(*)}$	-507.085	-509.212	-501.477$^{(*)}$
	tr1	-0.002	0.003	2.067	0.000	107.100	-0.009	1.800	-0.004	1.900	0.000	4.620	-0.120	3.290	-0.410	0.760	-0.028
	tr2	NA	NA	NA	NA	NA	0.005	3.200	-0.001	NA	NA	NA	NA	4.850	0.145	NA	0.034
	tr_lag	8	2	4	1	2	2	6	2	4	1	1	4	1	2	7	1
Luxembourg	BIC	**-341.727**	-334.479	-337.067	-333.683	-251.407	-248.454	-235.861	-230.819	-341.090	-330.662			-276.067	-274.471	-337.530	-334.913
	tr1	**0.003**	0.013	1.386	0.000	6.100	0.000	2.200	-0.005	1.500	-0.000			2.470	-0.235	0.800	0.000
	tr2	**NA**	NA	NA	NA	NA	NA	NA	NA	NA	NA			NA	0.172	0.910	NA
	tr_lag	**6**	2	3	2	1	1	1	1	1	1			1	1	8	2
Luxembourg $Crisis_t$	BIC	-335.403	-328.100$^{(*)}$	-331.745	-328.478$^{(*)}$	-233.531	-249.846$^{(*)}$	-237.182$^{(*)}$	-226.942$^{(*)}$	-339.923$^{(*)}$	-331.095$^{(*)}$			-275.140$^{(*)}$	-280.984$^{(*)}$	-332.851$^{(*)}$	-329.717$^{(*)}$
	tr1	0.007	-0.001	1.411	0.000	6.500	0.000	2.200	0.001	1.500	0.000			2.470	-0.235	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			NA	0.172	NA	NA
	tr_lag	8	3	2	3	4	1	1	2	1	2			1	1	5	1
Netherlands	BIC	-525.926	-514.605	-517.685	-511.810	-372.213	-366.367	-347.249	-337.800	-528.837	-503.103	-513.803	-509.692	-512.181	-511.927	-524.672	-503.018
	tr1	-0.000	0.004	1.253	-0.016	51.000	-0.014	1.900	-0.000	2.000	-0.003	3.580	-0.350	1.640	0.005	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	3.700	NA	NA	NA	NA	NA	3.680	NA	NA	NA
	tr_lag	6	1	1	1	1	1	1	1	3	2	2	1	1	1	8	1
Netherlands $Crisis_t$	BIC	-524.106	-510.569	-512.972$^{(*)}$	-505.339	-368.752	-360.292	-358.425$^{(*)}$	-343.250$^{(*)}$	**-533.514**$^{(*)}$	-500.141$^{(*)}$	-513.259$^{(*)}$	-505.500	-515.733$^{(*)}$	-518.624$^{(*)}$	-517.670	-500.080$^{(*)}$
	tr1	-0.000	0.004	1.253	-0.016	51.000	-0.014	1.900	0.000	**2.000**	-0.003	4.360	-0.090	1.640	-0.260	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	3.700	NA	**NA**	NA	NA	NA	3.680	NA	NA	NA
	tr_lag	7	1	3	1	1	1	1	3	**3**	1	7	1	1	1	7	1
Norway	BIC	-285.556	-278.961	-279.400	-272.972	-197.514	-202.427	-179.929	-173.772	-282.772	-273.100	-278.690	-269.086	**-288.072**	-270.916	-279.215	-269.812
	tr1	0.007	-0.003	1.131	0.000	41.900	0.004	3.400	-0.004	1.300	-0.003	5.190	-0.390	**4.750**	0.030	6.140	-0.002
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA	NA	NA
	tr_lag	4	1	1	1	2	1	1	1	1	1	6	1	**6**	1	5	1
Norway $Crisis_t$	BIC	-280.742$^{(*)}$	-272.344	-278.272$^{(*)}$	-269.156	-199.196$^{(*)}$	-208.699$^{(*)}$	-174.165	-172.431$^{(*)}$	-282.893$^{(*)}$	-269.180$^{(*)}$	-283.696$^{(*)}$	-280.213$^{(*)}$	-280.099	-263.738	-275.278$^{(*)}$	-274.427$^{(*)}$
	tr1	0.007	-0.003	1.163	0.000	41.900	0.004	3.000	-0.001	1.300	-0.003	4.810	-0.390	4.750	0.030	6.140	-0.002
	tr2	0.044	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	4	1	8	1	2	1	2	1	7	1	2	1	6	1	6	1
Spain	BIC	-559.229	-545.179	-562.921	-547.491	-420.415	-410.631	-563.839	-537.168	-552.460	-548.742	**-572.656**	-546.620	-571.002	-562.338	-560.891	-543.631
	tr1	-0.006	0.002	2.361	-0.010	43.500	-0.007	3.200	-0.007	2.900	0.000	**4.080**	-0.425	3.390	-0.373	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA	NA	0.102	NA	NA
	tr_lag	2	1	1	1	1	1	4	1	2	1	**5**	1	6	1	7	2
Spain $Crisis_t$	BIC	-554.101	-540.549$^{(*)}$	-556.282	-529.029	-415.905$^{(*)}$	-397.425	-557.522	-529.782	-549.632$^{(*)}$	-548.230$^{(*)}$	-564.475	-538.575	-563.120	-555.303$^{(*)}$	-552.701	-538.369
	tr1	-0.006	0.002	2.361	-0.010	43.500	-0.007	3.200	-0.007	2.900	0.000	4.080	-0.425	3.390	-0.373	0.760	0.000
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	2	1	2	3	1	1	4	1	3	1	5	1	6	1	7	1
Sweden	BIC	-318.557	-311.215	-318.611	-309.450	-223.467	-216.488	-313.373	-304.819	-313.671	-311.425	-312.832	-308.125	-318.178	-310.008	-317.704	-307.574
	tr1	-0.024	0.015	1.841	-0.011	38.600	-0.003	3.700	-0.001	1.500	-0.003	3.550	-0.405	3.420	-0.255	7.430	-0.003
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	5	2	5	2	1	1	5	1	6	1	5	2	5	1	7	1
Sweden $Crisis_t$	BIC	-320.827$^{(*)}$	-315.733$^{(*)}$	**-327.721**$^{(*)}$	-312.730$^{(*)}$	-230.065$^{(*)}$	-244.920$^{(*)}$	-315.268$^{(*)}$	-303.631$^{(*)}$	-321.759$^{(*)}$	-321.431$^{(*)}$	-318.061$^{(*)}$	-324.323$^{(*)}$	-325.666$^{(*)}$	-311.369$^{(*)}$	-325.471$^{(*)}$	-307.831$^{(*)}$
	tr1	-0.024	-0.004	**1.841**	-0.011	38.600	-0.033	3.600	-0.004	0.500	-0.003	3.650	-0.397	3.420	-0.255	6.850	-0.003
	tr2	NA	NA	**NA**	0.021	NA	-0.008	NA	NA	2.300	NA	NA	NA	NA	NA	NA	NA
	tr_lag	5	1	**6**	1	3	5	3	2	4	1	7	1	5	1	5	1
Switzerland	BIC	-368.409	-363.167							-364.484	-370.050	-360.684	-357.429	-359.900	-356.271	-359.507	-354.471
	tr1	-0.023	0.007							0.650	0.000	2.985	-0.315	0.283	-0.010	1.125	-0.031
	tr2	NA	NA							NA	0.004	NA	-0.060	NA	NA	NA	NA
	tr_lag	2	1							2	2	5	1	1	1	2	1
Switzerland $Crisis_t$	BIC	-363.359$^{(*)}$	-356.315							**-371.568**$^{(*)}$	-358.922	-364.919	-348.359	-356.757$^{(*)}$	-346.887	-353.953	-347.397
	tr1	-0.021	0.007							**0.400**	0.000	2.460	-0.315	1.545	-0.155	1.245	-0.031
	tr2	NA	NA							**NA**	0.004	NA	-0.060	NA	NA	NA	NA
	tr_lag	8	1							**4**	2	8	1	7	2	8	1
UK	BIC	-311.135	-301.577	-302.494	-298.448	-210.825	-207.751	-303.948	-298.135	-302.549	-299.242	-304.207	-300.323	-305.425	-303.764	-304.531	-294.855
	tr1	-0.032	-0.004	1.775	-0.020	38.925	0.011	2.600	-0.007	1.900	-0.003	4.755	-0.350	3.618	-0.230	0.620	-0.019
	tr2	0.042	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.163	NA	NA	NA
	tr_lag	4	1	4	1	1	1	2	1	2	2	3	1	4	1	1	1
UK $Crisis_t$	BIC	-312.156$^{(*)}$	-297.846$^{(*)}$	-314.776$^{(*)}$	-295.512	-198.873$^{(*)}$	-204.127	**-315.378**$^{(*)}$	-308.123$^{(*)}$	-308.544$^{(*)}$	-305.841$^{(*)}$	-314.469$^{(*)}$	-297.972$^{(*)}$	-311.403$^{(*)}$	-304.543$^{(*)}$	-314.686$^{(*)}$	-293.431$^{(*)}$
	tr1	0.001	0.016	1.629	-0.020	42.100	-0.002	**5.200**	-0.007	1.900	-0.002	4.895	-0.120	2.865	-0.230	0.570	0.000
	tr2	0.042	NA	NA	NA	NA	NA	**NA**	NA	2.675	NA	NA	NA	NA	NA	NA	NA
	tr_lag	3	1	5	1	4	1	**6**	1	4	1	6	1	1	1	2	1
Japan	BIC	-216.818	-214.783	-224.591	-211.900					-215.673	-213.441	-216.292	-216.887	-124.726	-132.335	-213.191	-212.838
	tr1	-0.051	-0.031	1.380	0.000					-0.200	-0.003	1.420	-0.050	0.330	-0.020	108.795	-0.027
	tr2	NA	NA	NA	0.026					NA	0.004	NA	NA	NA	0.010	NA	NA
	tr_lag	6	1	2	2					2	3	1	1	1	1	1	2
Japan $Crisis_t$	BIC	-217.050	-208.681	**-224.920**$^{(*)}$	-211.308$^{(*)}$					-221.970$^{(*)}$	-204.516	-212.656$^{(*)}$	-209.740	-99.120	-123.794	-218.567$^{(*)}$	-210.641$^{(*)}$
	tr1	-0.051	-0.006	**1.328**	0.000					-0.200	-0.003	1.420	-0.050	0.340	-0.020	91.332	-0.027
	tr2	NA	NA	**NA**	NA					0.125	NA	NA	NA	NA	0.010	118.440	NA
	tr_lag	8	1	**5**	1					7	1	1	1	8	1	6	1
US	BIC	-275.434	-269.474	-271.344	-260.972					-275.147	-259.386	-274.648	-258.552			-273.749	**-276.522**
	tr1	0.001	0.001	1.526	-0.011					1.700	-0.000	4.720	-0.425			1.099	**0.000**
	tr2	NA	NA	NA	NA					3.100	NA	NA	NA			1.316	**NA**
	tr_lag	1	1	1	1					3	1	5	1			1	**1**
US $Crisis_t$	BIC	-275.373$^{(*)}$	-267.362	-262.575$^{(*)}$	-252.437					-266.823	-254.088$^{(*)}$	-267.072	-251.376			-265.702	-273.053
	tr1	-0.046	0.001	1.526	-0.011					1.700	-0.004	4.720	-0.425			1.250	0.000
	tr2	NA	NA	NA	NA					NA	NA	NA	NA			NA	NA
	tr_lag	2	1	4	1					3	2	5	1			2	1

Table 5: Threshold models selected for monthly data (emerging economies)

Country		IPI	ΔIPI	CPI	ΔCPI	long IR	Δlong IR	short IR	Δshort IR	EXR	ΔEXR
Czech	BIC	-1338.090	-1340.275	-1348.358	-1344.171	-1091.712	-1079.383	-1354.049	-1351.206	**-1354.785**	-1341.122
	tr1	-0.033	-0.400	1.600	0.003	4.700	0.152	5.374	0.000	**17.940**	-0.028
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
	tr_lag	1	1	6	5	1	1	2	6	**6**	1
Czech $Crisis_t$	BIC	-1330.138	-1330.836	-1338.732	-1333.915	-1085.198	-1075.944(*)	-1338.053(*)	-1341.129	-1349.420(*)	-1337.512(*)
	tr1	-0.033	-0.400	1.600	0.003	4.700	0.152	4.234	0.000	17.940	0.007
	tr2	NA	NA	NA	NA	NA	0.270	NA	NA	NA	0.037
	tr_lag	1	1	6	5	1	1	4	6	6	3
Hungary	BIC	-1052.596	-1049.970	-1062.222	**-1064.249**	-1054.622	-1044.366			-1060.806	-1063.869
	tr1	-0.040	-1.910	7.600	**0.003**	6.373	-0.130			191.866	0.012
	tr2	NA	NA	NA	**NA**	NA	NA			NA	NA
	tr_lag	1	1	2	**1**	1	1			2	4
Hungary $Crisis_t$	BIC	-1042.666	-1040.025	-1051.906(*)	-1054.973	-1045.297(*)	-1034.200			-1052.205	-1054.007
	tr1	-0.040	-1.910	8.220	0.003	6.957	-0.130			191.866	0.024
	tr2	NA	NA	NA	NA	NA	NA			NA	NA
	tr_lag	1	1	5	1	1	1			2	5
Poland	BIC	-1055.589	-1047.625	**-1066.535**	-1065.694	-1049.599	-1042.445	-1067.917	-1064.313	-1064.457	-1063.005
	tr1	-0.014	-0.050	**7.819**	-0.001	5.986	0.070	15.966	0.045	2.930	0.000
	tr2	NA	NA	**NA**	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	**5**	3	1	1	2	3	4	4
Poland $Crisis_t$	BIC	-1045.805	-1045.839(*)	-1058.962(*)	-1058.939	-1048.369(*)	-1041.325(*)	-1057.536(*)	-1056.811	-1058.484(*)	-1054.529
	tr1	-0.014	-1.100	3.600	-0.001	5.986	-0.220	6.470	0.045	2.930	0.000
	tr2	NA	-0.300	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	1	5	1	1	5	3	5	4
Slovenia	BIC	-1400.831	-1400.017	-1418.661	-1415.935	-1111.021	-1090.173	-1125.699	-1112.443	**-1425.413**	-1410.403
	tr1	0.014	-0.200	7.860	0.004	5.237	-0.310	5.038	-0.020	**0.700**	-0.013
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
	tr_lag	1	1	6	1	2	1	1	1	**4**	4
Slovenia $Crisis_t$	BIC	-1395.107	-1413.413(*)	-1406.160	-1413.606(*)	-1097.502	-1084.369	-1116.110	-1111.421(*)	-1419.766(*)	-1402.729(*)
	tr1	-0.010	-0.300	5.100	-0.004	4.462	-0.010	5.038	-0.020	0.700	-0.013
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	2	1	1	1	1	1	4	6
Slovakia	BIC	-769.737	-773.249	-789.112	-789.956	-788.415	-789.049			-787.433	-782.069
	tr1	0.013	0.200	5.000	-0.003	5.030	0.100			0.750	-0.033
	tr2	NA	NA	NA	NA	NA	NA			NA	NA
	tr_lag	1	1	1	4	3	5			5	5
Slovakia $Crisis_t$	BIC	-761.489	-765.199	**-792.672**(*)	-788.469(*)	-791.955(*)	-782.961			-780.592	-775.645
	tr1	0.013	0.200	**4.200**	-0.003	4.675	0.100			0.700	-0.021
	tr2	NA	NA	**NA**	NA	5.030	NA			NA	NA
	tr_lag	1	1	**5**	4	4	5			2	6

(*) This means that the $Crisis_t$ was significant.
[1] This was the best model but the $Crisis_t$ was insignificant so the second best model was selected.
Results for the best model for certain country are bolded.

Table 6: Threshold models selected for monthly data

Country		IPI	ΔIPI	CPI	ΔCPI	long IR	Δlong IR	short IR	Δshort IR	EXR	ΔEXR
EU28	BIC	-1489.581	-1484.786								
	tr1	-0.022	-0.500								
	tr2	NA	0.000								
	tr_lag	1	1								
EU28 $Crisis_t$	BIC	-1486.719(*)	**-1509.658**(*)								
	tr1	-0.016	**-0.300**								
	tr2	NA	**NA**								
	tr_lag	1	**2**								
EURO18	BIC	-1574.131	-1570.849							-1595.156	-1588.033
	tr1	-0.023	-0.800							0.760	-0.034
	tr2	NA	NA							NA	NA
	tr_lag	1	2							2	6
EURO18 $Crisis_t$	BIC	-1568.316	**-1597.256**(*)							-1587.179	-1582.613(*)
	tr1	-0.023	**-0.300**							0.760	0.019
	tr2	NA	**NA**							NA	NA
	tr_lag	1	**2**							2	2
Austria	BIC	-1532.815	-1534.789	-1559.263	-1549.269	-1558.289	-1548.718	-1550.020	-1551.264	-1555.244	-1549.575
	tr1	0.012	0.100	2.400	-0.004	4.082	0.140	0.728	-0.190	0.760	-0.013
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	6	5	4	3	5	3	2	3
Austria $Crisis_t$	BIC	-1523.773	-1528.448	-1549.598	**-1561.271**(*)	-1553.511(*)	-1538.274	-1547.062(*)	-1557.623(*)	-1546.931	-1543.877
	tr1	-0.022	-0.100	2.400	**-0.004**	3.776	0.140	0.706	-0.040	0.760	0.019
	tr2	NA	NA	NA	**NA**	4.072	NA	NA	NA	NA	NA
	tr_lag	1	1	6	**1**	3	3	3	1	2	3
Belgium	BIC	-781.771	-788.792	-803.301	-797.760	**-823.304**	-803.278	-803.132	-803.955	-813.152	-794.280
	tr1	-0.051	-1.700	0.900	-0.005	**4.114**	0.010	2.140	-0.120	0.828	0.000
	tr2	NA	-0.300	3.400	-0.003	**5.126**	NA	4.780	NA	NA	NA
	tr_lag	1	1	5	1	**6**	1	6	2	1	1
Belgium $Crisis_t$	BIC	-778.657(*)	-790.219(*)	-794.906	-796.589(*)	-807.862(*)	-793.538	-795.865(*)	-792.289(*)	-800.536	-789.932(*)
	tr1	-0.051	-1.100	0.900	-0.003	4.290	0.010	2.140	-0.050	0.700	0.009
	tr2	NA	-0.300	1.500	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	5	1	5	1	6	1	1	2
Denmark	BIC	-1206.650	-1207.243	-1222.996	-1193.908	-1209.580	-1219.061	-1223.001	-1197.747	-1212.012	-1189.763
	tr1	0.025	0.600	1.700	0.001	4.100	-0.050	2.200	-0.126	5.516	0.000
	tr2	NA	0.900	2.900	NA	NA	NA	5.372	0.153	NA	NA
	tr_lag	1	2	6	1	5	1	2	1	2	1
Denmark $Crisis_t$	BIC	-1200.799(*)	-1218.903(*)	**-1230.042**(*)	-1190.126(*)	-1222.251(*)	-1208.273	-1228.064(*)	-1198.512(*)	-1207.297(*)	-1196.782(*)
	tr1	0.008	-1.700	**1.700**	0.001	4.390	-0.050	2.200	-0.275	5.516	0.000
	tr2	0.025	NA	**NA**	NA	NA	NA	5.372	0.070	NA	0.030
	tr_lag	1	2	**6**	1	5	1	2	3	1	1
Finland	BIC	-1346.309	-1343.721	-1370.249	-1358.757	-1370.662	-1367.329	-1367.827	-1380.644	-1365.010	-1366.468
	tr1	0.025	0.700	0.300	0.001	5.484	0.000	4.360	-0.110	0.700	-0.021
	tr2	NA	NA	2.800	NA	NA	NA	NA	0.123	NA	NA
	tr_lag	1	1	5	3	4	1	5	1	1	1
Finland $Crisis_t$	BIC	-1345.638(*)	-1355.326(*)	-1369.801(*)	-1356.574(*)	-1359.263(*)	-1359.209	-1368.094(*)	**-1382.498**(*)	-1361.415(*)	-1360.557
	tr1	0.006	-1.200	0.300	0.000	4.060	0.060	1.460	**-0.050**	0.700	-0.021
	tr2	NA	NA	2.800	NA	NA	NA	NA	**0.080**	NA	NA
	tr_lag	1	2	5	1	6	2	6	**1**	1	1
France	BIC	-1642.153	-1640.425	-1662.444	-1674.289	**-1679.549**	-1666.143	-1668.051	-1666.015	-1668.045	-1665.142
	tr1	0.008	0.400	1.800	-0.003	**3.654**	0.122	1.380	-0.120	0.700	-0.034
	tr2	NA	NA	2.000	NA	**5.858**	NA	4.876	NA	NA	NA
	tr_lag	1	1	1	3	**1**	4	3	3	1	6
France $Crisis_t$	BIC	-1641.367(*)	-1668.369(*)	-1656.972(*)	-1676.859(*)	-1663.659(*)	-1657.065	-1674.222(*)	-1660.581(*)	-1665.437(*)	-1667.024(*)
	tr1	0.001	-0.400	1.300	-0.003	4.528	0.122	1.426	-0.244	0.700	-0.013
	tr2	NA	NA	2.320	-0.001	NA	NA	3.686	NA	NA	NA
	tr_lag	1	2	1	2	5	4	4	2	1	2
Germany	BIC	-1421.540	-1425.249	-1434.478	-1435.375	**-1464.613**	-1441.082	-1445.154	-1441.129	-1438.793	-1434.105
	tr1	0.005	-0.400	0.680	0.001	**5.214**	0.130	3.340	-0.050	0.760	0.000
	tr2	NA	0.100	NA	NA	**NA**	NA	4.680	NA	NA	NA
	tr_lag	1	3	3	1	**2**	6	1	2	1	1
Germany $Crisis_t$	BIC	-1414.803	-1432.061(*)	-1432.260(*)	-1426.732(*)	-1431.866(*)	-1430.905	-1452.928(*)	-1443.989(*)	-1430.094	-1426.683(*)
	tr1	0.005	-0.400	1.100	-0.002	4.346	0.130	4.202	-0.050	0.700	-0.013
	tr2	NA	NA	NA	NA	NA	NA	4.744	NA	NA	NA
	tr_lag	1	1	1	2	1	6	5	1	3	1
Ireland	BIC	-564.183	-557.170	-452.016	-453.068	**-569.021**	-552.717			-558.312	-560.870
	tr1	0.052	-0.118	-99.393	-0.001	**4.930**	-0.030			0.700	-0.032
	tr2	NA	NA	NA	NA	**NA**	NA			NA	NA
	tr_lag	2	1	1	1	**4**	1			3	1
Ireland $Crisis_t$	BIC	-553.568	-546.671	-445.346	-449.257(*)	-559.012	-550.975(*)			-550.647	-550.909
	tr1	0.052	-0.068	-99.393	0.001	4.930	-0.030			0.700	-0.032
	tr2	NA	NA	NA	NA	NA	NA			NA	NA
	tr_lag	2	1	1	1	4	1			3	1

Table 7: Threshold models selected for monthly data

Country		IPI	ΔIPI	CPI	ΔCPI	long IR	Δlong IR	short IR	Δshort IR	EXR	ΔEXR
Italy	BIC	-1141.608	-1143.634	**-1167.681**	-1162.117	-1162.481	-1165.371	-1165.929	-1165.827	-1166.138	-1153.110
	tr1	-0.013	-0.760	**1.400**	-0.003	5.400	0.140	3.876	-0.020	0.880	-0.034
	tr2	NA	NA	**NA**	NA	NA	NA	4.686	NA	NA	-0.013
	tr_lag	1	2	**4**	4	4	4	6	5	6	6
Italy $Crisis_t$	BIC	-1134.663$^{(*)}$	-1152.885$^{(*)}$	-1160.699	-1161.450$^{(*)}$	-1164.520$^{(*)}$	-1162.815$^{(*)}$	-1160.290$^{(*)}$	-1160.672$^{(*)}$	-1157.324	-1149.185
	tr1	-0.013	-0.300	1.400	-0.001	4.760	0.140	1.460	-0.020	0.750	-0.034
	tr2	NA	NA	NA	NA	NA	NA	2.606	NA	NA	NA
	tr_lag	1	2	4	2	5	6	6	5	6	6
Luxembourg	BIC	-1337.385	-1325.910	-1345.304	-1334.361			-1023.546	-1027.257	**-1346.701**	-1329.320
	tr1	-0.002	-0.700	2.000	0.002			0.649	0.050	**0.700**	-0.021
	tr2	NA	NA	NA	NA			NA	NA	**NA**	NA
	tr_lag	6	2	2	1			2	1	**4**	1
Luxembourg $Crisis_t$	BIC	-1331.686	-1325.624$^{(*)}$	-1343.922$^{(*)}$	-1323.793			-1014.320	-1020.272	-1337.474	-1324.074$^{(*)}$
	tr1	-0.002	-0.300	2.000	0.00			0.649	0.050	0.700	-0.021
	tr2	NA	NA	NA	NA			NA	NA	NA	NA
	tr_lag	6	2	2	1			2	1	4	1
Netherlands	BIC	-1301.404	-1291.103	-1309.729	-1286.129	-1297.850	-1291.942	-1307.003	-1294.635	-1302.105	-1281.610
	tr1	-0.031	-1.800	1.500	-0.001	3.732	0.010	3.080	-0.116	0.700	-0.021
	tr2	NA	NA	2.600	NA	NA	NA	NA	NA	NA	NA
	tr_lag	6	2	1	1	4	2	6	1	1	1
Netherlands $Crisis_t$	BIC	-1292.440	-1311.607$^{(*)}$	**-1316.372**$^{(*)}$	-1276.680	-1294.630$^{(*)}$	-1282.049	-1308.748$^{(*)}$	-1286.618	-1294.428	-1279.096$^{(*)}$
	tr1	-0.018	-0.720	**2.200**	-0.001	4.526	0.010	1.460	-0.116	0.750	-0.013
	tr2	NA	NA	**NA**	NA	NA	NA	2.606	NA	NA	NA
	tr_lag	6	2	**6**	1	4	2	6	1	1	2
Norway	BIC	-799.573	-792.876	-798.460	-786.597	-796.383	-795.705	**-802.994**	-786.072	-793.748	-788.601
	tr1	-0.070	-0.050	2.500	0.003	6.258	0.146	**2.690**	0.130	5.896	0.001
	tr2	NA	NA	NA	NA	NA	NA	**NA**	NA	NA	NA
	tr_lag	1	1	3	1	5	1	**5**	1	1	1
Norway $Crisis_t$	BIC	-790.351	-782.339	-790.904	-779.536	-788.066$^{(*)}$	-788.201$^{(*)}$	-794.027	-782.395$^{(*)}$	-793.208$^{(*)}$	-780.914$^{(*)}$
	tr1	-0.070	-0.050	2.500	0.003	4.910	-0.250	2.690	-0.303	5.896	0.001
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	3	1	5	1	5	1	1	3
Spain	BIC	-1079.327	-1074.063	-1093.861	-1101.611	-1097.477	-1094.103	-1097.399	-1100.909	-1108.783	-1091.235
	tr1	0.006	-0.600	3.800	-0.004	4.740	0.150	4.850	-0.040	0.780	-0.013
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	tr_lag	1	1	1	4	3	3	1	6	1	6
Spain $Crisis_t$	BIC	-1078.303$^{(*)}$	-1099.460$^{(*)}$	-1090.148$^{(*)}$	**-1117.742**$^{(*)}$	-1092.421$^{(*)}$	-1084.687	-1101.939$^{(*)}$	-1093.001	-1099.078	-1091.429$^{(*)}$
	tr1	-0.012	-0.600	3.800	**-0.003**	4.780	0.150	1.380	-0.040	0.780	-0.013
	tr2	NA	NA	NA	**NA**	NA	NA	3.290	NA	NA	NA
	tr_lag	1	2	1	**2**	5	3	3	6	1	6
Sweden	BIC	-1526.594	-1520.914	-1521.238	-1517.772	-1526.257	-1511.731			-1520.001	**-1528.285**
	tr1	0.005	0.200	1.500	-0.002	4.430	0.080			6.554	**0.019**
	tr2	NA	NA	NA	NA	NA	NA			NA	**NA**
	tr_lag	6	1	1	2	4	1			5	**1**
Sweden $Crisis_t$	BIC	-1517.141	-1511.291	-1515.587$^{(*)}$	-1520.085$^{(*)}$	-1518.142$^{(*)}$	-1502.153			-1514.405$^{(*)}$	-1522.813$^{(*)}$
	tr1	0.005	0.200	0.540	-0.002	3.140	0.080			7.966	0.019
	tr2	NA	NA	NA	NA	3.490	NA			NA	NA
	tr_lag	6	1	2	2	2	1			5	1
Switzerland	BIC	-937.953	-935.604	-957.692	-954.645	-957.378	-951.508	-953.467	-951.673	**-962.134**	-954.246
	tr1	0.005	-0.300	-0.400	-0.002	2.560	-0.225	0.250	0.010	**1.202**	0.008
	tr2	NA	NA	1.800	NA	NA	NA	NA	NA	**NA**	NA
	tr_lag	1	1	3	4	1	3	6	5	**6**	5
Switzerland $Crisis_t$	BIC	-931.782$^{(*)}$	-936.408$^{(*)}$	-952.265$^{(*)}$	-953.079$^{(*)}$	-955.363$^{(*)}$	-944.045	-959.885$^{(*)}$	-947.815$^{(*)}$	-957.617$^{(*)}$	-949.796
	tr1	-0.014	-0.300	0.100	-0.002	2.560	-0.228	0.376	-0.100	1.202	0.008
	tr2	NA	NA	NA	NA	NA	NA	1.240	NA	NA	NA
	tr_lag	1	1	1	4	1	6	1	6	6	5
UK	BIC	-1232.795	-1227.570	-1252.058	-1258.453	-1262.727	-1247.432	-1243.056	-1246.548	**-1266.388**	-1244.845
	tr1	0.010	-1.400	2.000	-0.002	4.984	0.070	5.410	0.020	**0.640**	-0.015
	tr2	NA	0.300	NA	NA	NA	NA	NA	NA	**NA**	NA
	tr_lag	1	1	1	5	5	4	2	6	**6**	2
UK $Crisis_t$	BIC	-1223.164	-1242.037$^{(*)}$	-1255.293$^{(*)}$	-1257.188$^{(*)}$	-1254.084$^{(*)}$	-1237.544	-1246.255$^{(*)}$	-1240.070	-1261.065$^{(*)}$	-1239.682$^{(*)}$
	tr1	-0.011	0.000	2.900	-0.002	4.990	-0.030	6.204	-0.110	0.600	-0.016
	tr2	NA	NA	NA	NA	NA	NA	NA	NA	0.680	NA
	tr_lag	1	1	4	1	6	4	2	2	3	6

The results can be considered within two groups of countries, that is, developed and emerging EU countries. In the case of emerging EU countries, the CPI, ΔCPI and EXR constitute the set of most important switching variables for both quarterly and monthly data. The CPI became a switching variable for GDP in the Czech Republic and Slovenia, while EXR and ΔEXR were thresholds for Hungary and Slovakia. In the case of Poland short interest rate was responsible for the mechanism of growth. It is worth mentioning that in case of Poland the dummy variable $Crisis_t$ was significant. For the variable IPI, CPI (or ΔCPI) was a threshold variable in Slovakia and Hungary respectively. In Czech Republic and Slovenia the IPI mechanism was driven by the exchange rate (EXR) and for Poland short interest rate was the threshold again. These variables can be divided into three groups: those related with the high level of initial inflation measured by CPI and those corresponding to foreign trade transmission channel via EXR. In 2004, when emerging countries entered the EU, one of the formal requirements was to introduce the inflation targeting policy. In addition, all countries that transformed from centrally planned to market economies exhibited inflation. Therefore, the lagged price index became the threshold for the observed period of 1995-2013. The importance of the exchange rate is not only related with the competitiveness of the economies but also with the increasing capital investment via capital market and inflow of FDI. In Poland, for quarterly and monthly data, the threshold was the short-term interest rate what shows a linkage between monetary policy and the real economy.

As this study considered developed countries, the situation is even more diversified. When quarterly data were considered, CPI (or ΔCPI) as well as UNEMP (or ΔUNEMP) occurred in five cases. The ΔEXR was the threshold variable for the USA, which draws the attention to the magnitude of transactions realized in the EUR/USD. The real estate price index was indicated only in the case of the United Kingdom. Monetary variables like the short-term interest rate (or Δshort-term interest rate), the long-term interest rate and its first differences occurred incidentally in three cases, while lagged GDP was the threshold for itself in four cases (Austria, Ireland, Luxembourg and EU28). However, it is worth noting that the debt-to-GDP ratio was never chosen as a threshold variable and furthermore, the BIC levels were for the models in which there were the worst (the maximum) for the debt-to-GDP ratio, which was supposed to be a threshold. This finding supports our initial hypothesis: that a high level of debt-to-GDP ratio does not necessarily mean a decrease in the growth rate or it is not significant in the short run.

In the case of monthly data, the most frequent threshold variables were CPI and ΔCPI (in the cases of Austria, Denmark, Italy, the Netherlands and Spain), long-term interest rate (for Belgium, France, Germany, and Ireland) and exchange rate EXR or ΔEXR (in the cases of Luxembourg, Switzerland and the UK). For Switzerland and the United Kingdom, the exchange rate was of great importance, which is in line with the decision of the National Bank of Switzerland in January 2015 to discontinue its exchange rate ceiling. For EU28 and EURO18 the SETAR models were supported by the data.

The general remark is that for both types of data, the set of threshold variables consists of CPI, EXR and their first differences. Monetary variables were not of the great importance due to their low values since 2008. Only in four cases for quarterly data and in two cases for monthly data was the self-exciting mechanism supported by the data. These findings show that the inflationary as well as real mechanisms played an important role in diagnosing the phases of business cycle in most European economies. Thus, the debt-to-GDP ratio might have a contractionary impact in the short run that in the longer run was not observed. The initial debt-to-GDP ratio level is of no value for the economic growth pattern and was not a significant economic factor for countries with high public debt-to-GDP ratios, like Belgium and Italy. The same was indicated in Leigh et al. (2010) and Mota et al. (2012), among others. The path of economic growth within examined economies was than driven by real data (unemployment rate), inflationary processes, openness of the economies (particularly, financial markets and export/GDP ratio), and the self-exciting mechanism. The qualitative information related with institutional solutions are also important and might be hidden in different variables. The levels of thresholds were reasonable and depended on the range of data.

Referring back to the classification of the economies presented in Section 2, it can be stated that the intuition directly from the results of Reinhart and Rogoff (2010) was not confirmed by the empirical findings. The increasing debt-to-GDP ratio as a consequence of quantitative easing and decisions generated by central banks did not become a symbol of the defense against the recession in Europe, the United States, or in Japan. It is difficult to state whether applying this tool has brought a satisfactory result in practice. As the echo of recession is still present in different economies, it confirms the viewpoint of Krugman (2012), who states that the decisions were too late and not effective. Taking into account the results of quarterly data analyses three homogeneous groups of countries were classified:

1. According to unemployment rate Belgium, Germany and Sweden were indicated with the levels of

thresholds 2.0, 2.17 and 1.8 respectively.

2. According to CPI: Czech Republic, Slovenia, Denmark, the Netherlands and Switzerland were clustered. This group is much more diversified because the level of threshold is around 1.8-2.0 for Czech Republic, Denmark and the Netherlands. In the case of the Central European countries the threshold value is a bit higher, i.e. the second threshold for Czech Republic is equal to 6.7 and for Slovenia it is 5.5. In the case of Switzerland the threshold value is much lower.

3. According to the cyclical pattern of the GDP the following group of economies was found: EU28, Austria, Ireland and Luxembourg. The threshold value is then around zero.

This picture shows the importance of the endogenous economic policy. Particularly the changes in the labor market in Germany are important to other European countries.

Table 8: The best TAR model for Germany GDP: threshold variable Germany_UNEMP$_{t-3}$

	coeff.	std. err.	t-stat.	p-value	
r1	0.003428	0.001306	2.626	0.0086	***
Y_{t-1}	0.710873	0.112171	6.337	2.34E-10	***
Y_{t-2}	-0.330432	0.100803	-3.278	0.001	***
$Crisis_t$	-0.014553	0.003922	-3.711	0.0002	***
r2	-0.000022	0.001155	-0.012	0.9847	
Y_{t-1}	0.955801	0.149022	6.414	1.42E-10	***
Y_{t-2}	0.519902	0.204652	2.540	0.0111	**
Y_{t-3}	-0.598404	0.164633	-3.635	0.0003	***
$Crisis_t$	0.002048	0.005461	0.375	0.7076	

Threshold 1	8.399
R^2	87.67%
BIC	-507.42
Doornik–Hansen test for normality pval	0.292488
LMF test for serial correlation pval	0.562353
ARCH test pval	0.906754
White's test for heteroskedasticity pval	0.031055
Ramsey's RESET23 test pval	0.164748

Table 9: The best TAR model for UK IPI: threshold variable UK_longIR$_{t-5}$

	coeff.	std. err.	t-stat.	p-value	
r1	-0.000553	0.000843	-0.656	0.5116	
Y_{t-1}	1.259580	0.060932	20.670	6.2E-095	***
Y_{t-2}	-0.288726	0.094331	-3.061	0.0022	***
Y_{t-3}	-0.020695	0.095594	-0.217	0.8286	
Y_{t-4}	-0.085090	0.095453	-0.891	0.3727	
Y_{t-5}	0.231286	0.094418	2.450	0.0143	**
Y_{t-6}	-0.249949	0.060301	-4.145	0.000034	***
r2	0.000583	0.001221	0.477	0.6334	
Y_{t-1}	0.984997	0.098718	9.978	1.9E-023	***

Threshold 1	4.984
R^2	92.07%
BIC	-1262.73
Doornik–Hansen test for normality pval	0.022899
LMF test for serial correlation pval	0.000013
ARCH test pval	0.126984
White's test for heteroskedasticity pval	0.002252
Ramsey's RESET23 test pval	0.821524

The estimated models exhibit an important characteristic. In some cases, like in the case of GDP in Germany and IPI in the United Kingdom, the autoregressive models in regimes differ significantly concerning the number of regimes, number of lags (the persistence within a regime) and the magnitude of the parameters estimates. Additionally in the case of Germany the dummy variable Crisis was responsible for negative correction on the average GDP level in the first regime. The threshold magnitude was equal 8.4 that means that the unemployment rate achieving this value sharply divides the GDP regimes in Germany. In the case of monthly data (like in the example model for UK IPI) more lags may indicate greater persistence, but when we compare it with quarterly data the observed persistence seems to be almost the same. The level of threshold for long interest rate is equal 4.98.

6 Robustness analysis

To verify the robustness of the automatic TAR modeling procedure for shifts of the threshold values we decided to carry out Monte Carlo simulations.

In our approach we assume that the empirical threshold value is a priori unknown. To find it we check all possible combinations of quantiles at different lags of threshold variable. As the number of quantiles is limited by the number of observations we use quartiles for quarterly data and deciles for monthly data. Other quantiles (or even using raw data values) are possible if the number of observations is bigger than 100. Model selection procedure is based on the Schwartz information criterion (BIC), but for the model to be considered, criteria such as the minimum number of degrees of freedom in each regime and the stationarity in each regime must be satisfied at the initial stage. In the simulations' scenario we assumed that the threshold value will be drawn from the uniform distribution defined on the interval which is a certain neighborhood of the selected threshold value (found in the model selection procedure) and the range of that neighborhood will be changing in 3 variants. Since in the model selection procedure threshold values were taken as values of successive quantiles of the threshold variable, in the Monte Carlo simulation we had to ensure that the new threshold value (drawn from the uniform distribution) will not exceed the values of the adjacent quantiles. To achieve this, neighborhood of the threshold value was set so that the limit value was a specified fraction of the interval between the threshold value (a selected quantile) and the adjacent quantile. For example, if the threshold value was defined as the first quartile of the threshold variable and the range of the neighborhood was set to 1%, then the lower limit was in 0.5% of the distance between the first quartile and the minimum value of the threshold variable while the upper limit of the neighborhood was in 0.5% of distance between the first and second quartiles. Finally, the Monte Carlo simulation assumptions were set as:

1. Width of the threshold value neighborhood: $\{1\%, 2\%, 5\%\}$.
2. Number of replications: $N = 1000$.

As a result, 3×1000 Monte Carlo replications were performed for each selected model. For each newly drawn threshold value (in the case of two regime models) or threshold values (in the case of three regime models), the best TAR model was selected basing on the BIC criterion. Then, the cases in which models for the newly drawn threshold values had a higher BIC value than the baseline model were counted (cases when baseline model was better). If the percentages of these cases were at least 70%, the baseline model was considered as stable. If this percentage was less than 70%, then the baseline model was considered as unstable and such model was replaced by the second best model (in terms of BIC value) found in the model selection procedure. The fraction of 70% seems to be reasonable due to the facts that in many cases the baseline model was better in 100% but real data are much more sensitive than the data generated from a given known distribution. Monte Carlo simulation results are shown in tables 10 and 11.

In case of models for quarterly data 17 of 24 baseline models were considered to be stable. In 7 cases baseline model was not stable and had to be replaced by the subsequent model (in terms of BIC value). For countries such as Austria, Hungary, Norway and Slovenia second model was considered as stable. For Japan it was the third model in order, while for EURO18 and Luxembourg fourth model in order was considered as stable.

In case of models for monthly data 15 of 22 baseline models were considered to be stable. In 7 cases baseline model was not stable and had to be replaced by the subsequent model (in terms of BIC value). For countries such as France, Norway and United Kingdom second model was considered as stable. For Slovenia it was the third model in order, while for Luxembourg and Poland sixth model in order was considered as stable. The poorest results were obtained for Sweden because the seventh model in order was considered stable.

Summarizing, the results of Monte Carlo experiments showed that the proposed procedure of automatic threshold model selection is robust against the interventions in the threshold value. The scale of intervention was of minor impact on the results.

7 Conclusions

Although nominal convergence criteria were the same for all the EU member countries, the ways to fulfill them were different and in many case very difficult. The level of unionization of the EU is far from 100%. The findings obtained in our study depend on the relatively small number of observations taking into account the statistical requirements. When economic changes are studied the same time period is considered to be a long one. Between 1995 and 2013, developed EU economies experienced intense economic growth, which was interrupted in 2008 by the financial and economic recession. Thereafter, economic development divergence processes were exposed. The recession revealed complicated economic and social situations in many countries, even stable and well-established economies, like Germany and the United Kingdom. The weakest developed EU countries, namely, Portugal, Italy, Ireland, Greece,

Table 10: Percentage of cases the baseline model was robust to changes of threshold values (quarterly data)

Country	Threshold variable	Interval 1%	2%	5%
EU28	ΔGDP-01	100%	100%	100%
EURO18$_{(4)}$	longIR-01	100%	100%	100%
Austria$_{(2)}$	shortIR	100%	100%	100%
Belgium	UNEMP-01	100%	100%	100%
Czech	CPI	100%	100%	91.4%
Denmark	CPI-01	100%	100%	100%
Finland	ΔUNEMP-01	100%	100%	100%
France	CPI-01	100%	100%	100%
Germany	UNEMP-01	100%	100%	100%
Hungary$_{(2)}$	ΔEXR-01	100%	100%	100%
Ireland	GDP-01	100%	100%	100%
Italy	ΔCPI	98.9%	99.5%	99.9%
Japan$_{(3)}$	CPI-01	100%	100%	65.9%
Luxembourg$_{(4)}$	EXR	74.2%	74.2%	74.2%
Netherlands	CPI-01	100%	100%	100%
Norway$_{(2)}$	GDP	100%	100%	100%
Poland	shortIR-01	100%	100%	100%
Slovakia	EXR	80.5%	80.5%	80.5%
Slovenia$_{(2)}$	EXR	100%	100%	100%
Spain	longIR	100%	100%	100%
Sweden	UNEMP-01	100%	100%	100%
Switzerland	CPI-01	100%	100%	100%
UK	real_est-01	100%	100%	100%
USA	ΔEXR	100%	100%	100%

The numbers in subscripts indicate the rank of the model considered as stable and finally accepted.

and Spain, suffered greatly due to their lack or unsatisfactory levels of reforms and economic divisions, causing the crisis in Eurozone. Within this group, only the government in Ireland managed to improve its situation significantly after 2010. On the other hand, the East and Central European countries were considered. At the moment of entering the EU, these countries optimistically developed their economies, but the gaps with other EU economies were significant. During the last 20 years, they reduced inflation, improved economic efficiency, and developed many economic institutions. Slovenia and Estonia became the leaders of institutional changes in Central European countries coming out from the middle income trap countries (Lee, 2013). The results of this study show the difficulties these countries had to endure in order to became part of European capitalism.

In the study, we demonstrated the results of the assumed association between threshold variables and economic cycles, measured by the GDP growth rate (or IPI respectively) in the EU economies via the threshold models (TAR or SETAR). Following the latest disclosures about public debt dynamics and its influence on the growth rate, we assumed that the public debt-to-GDP ratio might serve as an important indicator for policy change. Different policy regimes were observed over quite a long time period but liberal policy was the dominant case from the early 1990s. We took into account the following threshold variables: the unemployment rate, debt-to-GDP ratio, real estate cost index, CPI, long- and short-term interest rate, the exchange rate, and their first differences. All the data were seasonally adjusted, transformed into logs, and detrended. The analysis was undertaken using two panels of data, that is, time series observed quarterly and monthly.

The general remark is that for both types of data, the CPI and its first differences were significantly associated with the economic cycles. For some countries (the Czech Republic, Slovakia, Slovenia, Hungary, Luxembourg, Switzerland), the exchange rate was of great importance as a channel for economic stimulation (exports and imports). In the case of quarterly data unemployment rate was important for Germany, Belgium, Sweden and Japan. Only in four cases for quarterly data (Austria, Ireland,

Table 11: Percentage of cases the baseline model was robust to changes of threshold values (monthly data)

Country	Threshold variable	Interval		
		1%	2%	5%
EU28	ΔIPI-01	100%	100%	100%
EURO18	longIR	100%	100%	91.7%
Austria	ΔCPI-01	100%	100%	100%
Belgium	longIR	100%	100%	54%
Czech	EXR	100%	100%	100%
Denmark	CPI-01	100%	100%	100%
Finland	ΔshortIR-01	100%	100%	100%
$\text{France}_{(2)}$	ΔCPI-01	100%	100%	100%
Germany	longIR	100%	100%	100%
Hungary	ΔCPI	100%	100%	100%
Ireland	longIR	100%	100%	100%
Italy	CPI	100%	100%	100%
$\text{Luxembourg}_{(6)}$	ΔIPI	93.7%	97.1%	98.6%
Netherlands	CPI	100%	100%	100%
$\text{Norway}_{(2)}$	IPI	87.8%	94.3%	97.7%
$\text{Poland}_{(6)}$	ΔEXR	70.1%	70.1%	70.1%
Slovakia	EXR	100%	100%	100%
$\text{Slovenia}_{(3)}$	ΔCPI	88.9%	88%	87.6%
Spain	ΔCPI-01	100%	100%	100%
$\text{Sweden}_{(7)}$	ΔCPI-01	100%	100%	100%
Switzerland	EXR	100%	100%	100%
$\text{UK}_{(2)}$	longIR	100%	100%	100%

The numbers in subscripts indicate the rank of the model considered as stable and finally accepted.

Luxembourg and EU28) and in two cases for monthly data (EU28 and EURO18) was the self-exciting mechanism supported by the data. These findings imply that inflationary and real mechanisms played an important role in diagnosing the phases of business cycle in most European economies. Thus, the debt-to-GDP ratio might have a contractionary impact only in the short run, which was omitted while the relatively long run was observed. The initial debt-to-GDP ratio level was of no value for the economic growth pattern. The path of economic growth within examined economies was than driven by real data (unemployment rate), inflationary processes, openness of the economies (particularly, financial markets and export/GDP ratio), and the self-exciting mechanism. The qualitative information related with institutional solutions are also important and might be hidden in different variables. The levels of thresholds were reasonable and depended on the range of data.

In the study, we set up the hypothesis that macroeconomic indicators can properly divide the business cycle in the European countries according to specified economic policy regimes in the years 1995-2013. Considering this in the broader context, the institutional order in these countries must be taken into account together with the level of economic development and the position of a given economy in the global system (core or peripheral). Looking back on the classification of the economies according to debt to GDP ratio provided in Section 2, we cannot indicate any similarities concerning threshold factors within the groups of countries, but rather, we can indicate country-specific factors. In the group comprising countries with low ratios of public debt to GDP, it is noticeable that the business cycle in Norway is dependent on the short-term interest rate for both quarterly and monthly data, that in Luxembourg it depends on the GDP level and on the exchange rate level for quarterly and monthly data respectively. In Switzerland the thresholds were: CPI when quarterly data were used and the exchange rate level in the case of monthly data. On the other hand, in the case of the highest level of debt-to-GDP ratio indicator, the economic cycle in Belgium depended on the long-term interest rate and in the case of Italy, on the levels and changes of CPI for quarterly and monthly observations, respectively. In the case of the middle group, the results were more diversified, covering almost all indicators considered apart from the debt-to-GDP ratio. Although short interest rate was relatively rarely represented due to its low value reaching the liquidity trap (Krugman et al., 1998). These findings can be generalized in such a way that "country-specific" factors were indicated as the thresholds that support specific institutional structures across the countries, specific economic policy, as well as the position of the economy in the global system.

In order to justify our findings we applied two types of analysis. The first one was a straightforward implementation of dummy variable denoting the crisis in 2008-2010. It should be emphasized that for quarterly data this variable was significant in 14 cases of the best models for 24 and for monthly data: in 8 cases for 22. The second procedure was related with the sensitivity analysis via Monte Carlo simulations. For each model the intervention for threshold value was made to check how robust are the best selected models. The results of simulations showed that the empirical threshold models are the appropriate tool for modeling the business cycle in the European countries.

Although many analyses have been undertaken in the last few years on the monetary and fiscal policy instruments corresponding to different phases of the economic cycle, a proper diagnosis is still an open issue. The quality of institutions, state integrity, the position of the economy (core or peripheral), and the middle-income trap are some examples of states that might affect the economic growth pattern in different countries, including the EU members.

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