Analyzing macroeconomic imbalances in the EU

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Abstract

This article aims to evaluate the efficiency of the currently applied MIP Scoreboard's indicators. We seek to provide an answer to the question which indicators included in the MIP Scoreboard are useful predictors of potential crisis. In order to do that, we examine the behaviour of the MIP Scoreboard's indicators in terms of the business cycle. Our results might shed some light on the magnitude how each particular tested variable can contribute to predicting crises events. The analysis relies on multivariate binary response model and on univariate simple signalling approach. The data used cover the time period from 2004 till 2014. Firstly, the individual performance of the variables of interest is measured. Then we rely on the properties of logit models and evaluate the performance of the system with all the fourteen indicators simultaneously. The results showed that activity rate, youth unemployment rate and private sector debt are the best performing variables from the MIP scoreboard either using the signalling approach or binary respond models in the short run (one to two years) and are accompanied by current account balance in the long run (three years).

Key Words: MIP scoreboard, Early warning systems, Binary response models.

Introduction

The recent economic and financial crisis followed by the debt crisis revealed serious weaknesses in the governance framework of the European Monetary Union (EMU). In order to prevent possible future crises, a governance reform had been undertaken in the European Union (EU) in 2011. The reform includes introduction of a new procedure within the EU's annual cycle of economic policy guidance and surveillance (the European Semester) for preventing and correcting macroeconomic imbalances in the euro area - the so called *Macroeconomic Imbalance Procedure* (MIP). The aim of the new surveillance mechanism is to prevent occurrence of asymmetric shocks by early identifying potential risks, correcting the existing imbalances that could lead to these shocks and preventing them from re-emerging. Implementation of such surveillance mechanism seems to be essential in the monetary union with single monetary policy, several national fiscal policies constrained by the *Stability and Growth Pact* (SGP), relatively strong labour unions and thus rather limited possibilities for the Member States to cope with potential asymmetric shocks (Essl et al., 2012).

The MIP legislation entered into force in December 2011 as a part of the so called six-pack legislation, which aims to reinforce the monitoring and the surveillance of fiscal, macroeconomic and structural reform policies in the EU and the euro area compared to previously applied legislation. The MIP legislation consists of two regulations included in the six-pack: Regulation (EU) No 1176/2011 of the European Parliament and of the Council of 16 November 2011 on the prevention and correction of macroeconomic imbalances and Regulation (EU) No 1174/2011 of the European Parliament and of the Council of 16 November 2011 on enforcement measures to correct excessive macroeconomic imbalances in the euro area. While Regulation 1176/2011 covers all EU Member States and lays out the

details of the surveillance procedure, Regulation 1174/2011 applies only to the euro area Member States and focuses on enforcement, including the possibility of sanctions. The MIP became an essential part of the European Semester in 2012.

Several authors have focused on weaknesses and possibilities of improving the MIP. Their suggestions relate to the choice of method used for computing the threshold values (Alcidi et al., 2014; Hallwirth, 2014), the need for some symmetry in the adjustment mechanism (De Grauwe, 2012), the single-country focus (Moschella, 2014), the relatively vague way of establishing excessive imbalances (Kamps et al., 2013) as well as the limited application of the reverse qualified majority voting (RQMV) (Moschella, 2014; Kamps et al., 2013). There is still ample room for further research that could contribute to improving the efficiency of the MIP, in particular by adjusting the overall design of the scoreboard of early warning indicators, which is allowed to evolve over time, while retaining its simplicity and clarity.

Another branch of the literature focuses on evaluation of Early warning systems (EWS). Such systems can be divided into univariate and multivariate according to the number of indicators applied simultaneously in the EWS (Alessi et al., 2014). The two mainstream approaches currently applied are the signalling approach proposed by Kaminsky et al. (1999) or several versions of binary response models which estimate the probability of crises events. As Alessi et al. (2014) point out, regardless the methods applied the variable or model is evaluated in terms of the adjusted-noise-to-signal (aNtS) ratio or a particular loss function of a policymaker. Other alternative criteria may be the number of correctly predicted events.

An influential paper by Kaminsky et al. (1999) discussed the signalling approach and applying the aNtS ratio as criterion of evaluation. Similar approach is applied e.g. by Csortos et al. (2013) on selected MIP scoreboard indicators. Furthermore, they also utilize a basic version of the loss function. The recent literature on the policymaker's loss function theory is discussed by Sarlin (2013) or El-Shagi et al. (2013). Christensen et al. (2014) develop three composite indicators and utilizing the signal extraction approach proposes a EWS able to predict the probability of financial stress incidence. A model free unified statistical framework aiming to assess crisis EWS is presented by Dumitrescu et al. (2010). Binary response model are also widely applied for predicting crises or evaluating EWS, e.g. Antunes et al. (2014), Alessi et al. (2014), Canova (1994).

This paper aims to contribute to the existing literature by providing a quantitative assessment of the predictive power of the MIP indicators in the early warning indicator framework using the logit and linear probability model. Based on that, this paper is structured as the following. In the first chapter we describe the background of the MIP scoreboard procedure as prepared and used by the European Commission. The second chapter provides an overview of the standard logit and linear probability model utilized to estimate average marginal effects of all MIP indicators. Then the results of the analysis are discussed and finally the conclusions are presented.

1. Background

Similarly to the SGP, the MIP has two arms – a preventive and a corrective arm. Within the preventive arm of the procedure potential macroeconomic problems have to be identified and regularly analysed in order to detect the emergence of imbalances early-on. The corrective

arm provides means to effectively enforce correction of imbalances and will come into effect if macroeconomic imbalances in a particular Member State prove to be serious, i.e. *excessive*.[1]

The preventive arm of the MIP consists of two steps. In the first step, an alert mechanism as an early warning system focuses attention on observed risks early-on and identifies the Member States for which, in the second step, more in-depth analysis needs to be conducted to assess their vulnerability and substantiate policy recommendations if appropriate (European Commission, 2012).

The MIP starts with the *Alert Mechanism Report* (AMR) prepared by the European Commission (henceforth referred to as "Commission") in November each year. The alert mechanism covers all EU Member States not benefiting from financial assistance and is based on the so-called *scoreboard*, i.e. a set of fourteen (previously ten) macroeconomic indicators of external imbalances, competiveness, internal imbalances and labour market with their threshold values established by the Commission. Table 1 contains the indicators, their transformations and indicative thresholds.

Table 1 Indicators of the MIP Scoreboard – latest version with fourteen indicators included

External imbalances and competitiveness		**Indicative thresholds**
Current account balance	% of GDP, 3 year backward moving average	+6% and -4%
Net international investment position	% of GDP	-35%
Real effective exchange rate	42 trading partners, HICP deflator, 3 years % change	±5% (EMU), ±11 (non-EMU)
Export market share	% of world exports, 5 years % change	-6%
Nominal unit labour cost	2010=100, 3 years % change	9% (EMU), 12% (non-EMU)
Internal imbalances		
House price index	deflated, 1 year % change	6%
Private sector debt	consolidated, % of GDP	133% (previously 160%)
Private sector credit flow	consolidated, % of GDP	14% (previously 15%)
General government gross debt	% of GDP	60%
Unemployment rate	3 year backward moving average	10%
Total financial sector liabilities	non-consolidated, 1 year % change	16.5%
New employment indicators		
Activity rate	% of total population aged 15-64, 3 years change	-0.2 p.p
Long-term unemployment rate	% of active population aged 15-74, 3 years change	0.5 p.p.
Youth unemployment rate	% of active population aged 15-24, 3 years change	2.0 p.p.

Source: European Commission, 2015b.

Using a larger set of indicators is basically in accordance with the general conclusion of Kaminsky et al. (1998) that an effective EWS should consider a broad variety of indicators. According to the *Regulation (EU) No 1176/2011 "the scoreboard shall comprise a small number of relevant, practical, simple, measurable and available macroeconomic and macrofinancial indicators for Member States"*. The choice of the scoreboard indicators focuses on the most relevant dimensions of macroeconomic imbalances and competitiveness losses, with a particular emphasis on smooth functioning of the EMU. The indicators and their thresholds should provide a reliable signalling device for potentially harmful imbalances and competitiveness losses at an early stage of their emergence. Accordingly, the scoreboard includes both stock and flow indicators which can capture short-term deteriorations as well as the long-term accumulation of imbalances.

[1] According to the Regulation 1176/2011, a macroeconomic imbalance means *"any trend giving rise to macroeconomic developments which are adversely affecting, or have the potential adversely to affect, the proper functioning of the economy of a Member State or of the Economic and Monetary Union, or of the Union as a whole*", while the excessive imbalances are defined as *"severe imbalances, including imbalances that jeopardise or risks jeopardising the proper functioning of the economic and monetary union".*

As stated in the Occasional paper of the Commission on the scoreboard (2012), the choice of the indicators is based on the results found in the economic literature available at that time. It includes in particular the paper of Frankel et al. (2010), who, based on an extensive review of more than eighty papers from the previous literature on early warning indicators and their own analysis, have identified the causes and symptoms of financial crises that have been most consistent over time, country and crisis. They have found the REER, the current account balance, the credit growth and the level of external debt to be useful indicators for predicting crisis incidence. Already Kaminsky et al. (1998), who examined the empirical evidence on currency crisis and proposed a specific EWS, identified the REER and domestic credit as indicators that proved to be particularly useful in anticipating crises. Later results of Babecky et al. (2013), who identified the most useful leading indicators with Bayesian model averaging, suggest that the current account balance to GDP ratio is robustly associated with the severity of crises (in line with Frankel and Saravelos, 2012), as well as private credit and the government debt-to-GDP ratio.

It is worth to mention, that the general government debt (a relatively often used early warning indicator of crises, along with the government deficit) is integrated into the scoreboard not to monitor risks of unsustainable public finances (covered by the SGP), but to offer a broader picture of country's indebtedness (together with the private sector debt), which can increase the vulnerability of a Member State to economic shocks. Similarly, the MIP looks at the financial sector from the point of view of macroeconomic imbalances, while *the European Systemic Risk Board* (ESRB) monitors financial stability risks. The indicator of total financial sector liabilities has been included into the scoreboard with the aim to better capture the interlinkages between the real economy and the financial sector, given the fact that the financial sector has been at the root of the recent crisis.

In addition to the already mentioned REER, competitiveness development is monitored by other two headline indicators within the MIP - the ULC indicator, which (together with the REER indicator) allows a comprehensive assessment of the cost/price competitiveness developments, and the export market share, which adds other aspects of competitiveness to the scoreboard that are not captured by price and cost competitiveness alone. Export performance was already identified in Kaminsky et al. (1998) among the useful indicators for anticipating crises.

The house price index has been chosen by the Commission as one of the headline indicators, since booms and busts in housing markets can be a source of macroeconomic imbalances. Later, Borgy et al. (2014) found some evidence that house price-booms are more likely to turn into costly recession or to trigger a banking crisis than stock-price booms. This finding is consistent with Barrel et al. (2010), who showed that house-price booms were a good leading indicator of banking crises in logit EWS.

The reason for including the four labour market indicators (unemployment rate and the three new indicators) into the scoreboard is rather specific. Monitoring these indicators helps to better understand the social consequences of imbalances, including the phase of correction of imbalances, and to fine-tune the policy recommendations under the MIP. Therefore, breaches of thresholds in these cases would not be read as implying, by themselves, an aggravation of macro-financial risks, and consequently will not trigger further steps in the MIP.

From the methodological point of view, more year averages or changes (3 or 5 years) are used in calculation of several headline indicators, in order to capture the medium term development and provide indications of the persistence of a potential imbalance. Calculation as a share of GDP is applied in case of several indicators to allow for cross-country comparability and

differentiated thresholds are used for the EMU and non-EMU countries in case of two indicators (real effective exchange rate, nominal unit labour cost), given different characteristics of the EU countries outside the monetary union.

Thresholds have been established with a statistical approach based on the distributions of the indicators' values, by identifying the thresholds as the lower and/or upper quartiles of the distributions. According to the Commission, such thresholds are in line with the values found in the available empirical literature (European Commission, 2012). However, as mentioned in the document of the Commission, in some cases it is difficult to establish the thresholds which can be considered as risky. It concerns e.g. the level of net external assets as well as an optimal level of private sector debt in the economy.

The threshold values are not interpreted mechanically, but in conjunction with the accompanying qualitative analysis. The overall number of breaches of thresholds, the severity of individual breaches as well as the combination of breaches, potentially signalling broad based problems, is also taken into account (European Commission, 2011). The appropriateness of the scoreboard indicators is regularly reviewed by the Commission from the side of the composition of indicators, the methodology used and the indicative thresholds established. In accordance with the MIP legislation, it is possible to add new or better-quality indicators to the scoreboard or replace some of the existing indicators.

Based on the reading of the scoreboard (headline indicators) in combination with relevant data beyond the scope of the scoreboard (auxiliary indicators for which no thresholds have been calculated), economic circumstances and all relevant factors available specific to the country's situation, the Commission identifies the Member States that face risk of excessive imbalances. In these countries closer analyses (so called *in-depth reviews* - IDRs) are being carried out by the Commission in collaboration with the affected Member States. Following the in-debt reviews the Commission determines whether imbalances exist in the Member States identified in the AMR and what their nature is. Depending on the severity of the imbalances the Commission proposes policy recommendation either under the preventive or under the corrective arm of the MIP.

In accordance with the Communication of the Commission *On steps towards Completing Economic and Monetary Union* (European Commission, 2015a), the Commission has recently enhanced the transparency in the implementation of the MIP and stabilised the categorisation of macroeconomic imbalances by streamlining the number of imbalance categories from six to four:

1. No imbalance,
2. Imbalances,
3. Excessive imbalances,
4. Excessive imbalances with corrective action (Excessive Imbalance Procedure, EIP).

If the situation in a Member State is considered unproblematic, the Commission will not propose any further steps. If the Commission considers that macroeconomic imbalances exist, it issues policy recommendations on the correction of the imbalances to the Member State. In the preventive arm, these are part of the integrated package of country-specific recommendations under the European Semester. However, if the Commission considers that there are excessive imbalances that may jeopardise the proper functioning of the EMU, it may recommend to the Council to open an *Excessive Imbalance Procedure* (EIP)[2] as an

[2] So far the Council has never launched any EIP.

enforcement mechanism, which falls under the corrective arm of the MIP. Alternatively, the Commission can decide not to activate the corrective arm, but introduce specific monitoring for a country with excessive imbalances. However, the Commission can at any time propose to launch an EIP for this country, without having to carry out an in-depth review again. In general, all Member States with imbalances or excessive imbalances identified are subject to specific monitoring adapted to the degree and nature of the imbalances presented.

After starting an EIP, the Member State concerned is obliged to submit a *corrective action plan* (CAP), based on a Council recommendation. The plan must contain adequate measures for the correction of the imbalances detected and specify the deadlines for implementing corrective action. In the case of contraventions, financial sanctions may be imposed for the EMU (but not for the non-EMU) Member States. An interest-bearing deposit equal to 0.1% of the country's GDP can be imposed by the Council after one failure to comply with the recommended corrective action. After a second compliance failure, this interest-bearing deposit can be converted into a fine (0.1% of GDP). Sanctions can also be imposed for failing twice to submit a sufficient CAP. The fine will be used for the financing of the *European Stability Mechanism* (ESM) and applied until the CAP has been accepted or the implementation of the corrective measures considered being adequate. The EIP will be terminated once the Council, based on a recommendation from the Commission, determines that the imbalances have been effectively eliminated.

An essential innovation of the MIP procedure is the use of a RQMV, under which a Council decision on a Commission recommendation regarding the activation of sanctions against euro area Member States is deemed to be adopted unless the Council decides by qualified majority to reject the recommendation within ten days. This semi-automatic decision-making procedure enhances the likelihood that the surveillance and enforcement process will not be blocked by political considerations.

2. Data and Methodology

The quantitative part of this analysis relies on data annually published by Eurostat and included into the MIP scoreboard. As the dependent variable, business cycle data are used, which are also published by the Eurostat and covering the time period of 2004 – 2014. We include all EU28 member states to the estimations and tested three different time lags: 1, 2 and 3 year time lags. The robustness of the results is confronted with the findings from the presentation of Domonkos et al. (2016) at the INFER workshop in Bratislava, where the authors rely on the signalling approach and test the similar 1, 2 and 3 year time lags. Crisis event is defined similarly as Csortos et al. (2013) did so in their work, i.e. crises is considered apparent when the deviation of real GDP from the potential GDP is lower than negative two percentage points.

We apply binary response model and standard linear probability model (LPM). The LPM is used as robustness check of the results estimated by the logit model. We do not rely only on the LPM because of its typical drawbacks of fitted probabilities greater than one or lower than zero or constant partial effects of the explanatory variables (Wooldridge, 2013). The logit model is defined as $P(y = 1|x) = G(\beta_0 + x\beta)$ where G is the standard logistic cumulative distribution function (Wooldridge, 2013).

Given the data available for 28 EU member states over different time periods, the panel data estimation methods for imbalanced panels were employed. Assuming that cross-country heterogeneity is uncorrelated with the error term as well as with explanatory variables, pooled

model was used both for the logit model and the LPM. Maximum likelihood estimation method was used for the estimation of logit model and ordinary least squares for the LPM. Potential serial correlation within clusters was accounted for by using cluster-robust standard errors, as was suggested by Cameron and Trivedi (2010). Although, the possible attenuation bias for logit model might be substantial, the analysis was focused on average marginal effects, which according to Wooldridge (2010) are consistently estimated. The standard errors of average marginal effects were computed using delta method.

Both applied models were estimated using all 14 indicators of the MIP scoreboard. The latent-variable model of logit function had the following functional form:

$$y^* = \beta_0 + \beta_1 AR + \beta_2 LTUR + \beta_3 YUR + \beta_4 EMS + \beta_5 PSD + \beta_6 UR + \beta_7 GGD + \beta_8 NIIP + \beta_9 REER + \beta_{10} CA + \beta_{11} NULC + \beta_{12} PSCF + \beta_{13} TFSL + \beta_{14} HPI$$

The linear probability model had the same form, explaining the original dependant variable y instead of latent variable y*, where:

- AR – activity rate,
- LTUR – long term unemployment rate,
- YUR – youth unemployment rate,
- EMS – export market share,
- PSD – private sector debt,
- UR - unemployment rate,
- GGD – general government debt,
- NIIP – net international investment position,
- REER – real effective exchange rate,
- CA – current account balance,
- NULC – nominal unit labour cost,
- PSCF – private sector credit flow,
- TFSL – total financial sector liabilities,
- HPI – house price index.

However, the obtained estimates of several average marginal effects seemed to contradict the expected sign. Therefore, an analysis of correlation among the explanatory variables was performed (see Appendix 2). The results suggest that there is a possible presence of multicollinearity which hinders the identification of individual effects of some examined indicators, due to the close relationship among them. To obtain an idea about the marginal effects, unaffected by the presence of multicollinearity, both models were estimated repeatedly focusing on one explanatory variable, while omitting other explanatory variables for which the pair-wise coefficient of correlation with the explanatory variable of interest was in absolute value higher than $\rho = 0.5$. Average marginal effects obtained this way were further denoted as a result of adjusted model. The adjusted model of latent variable for e.g. LTUR explanatory variable had the following form:

$$y^* = \beta_0 + \beta_1 AR + \beta_2 LTUR + \beta_3 EMS + \beta_4 PSD + \beta_5 GGD + \beta_6 NIIP + \beta_7 REER + \beta_8 CA + \beta_9 PSCF + \beta_{10} TFSL + \beta_{11} HPI$$

In this functional form the possible collinear explanatory variables with LTUR (YUR, UR, and NULC) were omitted. The functional forms for all other explanatory variables were

estimated following the same approach. If no other explanatory variable was sufficiently correlated than only the estimates of original model using all 14 indicators were reported.

3. Results and Discussion

The logit model and standard LPM serve as a tool to evaluate effects of change in the MIP indicators on probability of crisis. Firstly, we discuss performance of individual indicators and then confront the outcomes with findings from the presentation of Domonkos et al. (2016) using the signalling approach. Outcomes of the estimations for all particular time lags are reported in the Appendix 1 – Table 1, 2 and 3. In the second step of our analysis, the performance of MIP indicators estimated by the logit and linear probability models (LPM) is confronted with outcomes of the signalling approach as presented in the Domonkos et al. (2016) study. The PRED abbreviation stands for the ratio of correctly predicted events to all occurred events as a percentage. Domonkos et al. (2016) used PRED for evaluation of the MIP indicators. This ratio was further complemented by false negative rate or the probability of type I error. However, there is trade-off between type I and type II error; which led authors to use more complex measure of adjusted noise to signal (aNtS) ratio. According to Csortos and Szalai (2014) the ratio takes into account this trade-off by dividing type II error rate with correct prediction rate which is a function of type I error. The aNtS ratio is defined as the ratio of type II errors to one minus type I errors. Thus, by minimizing occurrence of both error types the aNtS ratio diminishes, converging to zero. Furthermore, Csortos and Szalai (2014) also state if the examined indicator should be of any use, than its aNtS must be lower than one. Indicators achieving lowest aNtS values and scoring below unit are said to produce less noise than signal.[3] If accompanied by statistically significant and strong average marginal effect derived from the probability model, we consider this MIP indicator to pass double-check test and belong to group of more reliable and efficient MIP EWS.

When evaluating the indicator of **current account balance**, the size of the average marginal effect depends on the number of years preceding the crisis event. While completely insignificant one year before the crisis occurrence the two and three year lag turns current account balance into the second-best performing indicator once controlling for the possible existence of multicollinearity. The negative sign associated with the estimated coefficient confirms general knowledge that deterioration of the external balance brings about rising risk of crisis event. Conversely, accumulation of surpluses in the external sector lowers the overall probability of negative events with average marginal effect in case of two year time lag fluctuating around -0.022 and having a tendency to grow as the time distance widens. The negative sign estimated to this parameter supports the question mark over the positive six percentage point threshold. This positive threshold may play an important role, if the stability of the Eurozone or the EU28 as a whole is evaluated, but according to the findings of this research in case of one particular member state it seems to be irrelevant.

The **net international investment position** accompanies the current account balance in the group of external imbalances and competitiveness indicators and, by definition, reflects its behaviour. Thus, while the indicator performs badly in one-year lag estimations, increase in distance yields improvement in statistical significance of coefficients achieving better results with indicator preceding the crisis event by two or three years. On the other hand, overall size of the average marginal effect (-0.001) places the indicator on the bottom of the virtual ranking of indicators, thus questioning its further usefulness in policy-making decision process. These findings are contradictory to the results achieved by the signalling approach,

[3] For more detail see Kaminsky et al. (1999) or Csortos et al. (2013).

according to which this variable performed quite well. Nevertheless, the effect is in line with the intuition that higher investment position decreases the probability of crisis event.

As in the case of their peers, the **real effective exchange rates** indicator almost copies the current account balance behaviour; scoring relatively high in terms of the size of the average marginal effect (-0.014) or length of the time distance (two to three years). Hence the favourable change in price and cost competitiveness ultimately materializes in decrease in the probability of crisis. This is not the case for the fourth external imbalance and competitiveness variable, the **export market share**, that is neither statistically nor economically important no matter the number of periods preceding the crisis event. Contradictory to these results, the REER indicator performs rather poorly and the EMS reports promising aNtS ratio and prediction ratio in terms of the signalling approach.

The group of external imbalances and competitiveness indicator is complemented by the **nominal unit labour cost indicator**. Increase in the number of years preceding the predicted event up to three years delivers a straightforward improvement in its performance turning initially statistically insignificant result into strong positive association between labour costs measure and probability of crisis event (0.010). The deterioration of cost competitiveness not accompanied by rise in the labour productivity is likely to be associated with increasing probability of economic crisis, yet the transmission of this adverse development is likely to take couple of years to materialize (3 years). In case of the NULC the results from the signalling approach analysis are in the same vein.

The second group of MIP indicators evaluates economic conditions from the internal sector perspective and can be further decomposed into labour-market and financial system-oriented indicators. Compared to the previous group, these variables tend, in general, to perform better if much closer in time to the predicted event but with some notable exceptions.

The **general government gross debt** belongs to the most often discussed variable potentially triggering the recent Eurozone debt crisis. Vast number of studies examined a complicated role of the government debt in influencing the economic growth confirming an existence of nonlinear relationship between the debt-to-GDP ratio and economic growth, in general (e.g. Checherita and Rother, 2010). Additionally, literature dealing with the early warning indicators topic often includes this indicator to its list of determinants e.g. Alessi et al. (2014). Yet, outcomes of our study do not confirm either as we robustly reject the existence of short-term and medium-term link between government debt and change in probability of economic crisis given the presence of other MIP indicators.[4] In respect of the signalling approach the performance of this variable tend to be relevant with shorter time lag – the best results are reported for one year time lag. Despite the general acceptance of this variable by policymakers, in terms of our results its role should seem to be overexposed. This may reflect the motivation for inclusion of general government debt into the scoreboard for providing further information about the country's current position and vulnerability to economic shocks, rather than for monitoring its financial stability. Regardless of these findings, the indicator has its merit and should be kept in mind when policy conclusions and austerity measures are drawn.

Contrary to this finding, the **private sector debt** indicator delivers expected response to the probability of crisis event. Statistically significant and positive relationship in the estimates with one (0.002) and two years (0.001) lag disappears in the third year. Higher private sector

[4] Study by Babecky et al. (2013) even reports positive link between decreasing government debt and occurrence of banking crisis.

debt levels tend to be associated with rise of vulnerability to economic shocks, thus drive the potential incidence of crisis especially from the short-term perspective. These findings are supported by the results reported from the signalling approach.

The **house price index** aims to capture a phenomenon when the real property prices are increasing extremely rapidly over relatively short period of time due to the potential occurrence of destabilizing bubbles. According to our estimations, the link between the risk of crisis occurrence and behaviour of this indicator yields powerful results especially for one-year lag (-0.033 vs. -0.019) while the effect slowly dissipates over the course of the second year (drop in size to -0.012) and disappears in the third year. Yet, the negative sign associated with the coefficient surprisingly suggests that rising property prices results in lowering the probability of crisis event, an outcome strongly contradicting recent historical experience and economic intuition. Possible explanation may be that the models implicitly control for the increases in prices connected with the expansion of the financial system and, hence, only price increases that are driven by other factors are considered. Thus the increase in housing prices may reflect the increase in specific market demand, which may be caused by e.g. migration into the country, indicating positive expectations for the future. Comparing to the results for signalling approach according to which this variable performed as one of the weakest among the pool of tested indicators, the utility of this indicator should be further confirmed with additional research. As discussed in the Babecky et al. (2013) the fall in the house prices and share prices could be therefore considered a late early warning indicator.

On top of that, to some extent similar experience is shared by two other indicators. The **total financial sector liabilities** indicator, a variable mirroring possible adverse developments in the financial sector, does not stand out from this group. With statistically significant, yet negative sign for estimates preceding the event in one year (-0.007), the link breaks down into zero effects introducing two and three year time distance between the crisis and this explanatory variable. At the first sight, the **private sector credit flow** behaves in a similar fashion as the coefficient reported for the estimates with l-year lag is statistically significant and negative (-0.004). Yet, as we move to longer time differences the initially negative response to increase in private sector credit flow transforms firstly to zero (2-year lag) and consequently into positive one (0.002, 3-year lag). As regards the signalling approach, for both variables results with same vein are reported i.e. their performance as crises predictors is rather weak in terms of the aNtS ratio and the correct prediction rate.

These puzzling findings require to be put into much wider context. An expansion of the domestic financial system with outburst in credit provisioning is likely to stimulate economic activity in the short run, but might turn potentially harmful in the long run; a phenomenon empirically confirmed by the private sector credit flow behaviour. Additionally, while the indicators focusing on financial flows tend to initially decrease probability of crisis event, impact of the private level of indebtedness as a stock variable clearly signifies adverse effect on probability of crisis occurrence.

Labour market-oriented MIP indicators include aggregate measure of unemployment rate as well as three additional variables measuring one specific dimension on labour market disequilibria. Once controlling for the potential collinearity, the **unemployment rate** performs poor in all specifications across all time lags. On the other hand, the inclusion of the new labour-market indicators introducing a more disaggregated view on the labour market and delivers more promising outcomes. In terms of the aNtS ratio, this variable performs well in the short run and the greater the time lag the worst the performance is.

The **activity rate** consistently over-performs all other indicators either in terms of the size of the coefficient or robustness of the outcomes over all time lags. The overall marginal effect is initially of an increasing magnitude and stabilizes around -0.10 at the three-year lag; the effect that marks activity rate as the most promising indicator among the all MIP indicators. As hypothesized, a positive increase in the activity rate is associated with a drop in the probability of crisis event. The results according to the simple signalling approach show similarly promising performance for the one and two year time lag. In case of three year time lag the performance dropped in terms of both the aNtS ration and the correct prediction rate.

The tendency to improve moving from one to two year lag is shared by the **youth unemployment rate** indicator. As in the previous case, the economic rationale linking deterioration in the youth unemployment rate to the higher probability of crisis is confirmed by positive and statistically significant coefficient in all specifications (maximum 0.013 for 2-year lag), once addressing the multicollinearity issue. The overall size of the marginal effect places this indicator behind the activity rate and current account indicators. Turning to the results of the simple signalling approach the youth unemployment rate performs very well regardless the time lag applied.

Changes in the **long-term unemployment rate** ought to gauge future developments in labour market participation, since longer duration of unemployment decreases considerably the prospects of re-employments. From this perspective, the performance of this indicator delivers rather disappointing outcomes. Only a very limited empirical evidence of existing link between crisis probability and long-term unemployment rate might be found for one-year lag specification, yet this evidence is not statistically significant if controlling for the multicollinearity. Aside from that, the empirical findings advocates against the capabilities of this indicator to contribute to the change in the probability of crisis. In contrast to the result from the logit estimations, the signalling approach shows different nature. This variable is among the best performing group in case of one and two year time lag. The three year time lag performance is weaker compared to the previous alternatives, but still not very poor. The unexpected short term prediction ability of the long-term unemployment rate in the logit model raises the question whether the unfavourable long-term unemployment causes the crises or is a result of the crises. This might be a question of interest in future research.

Possible differences between the outcomes from the signalling approach and probability models might be attributed to various reasons; each of them worth further investigation. Firstly, signalling approach used in the Domonkos et al. (2016) study calculates the PRED and aNtS ratios utilizing the thresholds for individual MIP indicators reported in the Table 1 as part of the procedure. Hence, while the success in prediction of crisis event is dependent on the thresholds levels relevant for each particular indicator, our findings are not conditioned by this kind of restriction. Additionally, since average marginal effects calculated in this study measure the response of probability of crisis with respect to an underlying indicator rather than ability to predict crisis, the procedures and outcomes derived from them should be viewed as complements rather than substitutes.

Based on this reasoning, the MIP indicators might be group into three distinct categories whose content varies by number of time lags. The ***activity rate, youth unemployment rate*** and ***private sector debt*** belongs to best performers in both the signalling and probability models in the short-to-medium term (up to 2 years). Not only do they relatively succeed in predicting the crisis with lowest noise-to-signal ratio, the statistically significant and strong average marginal effect might signal increase in crisis occurrence even without imposing any distinct threshold values. On top of that, by targeting these indicators by various policy measures the

probability of crisis might be further mitigated. Increasing the time horizon to 3-years lag, this group is expanded by inclusion of the ***current account balance*** and ***net international investments*** position indicator.

The second group of indicators incorporates variables that perform poor according to results of both models. Once again, the content of this group is time-varying as the performance of indicators is inherently linked to the number of lags introduced in the models; a fact widely acknowledged in the early-warning indicators literature (e.g. Babecky et al., 2013). The r***eal effective exchange rate, current account,*** and ***nominal unit labour costs*** do not represent an adequate early warning indicator in the MIP setup as they score badly from the short-term perspective. On the other side, the ***general government gross debt, private sector credit flows*** and ***total financial sector liabilities*** do not represent reliable variables once moving to longer time horizons.

Finally, the group of indicators delivering mutually contradicting outcomes might be further decomposed into two classes. Scoring high in probability model but being the worst performer in the signalling method characterizes the ***house price index***, ***total financial sector liabilities*** and ***private sector credit flows***. As already discussed, this outcome might point to the problem of threshold level specification used in the signalling approach. In other words, if threshold is set too low or too high, the predictive power of an indicator might be seriously hindered. On the other hand, even a low predictive power associated with an indicator does not necessarily need to rule out possibility that an indicator might be highly efficient in changing the probability of crisis incidence, as both characteristics might be of a totally separate nature. Conversely, relatively high prediction ability in the ***export market share*** indicator might not need to be associated with strong and statistically significant response in change of probability of crisis.

4. Conclusions

The research presented in this paper aimed to discuss the performance of the indicators included in the MIP Scoreboard in terms of their usefulness as predictors of potential crisis. Three different models were compared and the conclusions were drawn from these results. We applied binary response model, i.e. an unbalanced panel logit model estimated by maximum likelihood approach with cluster-robust standard errors. The results were confronted with a standard linear unbalanced panel probability model estimated by ordinary least square method. Furthermore, the estimated parameters of the models and the average marginal effects were to be compared with the findings from the simple signalling approach reported in Domonkos et al. (2016).

Although, the results are in some cases adverse, most of the variables tend to perform similarly regardless the method of evaluation applied. The house price index, total financial sector liabilities and private sector credit flows are scoring satisfactory in the logit model but failed to be useful predictor according to the signalling approach. On the contrary, the export market share is not significantly responding to changes of probability of crisis, but tends to be an effective crisis signaller in compliance with the signalling method, on the other hand. The activity rate, youth unemployment rate, private sector debt, current account balance and net international investments position belong to the group of variables best performing regardless the method of evaluation applied. The variables can be further evaluated, whether they signalize crises events in short term or long term. The activity rate, youth unemployment rate and private sector debt has significant contribution to the probability models in the short-to-medium term (up to two years). The current account balance and net international investments

position has performed best with three year time lag. Conversely, the third group of indicators has common failing to be a good predictor of crises either based on the signalling approach or on the logit model. The indicators belonging to this group are the real effective exchange rate, current account balance (one year time lag) and nominal unit labour costs.

Likely differences between the results from the signalling method and the probability models might be attributed to the following reasons: signalling approach utilizing the thresholds for the individual MIP indicators which is an information lacking from the probability model; and the average marginal effects are measuring the response probability of crisis with respect to a particular indicator and not the ability to predict crisis. Thus, we encourage viewing the procedures and outcomes rather as complements not as substitutes.

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Appendix 1

Appendix 1 - Table 1 Estimations of probit and logit models and the results from the signalling approach with one year time lag

	Lag 1					
Indicator	Logit	Logit Ajdusted	LPM	LPM Adjusted	PRED	aNtS
Activity rate	-0,044 (0.107)		***-0.056**** ***(0.062)***		33,01%	0,388
Long-term unemployment rate	***0.081**** ***(0.037)***	0,022 (0.126)	***0.068**** ***(0.057)***	0,023 (0.118)	59,22%	0,497
Youth unemployment rate	***-0.017**** ***(0.089)***	***0.011**** ***(0.051)***	-0,011 (0.323)	***0.012***** ***(0.041)***	62,14%	0,502
Export market shares	-0,002 (0.272)	-0.003 (0.202)	-0,001 (0.718)	-0,001 (0.731)	63,83%	0,641
Private sector debt	***0.002******* ***(0.000)***		***0.002******* ***(0.004)***		53,40%	0,703
Unemployment rate	-0,015 (0.287)	0,003 (0.723)	-0,014 (0.409)	0,007 (0.488)	34,95%	0,712
General government gross debt	0,000 (0.880)	0,001 (0.529)	0,000 (0.781)	0,001 (0.683)	50,49%	0,763
Net international investment position	-0,001 (0.508)	0,000 (0.661)	-0,001 (0.414)	-0,001 (0.252)	58,59%	0,825
Real effective exchange rate	0,005 (0.413)		0,001 (0.937)		37,86%	0,928
Current account balance	-0,001 (0.912)	-0,006 (0.420)	-0,005 (0.638)	-0,013 (0.120)	46,08%	0,980
Nominal unit labour cost	0,000 (0.929)	-0,005 (0.334)	0,005 (0.336)	0,000 (0.962)	33,01%	1,167
Private sector credit flow	***-0.004******* ***(0.094)***		***-0.004******* ***(0.000)***		6,25%	4,299
Total financial sector liabilities	0,001 (0.615)	***-0.007**** ***(0.096)***	0,002 (0.479)	***-0.007**** ***(0.039)***	4,85%	5,581
House price index	***-0.035******* ***(0.000)***	***-0.033******* ***(0.000)***	***-0.021******* ***(0.000)***	***-0.019******* ***(0.000)***	2,97%	11,998

Source: Authors'own calculations.

Appendix 1 - Table 2 Estimations of probit and logit models and the results from the signalling approach with two years time lag

	Lag 2					
Indicator	Logit	Logit Ajdusted	LPM	LPM Adjusted	PRED	aNtS
Youth unemployment rate	-0,004	***0.012***	-0,003	***0.013***	57,43%	0,584
	(0.613)	***(0.023)***	(0.747)	***(0.031)***		
Long-term unemployment rate	***0.053***	0,010	0,051	0,013	51,49%	0,633
	(0.099)	(0.499)	(0.145)	(0.438)		
Activity rate	***-0.099****		***-0.106****		24,75%	0,662
	(0.000)		***(0.001)***			
Private sector debt	***0.001****		***0.001****		52,48%	0,703
	(0.029)		***(0.077)***			
Export market shares	-0,001	0,000	-0,001	0,000	57,47%	0,720
	(0.694)	(0.865)	(0.626)	(0.989)		
Current account balance	-0,014	***-0.022****	-0,016	****-0.026***	55,00%	0,793
	(0.148)	***(0.003)***	(0.155)	***(0.002)***		
Net international investment position	-0,001	***-0.001****	-0,001	-0,001	56,84%	0,846
	(0.353)	***(0.089)***	(0.405)	(0.104)		
General government gross debt	0,000	0,000	0,000	0,000	43,56%	0,910
	(0.885)	(0.888)	(0.900)	(0.894)		
Nominal unit labour cost	***0,009***	0,003	0,009	0,003	38,61%	1,027
	(0.070)	(0.606)	(0.107)	(0.602)		
Unemployment rate	-0,025	-0,005	-0,025	-0,006	24,75%	1,128
	(0.129)	(0.602)	(0.123)	(0.596)		
Private sector credit flow	0,001		0,001		19,80%	1,241
	(0.317)		(0.223)			
Real effective exchange rate	***-0.014****		***-0.013****		31,68%	1,322
	(0.042)		***(0.038)***			
Total financial sector liabilities	0,003	-0,002	0,004	-0,003	13,86%	1,834
	(0.233)	(0.363)	(0.198)	(0.404)		
House price index	***-0.013****	***-0.012****	***-0.013****	***-0.012****	10,20%	3,307
	(0.004)	***(0.018)***	***(0.004)***	***(0.010)***		

Source: Authors'own calculations.

Appendix 1 - Table 3 Estimations of probit and logit models and the results from the signalling approach with three years time lag

	Lag 3					
Indicator	Logit	Logit Ajdusted	LPM	LPM Adjusted	PRED	aNtS
Youth unemployment rate	0,006	***0.010******	0,007	***0.011****	55,45%	0,621
	(0.582)	***(0.007)***	(0.460)	***(0.018)***		
Private sector debt	0,000		0,001		50,50%	0,721
	(0.427)		(0.412)			
Export market shares	-0,001	0,000	-0,002	0,000	52,44%	0,745
	(0.587)	(0.936)	(0.500)	(0.969)		
Nominal unit labour cost	***0.015****	***0.010****	***0.016****	***0.011****	49,50%	0,776
	(0.014)	***(0.018)***	***(0.014)***	***(0.032)***		
Current account balance	-0,012	***-0.024******	-0,015	***-0.027******	58,16%	0,783
	(0.266)	***(0.000)***	(0.249)	***(0.002)***		
Long-term unemployment rate	0,037	0,003	0,031	0,002	40,59%	0,887
	(0.426)	(0.878)	(0.448)	(0.908)		
Net international investment position	-0,001	***-0.001****	-0,001	-0,001	53,19%	0,918
	(0.255)	***(0.065)***	(0.328)	(0.101)		
Private sector credit flow	0,001		***0.002****		24,75%	1,017
	(0.109)		***(0.076)***			
Activity rate	***-0.094******		***-0.106******		14,85%	1,039
	(0.000)		***(0.001)***			
General government gross debt	0,001	0,001	0,000	0,000	37,62%	1,074
	(0.758)	(0.644)	(0.908)	(0.777)		
Total financial sector liabilities	0,000	0,001	0,000	0,001	18,81%	1,427
	(0.986)	(0.704)	(0.925)	(0.601)		
Real effective exchange rate	***-0.013****		***-0.014****		31,68%	1,547
	(0.064)		***(0.041)***			
House price index	0,007	0,004	0,006	0,003	18,95%	1,721
	(0.159)	(0.422)	(0.253)	(0.517)		
Unemployment rate	***-0.036****	-0,015	***-0.031****	-0,013	16,83%	1,731
	(0.042)	(0.339)	***(0.041)***	(0.310)		

Source: Authors'own calculations.

Appendix 2

Appendix 2 - Table 1 Correlation matrix

Ind.	AR	LTUR	YUR	EMS	PSD	UR	GGD	NIIP	REER	CA	NULC	PSCF	TFSL	HPI
AR	1.00													
LTUR	-0.29	1.00												
YUR	-0.31	0.82	1.00											
EMS	0.27	-0.30	-0.24	1.00										
PSD	-0.21	0.18	0.16	-0.32	1.00									
UR	-0.07	0.63	0.39	-0.09	-0.15	1.00								
GGD	-0.22	0.43	0.34	-0.55	0.07	0.39	1.00							
NIIP	0.07	-0.37	-0.33	-0.14	0.14	-0.59	-0.16	1.00						
REER	0.07	-0.26	-0.03	0.38	-0.15	-0.16	-0.26	-0.04	1.00					
CA	-0.08	-0.02	-0.08	-0.38	0.35	-0.20	-0.11	0.61	-0.20	1.00				
NULC	0.29	-0.52	-0.29	0.50	-0.11	-0.39	-0.42	0.03	0.37	-0.41	1.00			
PSCF	0.03	-0.20	-0.24	0.17	0.21	-0.22	-0.22	0.11	0.05	0.03	0.13	1.00		
TFSL	0.18	-0.40	-0.39	0.37	-0.03	-0.31	-0.40	0.15	0.02	-0.09	0.33	0.32	1.00	
HPI	0.17	-0.35	-0.52	0.15	0.00	-0.18	-0.23	0.27	-0.03	0.16	0.02	0.29	0.51	1.00

Source: Authors'own calculations.

Note: AR represents activity rate, LTUR long term unemployment rate, YUR youth unemployment rate, EMS export market share, PSD private sector debt, UR unemployment rate, GGD general government debt, NIIP net international investment position, REER real effective exchange rate, CA current account balance, NULC nominal unit labour cost, PSCF private sector credit flow, TFSL total financial sector liabilities, and HPI house price index.