European Commission

ISSN 1725-3187

EUROPEAN ECONOMY

Economic Papers 475 | December 2012

An early-detection index of fiscal stress for EU countries

Katia Berti, Matteo Salto
and Matthieu Lequien

Economic and Financial Affairs

Economic Papers are written by the Staff of the Directorate-General for Economic and Financial Affairs, or by experts working in association with them. The Papers are intended to increase awareness of the technical work being done by staff and to seek comments and suggestions for further analysis. The views expressed are the author's alone and do not necessarily correspond to those of the European Commission. Comments and enquiries should be addressed to:

European Commission
Directorate-General for Economic and Financial Affairs
Publications
B-1049 Brussels
Belgium
E-mail: Ecfin-Info@ec.europa.eu

This paper exists in English only and can be downloaded from the website
ec.europa.eu/economy_finance/publications

A great deal of additional information is available on the Internet. It can be accessed through the Europa server (ec.europa.eu)

KC-AI-12-475-EN-N
ISBN 978-92-79-22996-1
doi: 10.2765/28160

European Commission

Directorate-General for Economic and Financial Affairs

An early-detection index of fiscal stress for EU countries

By Katia Berti, Matteo Salto and Matthieu Lequien *

Abstract

The financial and economic crisis has generated renewed interest, especially among policy-makers, in early-warning systems that could help identifying fiscal and macro-financial vulnerabilities potentially triggering risks. Against this background, this paper presents an early-warning index of fiscal stress, incorporating fiscal, financial and competitiveness variables, some of which are common to the scoreboard used in the EU for the surveillance of macroeconomic imbalances. Thresholds of fiscal risk are determined, based on the non-parametric signals approach, for the overall index, the two sub-indexes grouping fiscal and financial-competitiveness variables and each individual variable used in the analysis. Values of the overall index beyond its critical threshold pinpoint to potential risks of fiscal stress in the short run, while the analysis at individual variable level allows identifying possible sources of vulnerabilities, which is key to design appropriate risk-mitigating policies. The results obtained highlight the importance of incorporating financial-competitiveness variables in an early-warning system for fiscal stress, as such variables appear to be better "leading indicators" of fiscal stress than fiscal variables are. The results also speak in favour of using an early-warning composite indicator of fiscal stress, rather than looking at the individual variables taken in isolation. Results obtained by applying the proposed methodology to EU countries are presented in the last part of the paper.

JEL classification: E62, E65, E66, H62, H63, E21, F32, F34.

* Katia Berti and Matteo Salto are economists in the Fiscal Policy Directorate of the Directorate General for Economic and Financial Affairs of the European Commission. Matthieu Lequien was an intern in the Fiscal Policy Directorate when this work was first conducted. The views expressed in this paper are those of the authors and do not necessarily coincide with those of the European Commission. Corresponding author: Katia Berti, DG ECFIN, European Commission, CHAR 12/129, B-1049 Brussels, Belgium; e-mail: Katia.Berti@ec.europa.eu.

1. Introduction

The financial and economic crisis, that started late 2007 with the collapse of the subprime mortgage market in the US and spread to the global economy in 2008, has generated renewed interest, especially among policy-makers, in early-warning systems that could help identifying fiscal and macro-financial vulnerabilities potentially triggering risks. The early detection of risks is indeed crucial to allow the effective coordination of early policy responses in a world of economies that are more and more interconnected and globalised.

Such renewed interest in early-warning systems is clearly witnessed by the analytical work that has been conducted both at the European Commission and the IMF,[1] and also, and more prominently, by new institutional processes that have been set up at international level for the identification, monitoring, and correction of macro-financial vulnerabilities (mainly the new surveillance procedure for the prevention and correction of macroeconomic imbalances, or Macroeconomic Imbalance Procedure (MIP) in the European Union, but also the joint International Monetary Fund – Financial Stability Board[2] Early Warning Exercise, in which the IMF and the FSB respectively lead the work on macroeconomic and macro-financial vulnerabilities and on vulnerabilities and regulatory challenges in the financial sector).

The joint IMF-FSB Early Warning Exercise (EWE) has been established in 2009, upon request by the G-20.[3] The mandate to the two bodies consisted in setting up an exercise to "..better identify vulnerabilities, anticipate potential stresses, and act swiftly to play a key role in crisis response..".[4] Following this request, a regular semi-annual exercise has been set up, based on a large number of empirical tools, surveys of experts and market intelligence, including vulnerability indicators assessing individual countries' risks to macro, financial and external crises.

Even more prominently than this, recent important changes in EU economic governance included, as part of the so called "six-pack", the setting up of an alert mechanism in the context of the new surveillance procedure for the prevention and correction of macroeconomic imbalances.[5] Imbalances identified as the root causes of the current economic and financial crisis (large and persistent external deficits and surpluses, sustained losses in competitiveness, the build-up of private and public indebtedness and housing market bubbles) are targeted by the alert mechanism used in the procedure,[6] which relies on a scoreboard of ten indicators with respective indicative thresholds.[7] The MIP is clearly the most prominent

[1] See European Commission (2012a) and European Commission (2011), Part IV, Chapter 3, where this work was first presented, and Baldacci, Petrova, Belhocine, Dobrescu and Mazraani (2011a) on the IMF side.
[2] The Financial Stability Board represents experts and policy-makers from financial supervisory agencies and central banks in member countries.
[3] See IMF (2012 and 2010) for more details.
[4] G20 Communiqué, 15 November 2008.
[5] See 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.
[6] See the first annual Alert Mechanism Report by the European Commission (2012b).
[7] The following indicators are included in the scoreboard: current account balance in percent of GDP (3-year backward-moving average); net international investment position in % of GDP; percentage (3-year) change of real effective exchange rate based on consumer price index deflators; percentage (5-year) change of export market shares; percentage (3-year) change in nominal unit labour costs; (year-on-year) growth rate of the deflated house price index; private sector debt in percent of GDP; private sector credit flow in percent of GDP; general government debt in percent of GDP; unemployment rate (3-year backward-moving average). For a more detailed explanation see European Commission (2012c).

result of the renewed importance attributed to early-screening devices as a response to the need for reinforced surveillance.

Clearly, one of the lessons taught by the crisis is that fiscal and macro-financial imbalances cannot be looked at separately, but should rather be jointly analysed and monitored. Indeed, fiscal imbalances can negatively affect macroeconomic conditions and financial stability, and macro-financial imbalances can quickly turn into fiscal imbalances. These interconnections can certainly not be neglected in the context of an early-warning system for fiscal stress, object of our analysis in this paper. Risks of a fiscal nature can only be detected by jointly taking into account the two dimensions (fiscal and macro-financial), in full recognition of the role played by macro-financial variables in the run up to fiscal crises. This would indeed call for widening the scope of observation beyond fiscal variables when monitoring fiscal risks.

Against this background, this paper presents an early-warning index of fiscal stress (so called "S0") that relies on the non-parametric "signals approach" pioneered by Kaminsky, Lizondo and Reinhart (1998) and Kaminsky and Reinhart (1999) and applied to debt and fiscal crises in more recent contributions (Hemming, Kell and Schimmelpfennig, 2003; Baldacci, Petrova, Belhocine, Dobrescu and Mazraani, 2011a). Along the lines of other contributions to this strand of the literature, we rely on a certain definition of fiscal stress, based on which past episodes are identified, so as to allow for the analysis of variables' behaviour ahead of those episodes (the broad definition of fiscal stress proposed by Baldacci et al., 2011a, is used here).[8] We then select a set of variables identified as playing a role in the run up to fiscal stress events; we choose a "signalling window", i.e. the horizon over which the fiscal stress prediction would extend; and we make use of an optimisation criterion to determine critical thresholds for fiscal risk for each of the variables considered, as well as for the composite early-warning indicator of fiscal stress constructed with the individual variables.

While previous contributions on early-warning indicators of fiscal risk based on the signals approach (Baldacci et al., 2011a; Hemming, Kell and Schimmelpfennig, 2003) mainly relied on fiscal variables to predict fiscal risk, our paper stresses the importance of incorporating in the analysis both fiscal and financial-competitiveness variables. Our original contribution indeed mainly lies in the introduction of competitiveness-financial variables, some of which common to the scoreboard for the macroeconomic imbalance procedure, in a composite early-warning index of fiscal stress, constructed along the lines of Baldacci et al. (2011a) and Reinhart, Goldstein and Kaminsky (2000). It should be stressed that our interest in the MIP scoreboard variables relates exclusively to risks that macroeconomic imbalances entail for public finances. Here our intention is not to measure macroeconomic imbalances as a more general reason for concern to a solid process of economic integration, also beyond the possible repercussions on public accounts. Thus, though some of the financial-competitiveness variables are common between our early-warning system for fiscal stress and the MIP scoreboard, the purpose to which they are used differs between the two.

Two main findings emerge from our analysis. The first relates to the potential displayed by financial-competitiveness variables as possible fiscal stress predictors. Based on past fiscal stress events, their predictive power is generally significantly higher than that displayed by fiscal variables. In particular, some of the variables common to the MIP scoreboard appear to be among the best-performing predictors of fiscal stress. This highlights the importance of including these variables in the context of an early-detection index of fiscal stress. The second finding refers to the relative performance, in terms of fiscal stress prediction, of the composite

[8] Details on the definition of fiscal stress by Baldacci et al. are provided in Section 3.1.

indicator (incorporating both fiscal and financial-competitiveness variables) versus the same individual variables taken in isolation. Results obtained pinpoint to a significantly higher predictive power for the composite indicator. This speaks in favour of its use in the context of our early-warning model.

The remaining of the paper is organised as follows. Section 2 presents a review of the literature on early-warning systems, with particular attention to the signals approach used here. Section 3 provides a detailed description of the methodology to determine the critical thresholds for fiscal stress and to construct the early-warning composite indicator. Section 4 briefly describes the data used and the results obtained, while Section 5 concludes.

2. Literature review

The literature on early-warning systems covers different types of crises (currency, banking, fiscal crises). Various methodologies have been proposed to detect risks,[9] but the two most widely used, and by now standard, approaches are the non-parametric "signals approach" (also called "indicators approach") and the multivariate regression approach based on probit or logit models.

The regression approach consists of panel models analysing the impact of a set of independent variables on crisis probability (the dependent variable being a binary variable that takes value 1 if a crisis occurred and 0 otherwise). From a methodological point of view, this approach has the advantage of allowing taking into account correlations between variables and testing for the statistical significance of the variables. The predicted probability of a crisis taking place within a pre-defined time frame is calculated using the latest values of the explanatory variables and the estimated coefficients from the probit or logit model.

A number of contributions have been produced using this approach, with regard to different types of crises and using different sets of explanatory variables. In Manasse, Roubini and Schimmelpfennig (2003), for instance, a logit model for sovereign debt crises is estimated using a whole set of macroeconomic variables reflecting solvency and liquidity factors, external developments (current account balance), macroeconomic conditions (real GDP growth rate, inflation) and political economy factors. Hemming, Kell and Schimmelpfennig (2003) construct a probit model to analyse the role of fiscal variables in predicting financial crises, while Kumar, Moorthy and Perraudin (2002) use a logit model with lagged financial and macroeconomic variables to predict currency crises. The impact of corporate balance sheet indicators on the probability of a currency crisis is investigated by Mulder, Perrelli and Rocha (2002) using the probit model by Berg and Pattillo (1999). The authors highlight potentially large improvements in the predictive power of the model by including these balance sheet indicators, with high leverage and short maturity structure of the corporate sector shown to increase the probability of a currency crisis.

The early-warning index presented in this paper is based on the alternative methodological approach, the signals approach, pioneered by Kaminsky, Lizondo and Reinhart (1998) and Kaminsky and Reinhart (1999). The basic idea behind this non-parametric approach lies in the observation that some variables tend to behave differently on the eve of crises/stress events

[9] See Abiad (2003) for a comprehensive literature review on different methodological approaches used for early-warning models.

relative to normal times. The historical behaviour of a set of relevant variables is therefore analysed with reference to the series of past crisis/stress events (a series taking value 1 in correspondence to crisis/stress years, and 0 for no-crisis/stress years), so as to capture signals sent by the variables prior to these events. The methodology (explained in detail in Section 3) allows for the endogenous determination of a critical threshold for each variable included in the analysis, so that values of the variable beyond such threshold provide early signals of crisis/stress risks. Variables can then be ranked based on their performance in terms of correctly predicting actual past crisis/stress events and avoiding sending wrong signals ahead of tranquil years. Contrary to the aforementioned regression approach, correlations between variables cannot be accounted for with this approach.[10]

The construction of composite indicators using the (best-performing) individual variables characterises a number of contributions relying on the signals approach. Kaminsky (1998) suggests three possible options to construct such composite indicators, respectively by letting the indicators reflect the number of variables that flash red within the set of pre-selected variables; by letting them (separately) reflect respectively the number of variables sending "mild" and "extreme" crisis signals, with more weight assigned to the latter (so as to account for the intensity of the signals); or by accounting for the number of variables flashing red in at least one of the *n* preceding periods (to take account of the fact that different variables may signal with different timing). The first option is applied here, as in Baldacci et al. (2011a). Advantages of the approach used here are its relative simplicity and the fact that it easily accommodates for differences in data availability across variables (which is not the case in multivariate regression analysis), together with the possibility to incorporate a large set of variables in the composite indicator.

The signals approach has also been used with regard to various types of crises, with most applications referring to banking and currency crises (Kaminsky, Lizondo and Reinhart, 1998; Kaminsky and Reinhart, 1999; Hemming, Kell and Schimmelpfennig, 2003; Brüggermann and Linne, 2002). Hemming et al. (2003) apply the methodology to external debt crises,[11] while fiscal stress is the specific object of analysis in Baldacci et al. (2011a).

Contributions on early-warning indicators of fiscal risk have so far relied mainly on fiscal variables. Baldacci et al. (2011a; the closest contribution to ours in terms of focus on the early detection of fiscal stress relying on the signals' approach) include only fiscal variables, classified into basic fiscal variables, long-term fiscal trends, and asset and liability management.[12] Hemming et al. (2003; analysing debt crises using the signals' approach) also rely mainly on fiscal variables. On the contrary, Manasse, Roubini and Schimmelpfennig (2003; focussing on sovereign debt crises) consider a wider set of variables divided into

[10] Interactions between variables would be taken into account by adopting a more complex non-parametric approach, the binary recursive tree approach, which is rooted in the signals approach. In brief, this would require splitting the sample into two sub-samples by using the critical threshold for crisis risk endogenously identified for the best-performing indicator, then repeating this operation to further divide the sub-samples into two according to the threshold for the second best-performing indicator and so on till when a certain stopping rule is satisfied. This leads in the end to the partition of the overall sample into crisis and non-crisis prone subgroups identified by a set of conditions involving more than one indicator (see Manasse and Roubini, 2009; Manasse, Roubini and Schimmelpfennig, 2003; Ghosh and Ghosh, 2002). A critical point with this more sophisticated approach lies in the instability of the so obtained trees, with a small change in the data often resulting in a very different series of splits, making interpretation somewhat precarious (Hastie, Tibshirani and Friedman, 2009).

[11] The reference is to both public and private debt.

[12] See Baldacci, McHugh and Petrova (2011b) for a detailed definition of the variables used in Baldacci et al. (2011a).

external debt variables, public debt variables, variables from the IMF's currency crisis early-warning system,[13] other macroeconomic variables,[14] fiscal flow variables and political economy variables. They also include the current account (one of the MIP variables) and find that, ceteris paribus, countries with a high current account balance have a reduced probability of entering in a crisis. The contribution by Manasse et al. anyway differs significantly from ours with regard to the approach used, as they rely on logit regression modelling and binary recursive tree analysis, while we apply here the signals' approach.

To be absolutely precise about the purpose to which the early-warning models described here are used, it is important to add that they do not actually attempt "to predict crises". These models rather aim at an early identification of economic vulnerabilities, from which crisis risks might stem, to be better able to timely define risk-mitigating policies. As is explained by Ghosh, Ostry and Tamirisa (2009), the analysis of past crises shows that nearly all of them "..reflect a confluence of some underlying economic vulnerability and a specific crisis trigger. The underlying vulnerability is often a credit or asset price bubble, a balance sheet mismatch (excessive borrowing in foreign currency, at too-short maturities, or with inadequate capitalization), whereas the crisis trigger can be almost any event – political turmoil, terms of trade shocks, contagion from other countries, or, to take the example of the current crisis, the collapse of the subprime market..". While crisis triggers are unpredictable, economic vulnerabilities potentially leading to crises could be identified through an appropriately designed early-warning system allowing to adopt corrective measures aimed at averting risks.

In some of the contributions on early-warning systems, assessments are provided as to "how successful" different models are at anticipating crises. Some of these assessments refer to the methodology proposed in this paper. They find that indeed, for currency and financial crises, systems of this type tend to provide real value added by outperforming other instruments used as predictors, like interest rate spreads, changes in sovereign credit ratings and assessments by informed analysts (see Berg, Borensztein and Pattillo, 2004; Reinhart, 2002; Reinhart, Goldstein and Kaminsky, 2000).

Such positive results point to the desirability of having or setting in place early-warning systems for fiscal stress. Main contribution of a system like the one presented in the following sections would be the systematic and relatively objective nature it confers to the search for fiscal and macro-financial vulnerabilities potentially leading to fiscal stress. Such a system would clearly provide important input to support and discipline the use of judgement, thus strengthening it. Informed judgements based on country-specific expertise anyway are, and would of course always remain, an essential ingredient to ensure the intelligent and correct reading of results obtained from early-warning indicators.

3. A composite early-warning indicator of fiscal stress: description of the methodology

This paper provides an early-warning indicator of fiscal stress incorporating fiscal and financial-competitiveness variables based on the signals approach. The focus is specifically on the design of a possible early-warning system for EU countries. Some of the variables

[13] These are, for instance, reserves growth and the current account balance (variables from the IMF's currency crisis early-warning system are included given the possible link between currency crises and sovereign debt crises).

[14] For instance, the US treasury bill rate, real GDP growth, FDI in percent of GDP and inflation volatility.

from the scoreboard for the surveillance of macroeconomic imbalances have therefore been incorporated within a larger set of financial-competitiveness variables considered relevant in anticipating fiscal stress.

As explained in the previous section, the signals approach is based on the idea that economies behave in a systematically different way in periods preceding fiscal stress. The methodology allows identifying variables, among a set of selected fiscal and financial-competitiveness variables, whose anomalous behaviour could hint at incoming fiscal stress. Basically, the methodology requires going through four steps: first, a precise definition of fiscal stress is adopted; second, a set of variables is chosen, which are thought to be relevant for prompting fiscal stress (based on economic theory, as well as on the observation of variables' behaviour on the eve of past fiscal stress episodes); third, critical thresholds for fiscal risk are determined for each variable included in the analysis in order to maximize the "signalling power" of the model based on a selected mathematical criterion (this also requires choosing a "signalling window", i.e. the horizon ahead of the observation of the variables over which the fiscal stress prediction is to be extended); fourth, variables are aggregated into a composite early-warning indicator of fiscal stress. All the steps are described in detail here below.

3.1 The definition of fiscal stress

Different definitions of fiscal crisis have been proposed in the literature and used in contributions on early-warning models. Hemming et al. (2003), for instance, follow Detragiache and Spilimbergo (2001) by defining a "debt crisis" as an event occurring if either or both of the following conditions apply: 1) there are arrears of principal or interest on external private and public debt to commercial creditors of more than 5% of total external debt outstanding to commercial creditors; 2) there is a rescheduling or debt restructuring agreement with commercial creditors as from the World Bank Global Development Finance database. Two important limitations of this definition, as highlighted by Manasse et al. (2003), are the absence of differentiation between public and private sectors (due to data limitations) and the exclusion of implicit debt crises that were avoided only thanks to large-scale financial support from official creditors. The authors therefore propose an alternative and more precise definition of "sovereign debt crises" as cases where countries are classified as being in default by S&P[15] or receive large non-concessional IMF loans, defined as access to more than 100% of quota.

Here we decided to adopt the broader definition of fiscal stress used in Baldacci et al. (2011a). As explained by the authors, their definition reflects the fact that fiscal crises can take different forms since the mid-1990s, in a context of highly developed bond markets and lower reliance on bank loans, in which severe government funding difficulties might be present despite the fact that they do not result in default or restructuring. A fiscal stress episode is therefore identified if any of the four following criteria is satisfied:

- the yearly inflation rate is above 35%, capturing a moderate implicit default event[16] (as our analysis is focussed exclusively on EU countries and a few other advanced economies, we apply this threshold to all countries, including Eastern European countries, departing in this respect from Baldacci et al. that use a 35% threshold for

[15] A government is in default according to S&P if it fails to meet principal or interest payment on external obligations on due date, including exchange offers, debt equity swaps, and buy back for cash.

[16] Baldacci et al. (2011a) justify this threshold based on the average haircut on debt in case of external debt restructuring as from Sturzenegger and Zettelmeyer (2006).

advanced economies and a 500% threshold for emerging economies, including most Eastern European countries);

- sovereign bond yield spreads are two standard deviations above the country-specific mean (or exceed 1,000 basis points for emerging economies), highlighting significant market financing pressure;[17]
- public debt default is reported based on S&P's definition, or a restructuring/rescheduling is reported (defined as any operation altering the terms of the debtor-creditor contract);
- a large-scale IMF-supported programme is in place (with access to more than 100% of quota; typically non-concessional loans part of an adjustment programme).

The main novelty of the definition by Baldacci et al. is the inclusion of sovereign bond yield spreads among the elements considered to identify fiscal stress episodes. This allows capturing severe fiscal stress events that do not result into defaults, implicit defaults or restructuring and would therefore be missed by the more traditional definitions used in the literature.

3.2 The variables used for the early detection of fiscal stress

Financial-competitiveness variables are used together with fiscal variables to detect fiscal stress in the early-warning device presented in this paper. The introduction of financial-competitiveness variables in this type of framework (our main contribution relative to previous work) acknowledges the role played by macro-financial and competitiveness variables in generating fiscal stress. The precise set of variables used has been selected based on: i) theoretical considerations, ii) the analysis of the behaviour of the variables (whether anomalous or not) on the eve of fiscal stress episodes relative to tranquil times and iii) the performance in terms of fiscal stress prediction in the context of the applied methodology.[18]

Both flow and stock fiscal variables are considered, including the balance and the primary balance, the cyclically adjusted balance, gross debt over GDP and its change, the change in expenditure and in final consumption expenditure of the general government. Also included on the fiscal side are variables like the interest rate-growth rate differential and gross financing needs (important to highlight possible governments' funding problems, especially in contexts of financial market pressure). Other two variables (the change in projected age-related public expenditure in percent of GDP and the projected old-age dependency ratio) are included to capture (both directly and through projected demographic developments) the role of implicit governments' liabilities linked to ageing cost.
Variables considered on the fiscal side are broadly in line with those employed in other contributions on early-warning models for fiscal or debt crises. Baldacci et al., for instance, use three groups of variables: basic fiscal variables, variables linked to asset and liability management and variables capturing long-term fiscal trends.[19] In Hemming et al. (2003) some

[17] More precisely this is computed, based on Baldacci et al. (2011a), by taking both annual and monthly data on yield spreads and considering that a given year is classified as a fiscal stress event if the annual data exceeded either two standard deviations (in terms of annual data) or 10 percent, or the monthly data exceeded the thresholds (with standard deviation calculated using the monthly data) for at least 6 months in the year.
[18] Conducting also out-of-sample testing would be highly desirable but still rather difficult to implement due to the limited number of fiscal stress events available.
[19] Basic fiscal variables are the interest rate-growth rate differential, general government's gross debt over GDP and the cyclically adjusted primary balance; variables linked to asset and liability management are gross financing needs, the share of short-term debt over total debt, debt held by non-residents and the weighted

other fiscal variables are used, on top of the basic ones, like social expenditure, defence expenditure and foreign currency debt.

Among the financial-competitiveness variables we use, some are common to the EC scoreboard for the surveillance of macroeconomic imbalances. The current account, the net international investment position, the change in nominal unit labour costs, private sector debt and private sector credit flow fall into this category (for each of them both the exact definition of the variable and the statistical source are fully aligned to what agreed for the MIP).[20] To these, we add the change in real effective exchange rate based on exports deflator among the competitiveness variables,[21] as well as other variables related to the size and structure of households' and corporations' debt and savings (net savings of households, the leverage of financial corporations, short-term debt of non-financial corporations, short-term debt of households). Other variables include construction as a percent of value added (in the light of the role played by the construction sector, also in the current crisis), the yield curve[22] and real GDP growth. All these variables are included in our analysis for their specific role as possible predictors of fiscal stress (the whole list of variables with the indication of the ones that are common to the MIP scoreboard is reported in Annex 1, Table A1).

3.3 The method used for calculating critical thresholds for fiscal stress

Thresholds of fiscal stress, for each of the variables used in the analysis, are determined using the signals approach. The approach is designed to determine the optimal threshold as the one that maximises the ability to predict fiscal stress episodes based on the value taken by the variable in question.

Each variable will be sending a "fiscal-stress signal" when taking a value above (below) the optimal threshold (depending on the variable in question),[23] while a signal of no fiscal stress will be sent in the opposite case of a value below (above) the threshold. Based on historical data, signals sent by the variable, for the different countries and years, are compared to the historical record of fiscal stress events. The "signalling window" in our analysis is set to 1, meaning that the value of the variable at time *t* is used to predict fiscal stress one year ahead, at $t+1$.[24] A signal is correct when, for the country in question, the variable indicated a fiscal stress (no-fiscal stress) year ahead and this was indeed the case, based on historical evidence.

---

average maturity of general government debt; variables capturing long-term fiscal trends are the fertility rate, long-term projections of public health expenditure in % of GDP, long-term projections of pension expenditure in % of GDP, and the dependency ratio (Baldacci et al., 2011b).

[20] In terms of exact definition of the variables, this means, for instance, that we use the 3-year backward-moving average for the current account over GDP, and the 3-year change in nominal unit labour costs.

[21] The definition of this variable differs relative to the MIP scoreboard, as we use the REER based on exports deflator, while the MIP refers to the REER based on the harmonised index of consumer prices deflators (HICP). Our choice is based on the fact that the former performs better than the latter in our early-warning system for fiscal stress. We use the 3-year change of the variable as in the MIP.

[22] The slope of the yield curve (which depicts interest rates with different remaining maturities) has often appeared to be a useful indicator to predict future economic activity, with a flattening, and in particular an inversion of the curve, often anticipating an imminent slowdown.

[23] For the change in public debt over GDP, for instance, a value above the optimal threshold would signal fiscal risk, while for the general government balance over GDP a value below the optimal threshold is taken as a fiscal-stress signal.

[24] As will be better explained later, when presenting the results, the one-year signalling window was chosen after having experimented with 1-year and 2-year signalling windows with both groups of variables (fiscal and financial-competitiveness).

On the contrary, a signal is wrong when the variable signalled no fiscal stress ahead of a fiscal-stress year (type II error) and when it signalled a fiscal stress episode that did not follow (type I error). The four possible combinations of events are reported in Table 1.

Table 1 – Possible cases based on type of signal sent by the variable at time *t*-1 and state of the world at time *t*

	Fiscal stress episode (*Fs*)	**No-fiscal stress episode** (*Nfs*)
Fiscal stress signal	True Positive signal	False Positive (*FP*) signal (type I error)
No-fiscal stress signal	False Negative (*FN*) signal (type II error)	True Negative signal

For each variable *i* the optimal threshold (t_i^*) will be such as to minimise the sum of type I and type II errors for variable *i* (respectively the share, out of the number of no-fiscal stress episodes, of fiscal stress signals followed by no-fiscal stress episodes – False Positive signals – and the share, out of the number of fiscal stress episodes, of no-fiscal stress signals followed by fiscal stress episodes – False Negative signals), as from the following total misclassification error for variable *i* (TME_i):

$$t_i^* = \arg\min_{t_i \in T_i}\left(TME_i(t_i)\right) = \arg\min_{t_i \in T_i}\left(\frac{FN_i(t_i)}{Fs} + \frac{FP_i(t_i)}{Nfs}\right) \qquad i = 1,\ldots, n \qquad (1)$$

where T_i = set of all values taken by variable *i* over all countries and years in the panel; $FN_i(t_i)$ = total number of false negative signals sent by variable *i* (over all countries and years) based on threshold t_i; $FP_i(t_i)$ = total number of false positive signals sent by variable *i* (over all countries and years) based on threshold t_i; *Fs* = total number of fiscal stress episodes recorded in the data; *Nfs* = total number of no-fiscal stress episodes recorded in the data;[25] *n* = total number of variables used.

Based on (1), the optimal threshold will therefore be such as to balance between type I and type II errors. For variables for which values above the threshold signal fiscal stress, for instance, a relatively low threshold would produce relatively more false positive signals and fewer false negative signals, meaning higher type I error and lower type II error. The opposite would hold with a relatively high threshold.

In the minimisation problem (see (1)), False Negative signals are weighted more than False Positive signals as:

$$\frac{1}{Fs} > \frac{1}{Nfs}$$

The total number of fiscal stress episodes recorded over a (large enough) panel of countries will be typically much smaller than the total number of no-fiscal stress episodes. This is a positive feature of the model as we might reasonably want to weigh the type II error more

[25] Here we simplify on the total number of fiscal stress and no-fiscal stress episodes as in fact also these numbers vary across variables. This is due to the fact that data availability constraints do not allow us to use the whole series of episodes for all variables.

than the type I given the more serious consequences deriving from failing to correctly predict a fiscal stress episode relative to predicting a fiscal stress episode when there will be none.

The threshold for variable *i* (with *i* = 1,…, *n*) obtained from (1) is common to all countries in the panel. We define this as a common *absolute* threshold, but the threshold could have also been defined as a common *relative* threshold (i.e. a common percentage tail of the country-specific distributions).[26] In the latter case, while the optimal percentage tail obtained from (1) would be the same for all countries, the associated absolute threshold would differ across countries reflecting differences in distributions (country *j*'s absolute threshold for variable *i* would reflect the country-specific history with regard to that variable). Both methods were applied and a decision was made to focus exclusively on the first.[27]

An alternative criterion to the TME in equation (1) would be the minimisation of the noise-to-signal ratio (*NSR*),[28] in which case the optimal threshold for variable *i* (t_i^*) is obtained as:

$$t_i^* = \arg\min_{t_i \in T_i} \left(NSR_i(t_i) \right) = \frac{FP_i(t_i)/Nfs}{TP_i(t_i)/Fs} \qquad i = 1,\ldots, n$$

where $TP_i(t_i)$ = total number of true positive signals sent by variable *i* (over all countries and years) based on threshold t_i. The TME minimisation was preferred to this alternative criterion based on the size of the total errors produced (same choice and justification as in Baldacci et al., 2011a).

Given the optimal thresholds t_i^* from (1), it is straightforward to calculate for each variable *i* (with *i*=1,…,*n*) a measure of the variable's predictive power, or "signalling power", z_i as follows:

$$z_i = 1 - \left(\frac{FN_i(t_i^*)}{Fs} + \frac{FP_i(t_i^*)}{Nfs} \right) \qquad (2)$$

3.4 An early-warning composite indicator of fiscal stress

As done in other contributions to the literature,[29] results from the application of the methodology described above can be used to construct an early-warning composite indicator. As already said, the indicator constructed here is designed for the early-detection of fiscal stress relying on both fiscal and financial-competitiveness variables (the full list of variables used is reported in Table 2).[30]

---

[26] See, for instance, Reinhart, Goldstein and Kaminsky (2000) and Hemming et al. (2003).

[27] The method relying on common relative thresholds tends to produce sensitive country-specific absolute thresholds for variable *i* only for countries having a history of medium to high values for the variable concerned (or medium to low, depending on what the fiscal-stress-prone side of the distribution is), while country-specific thresholds would not be meaningful for the rest of the sample.

[28] See, for instance, Reinhart et al. (2000), Hemming et al. (2003).

[29] See Baldacci et al. (2011a), specifically on an early-warning indicator of fiscal stress; IMF (2010) and Reinhart et al. (2000), more generally on early-warning composite indicators based on the signals approach.

[30] The early-warning indicator of fiscal stress presented here is constructed in a similar way to Baldacci et al. (2011a) and Reinhart et al. (2000). The difference with Baldacci et al. (2011a) is that we do not use a system of "double weighting" of each variable incorporated in the composite indicator based on the weight of the subgroup of variables it belongs to (for us fiscal and financial-competitiveness variables) and the weight of the individual variable within the group. The difference with Reinhart et al. (2000) is in the way the individual variables'

As a first step, a dummy d^i is created for each variable *i* such that $d^i_{jt} = 1$ if a fiscal stress signal is sent at time *t* by variable *i* for country *j* for the following year and $d^i_{jt} = 0$ otherwise, i.e. if a no-fiscal stress signal is sent or the variable is missing. Then, the value of the composite indicator, which we call *S0*,[31] for country *j* and year *t* ($S0_{jt}$) is then calculated as the weighted number of variables having reached their optimal thresholds (thus sending fiscal stress signals), with the weights given by the signalling power of the individual variables as from (2):

$$S0_{jt} = \sum_{i=1}^{n} w_i d^i_{jt} = \sum_{i=1}^{n} \frac{z_i}{\sum_{k=1}^{n} h^k_{jt} \cdot z_k} d^i_{jt} \qquad (3)$$

where *n* = total number of variables; z_i = signalling power of variable *i*; and $h^k_{jt} \in \{0,1\}$ is an indicator variable taking value 1 if variable *k* is observed for country *j* at time *t* and 0 otherwise.[32] The variables are therefore assigned higher weight in the composite indicator, the higher their past forecasting accuracy.[33] Based on (3), the early-warning indicator of fiscal stress *S0* will be higher, the greater the number of variables that are "flashing" in correspondence to that country/year, signalling risk of fiscal stress for the following year, and the higher the signalling power of the flashing variables (i.e. the variables' estimated ability to send the right signals).

The methodology to determine optimal thresholds described in Section 3.3 is then applied also to this *S0* indicator, for which a value above the critical threshold for a certain country/year provides a signal of incoming fiscal stress in the country in question for the following year.

Given that we rely on two different subsets of variables (fiscal and financial-competitiveness) as possible predictors of fiscal stress, a thematic composite indicator is also constructed for each of the two subgroups (following the same methodology as for the overall indicator). By analysing values taken by these sub-indexes for each country/year, information can be derived on the type of vulnerabilities (fiscal, financial-competitiveness) that are behind fiscal stress signals sent by the *S0*.

4. Description of the data and results

4.1 The data used

The calculation (as explained in Section 3.3) of the critical thresholds of fiscal stress for the variables listed in Table 2 is based on a panel of 33 countries for a 40-year period (all EU

weights are computed (they apply the NSR criterion and therefore use as weights the inverse of the noise-to-signal ratios of the individual variables).

[31] This S0 indicator is used in the Fiscal Sustainability Report 2012 to highlight risks of fiscal stress in the short run (see European Commission, 2012a).

[32] This ensures that the sum of the weights is equal to 1 regardless of data availability (which is of course necessary to be able to analyse the evolution of the composite indicator).

[33] Moreover, as evident from (3), the weight attached to each variable is decreasing in the signalling power attached to the other variables, as well as in the number of variables available for a given country and year.

countries but Cyprus, Luxembourg and Malta,[34] plus other nine advanced economies that are Australia, Canada, Iceland, Israel, Japan, New Zealand, Norway, Switzerland and the US).

Data for the set of fiscal and financial-competitiveness variables come from DG ECFIN's AMECO database, Eurostat, the IMF's World Economic Outlook (WEO), the Bank for International Settlements, Bloomberg, OECD and WHO (statistical sources, as well as distribution percentiles, by variable are reported in Annex 1, Table A1). Pension and healthcare expenditure projections by the Economic Policy Committee Working Group on Ageing Populations and Sustainability are used for the calculation of the ageing cost variable. Whenever possible we used time series covering the period 1970-2011/12 but for some variables data are only available starting from 1995. Data for 2011/12 were extrapolated only for a few variables and countries, for which observations were missing.[35] This does not anyway affect the optimal thresholds as 2011/12 values of the variables do not enter into their computation.

The identification of fiscal stress episodes over the time interval 1970-2010 is borrowed from Baldacci et al. (2011a).[36] The sample we use (a sub-sample of the one used by Baldacci et al., which also includes non-EU emerging market economies) contains 143 fiscal stress years regrouped in 54 episodes, leading to an average duration of about 3 years per episode. There are however 21 one-year episodes. In case of fiscal stress episodes lasting over two or more consecutive years, only the first year is used in the computation of the critical thresholds.[37]

4.2 Results

As explained in Sections 3.3-3.4, optimal thresholds based on the signals approach are derived for the early-warning indicator S0, the fiscal and financial-competitiveness sub-indexes and all individual variables included in the analysis. Results are reported in Table 2, where thresholds are displayed together with the indication of the interval (above/below the threshold), where values of the variable would signal upcoming fiscal stress; the type I and type II errors separately (respectively the share, out of the number of no-fiscal stress episodes, of fiscal stress signals sent ahead of no-fiscal stress years and the share, out of the number of

[34] Cyprus, Luxembourg and Malta are excluded from the panel used for the calculation of the optimal thresholds as we miss the necessary information on recorded fiscal stress episodes over the past four decades.

[35] For six countries (Bulgaria, Cyprus, the United Kingdom, Lithuania, Latvia and Poland), latest available data on net savings of households refer to 2010 so that extrapolations were needed to obtain 2011 values used in the calculation of the S0 indicator for 2012. For other three countries (Luxembourg, Romania and Malta), for which also 2010 values of net savings of households are missing, the variable has been excluded from the computation of the S0 indicator. For the yield curve figures are available till 2011 and are extrapolated for 2012, to be used in the calculation of the S0 indicator for 2012 (the only exception being Estonia, for which also the 2011 value is missing and extrapolated from the 2010 value, and Luxembourg, for which the 2010 value of the variable is also missing, so that the variable drops from the computation of the S0 indicator). Extrapolations respectively for 2011/2012, for the aforementioned variables, were done by adding to the 2010/2011 value 50% of the change recorded for the variable over the previous year. For the variable short-term government debt over GDP, 2011 values are available for all countries, and they are assumed to remain constant for 2012. Finally, the variable net public debt over GDP has been excluded from the computation of the S0 for seven countries (Cyprus, the Czech Republic, Luxembourg, Malta, Romania, Slovakia and Slovenia), for which data are missing.

[36] As specified in Baldacci et al. (2011a), data on debt default and restructuring are from S&P; information on exceptional IMF-supported programmes comes from the IMF's Finance Department database; data on sovereign bond yields at annual and monthly frequencies are from the IMF's International Financial Statistics (IFS), Bloomberg and Datastream.

[37] In this way, thresholds truly reflect the behaviour of variables ahead of fiscal stress episodes, which is likely to differ from their behaviour when fiscal stress is already present.

fiscal stress episodes, of no-fiscal stress signals sent ahead of fiscal stress years); the signalling power of the variable, as a measure of its reliability as a fiscal stress predictor; the number of fiscal stress and no-fiscal stress events entering the computation of the threshold.[38]

For the early-warning indicator S0, a threshold of 0.44 is obtained, meaning that for values at *t* greater than 0.44 fiscal stress would be signalled for *t*+1. Corresponding to this threshold, the indicator would have signalled fiscal stress ahead of no fiscal stress (type I error) for 20% of past no-fiscal stress episodes, while it would have signalled no fiscal stress ahead of fiscal stress (type II error) for 23% of past fiscal stress events. Equivalently, the indicator would have properly identified 77% of past fiscal stress episodes and 80% of past no-fiscal stress episodes, highlighting a good overall performance for this type of methodology[39] (reflected in the relatively high signalling power of 0.57). Positive is also the fact that the indicator displays a relatively good performance at not missing crises (the predictive error entailing more serious consequences between the two).

Results in Table 2 show that the financial-competitiveness sub-index has a significantly better overall performance at predicting fiscal stress than the fiscal sub-index (a signalling power of 0.5 against 0.22). Moreover, the financial-competitiveness sub-index displays the attractive feature of performing relatively better at not missing fiscal stress episodes than at avoiding false fiscal stress alarms (an error of 0.18 against one of 0.32). Overall, financial-competitiveness variables appear to be better "leading indicators" for fiscal stress than fiscal variables are. It is therefore strongly advisable to include this type of variables in early-warning indicators of fiscal stress.

At individual variable level, among the fiscal variables, the cyclically adjusted balance and the primary balance, followed by the change in general government final consumption expenditure and gross financing needs, turn out to be the best predictors of fiscal stress, displaying some of the highest signalling powers (0.14 to 0.24) and lowest rates of missed fiscal stress events (30-43% for the first two variables; 63-64% for the other two). The variable change in general government expenditure also displays, in relative terms, a good signalling power (0.14) but a significantly higher rate of missed stress episodes (74%).

Among the financial-competitiveness variables, best predictors of fiscal stress, based on historical data, are the yield curve, the private sector credit flow and the current account (signalling powers between 0.38 and 0.5 and rates of missed stress episodes between 14 and 25%). The change in nominal unit labour costs is also among the best-performing variables at not missing fiscal stress episodes (with a rate of missed stress events of 25%), though the overall signalling power of the variable (0.28) is lower than the best performing. Finally, the variables net savings of households and net international investment position also display relatively high signalling powers (0.35 and 0.3 respectively) but with higher rates of missed stress episodes (40 and 56% respectively). One of the important conclusions that can be drawn from this analysis is that the variables that we use common to the MIP scoreboard appear to be among the best-performing predictors of fiscal stress (four of the five MIP variables used in our analysis fall among the best "leading indicators", based on historical

[38] The number of fiscal stress and no-fiscal stress events in Table 2 differs by variable depending on data availability (for variables for which longer time series are available the calculation of the threshold can be based on a larger number of episodes).

[39] As indicated in the relevant literature, non-negligible predictive errors are typically recorded with early-warning system methodologies. The size of the errors reported in Table 2 is in line with findings in other studies (see Baldacci et al., 2011a; Hemming et al., 2003).

data). This is particularly the case for the private sector credit flow and the current account that are on the top of the ranking. Clearly, there appears to be a strong case for incorporating these variables in an early-warning system for fiscal stress.

Table 2 – Thresholds and signalling power of the S0 indicator, fiscal and financial-competitiveness sub-indexes and individual variables used in the analysis

Variables	Safety	Threshold	Signaling power	Type I error	Type II error	Fiscal stress episodes no.	No fiscal stress episodes no.
Balance, % GDP	>	-10.17	0.07	0.04	0.89	37	972
Primary balance, % GDP	>	0	0.15	0.42	0.43	35	939
Cyclically adjusted balance, % GDP	>	-3.12	0.24	0.46	0.3	30	806
Stabilizing primary balance, % GDP	<	2.55	0.03	0.12	0.86	28	851
Gross debt, % GDP	<	103.28	0.03	0.06	0.91	33	940
Change in gross debt, % GDP	<	8.24	0.1	0.05	0.84	32	912
Short-term debt, gov't, % GDP	<	16	0.11	0.11	0.79	14	369
Net debt, % GDP	<	58.11	0.11	0.21	0.68	22	591
Gross financing need, % GDP	<	16.83	0.14	0.23	0.63	19	536
Interest rate-growth rate differential	<	5.92	0.08	0.06	0.85	27	831
Change in expenditure of gen. gov't, % GDP	<	2.25	0.14	0.12	0.74	34	945
Change in fin. consumption expend. of gen. gov't, % G	<	0.64	0.18	0.18	0.64	33	883
Old-age dependency ratio 20 years ahead	<	33.93	0.08	0.14	0.78	41	972
Avg yearly change (5 years) in projected age-related public expend. as % of GDP	<	0.26	0.1	0.13	0.77	13	391
Fiscal index	<	0.34	0.22	0.23	0.55	49	1188
L1.net international investment position, % GDP	>	-50.1	0.3	0.15	0.56	27	667
L1.net savings of households, % GDP	>	0.96	0.35	0.25	0.4	20	591
L1.private sector debt, % GDP	<	191.1	0.21	0.15	0.64	14	390
L1.private sector credit flow, % GDP	<	10.9	0.49	0.37	0.14	14	382
L1.leverage, financial corporations	<	2.22	0.02	0.98	0	15	384
L1.short-term debt, non-financial corporations, % GDI	<	27.4	0.23	0.23	0.54	13	354
L1.short-term debt, households, % GDP	<	3.5	0.26	0.35	0.38	13	356
L1.construction, % value added	<	7.25	0.28	0.35	0.38	37	943
L1.current account (3-year backward MA), % GDP	>	-2.45	0.38	0.37	0.25	36	857
L1.change (3 years) of real eff. exchange rate, based	<	9.76	0.24	0.17	0.59	17	363
L1.change (3 years) in nominal unit labour costs	<	12.7	0.28	0.47	0.25	32	853
Yield curve	>	0.59	0.5	0.36	0.14	29	749
Real GDP growth	>	-0.89	0.1	0.07	0.83	41	994
GDP per capita in PPP, % of US level	>	73.32	0.29	0.44	0.27	44	1020
Financial-competitiveness index	<	0.46	0.5	0.32	0.18	50	1065
Overall index	<	0.44	0.57	0.2	0.23	52	1232

As indicated in Table 2, it should be noticed that, in the light of their comparable predictive power, the financial and the competitiveness variables used in the analysis are taken with a one-year lag (thereby having variables' values at t-1 used to predict fiscal stress at t+1), whereas for the fiscal variables, and a few macroeconomic variables like real GDP growth and the yield curve, contemporaneous values are used (thus having variables' values at t used for predicting fiscal stress at t+1).[40] This importantly allows us to use latest available data for all variables to predict fiscal stress one year into the future, given that latest figure for the financial and the competitiveness variables date to 2011.

Results in Table 2 finally show that the joint consideration of all the variables combined into the composite indicator S0 provides better results in terms of early warning of fiscal stress than the separate observation of the individual variables. The signalling power is indeed higher for the S0 indicator than for the individual variables and the two sub-indexes. The

[40] We experimented with different lags (1-year and 2-year lags) with the two groups of variables (fiscal and financial-competitiveness), and obtained that fiscal variables lost predictive power when taken with a lag relatively to the case where contemporaneous values are used. On the contrary, financial-competitiveness variables performed better when taken with a 1-year lag, and lost predictive power with a 2-year lag.

overall composite indicator seems therefore to be a useful building block of an early-warning system for fiscal stress.

Figure 1 reports results for EU countries (excluding countries under adjustment programmes) for the fiscal stress index S0 over 2009-12 (with the critical threshold represented by the horizontal line). We can clearly see the considerable improvement in the situation across countries over time. While the index was above the critical threshold of fiscal risk for 14 countries out of 24 in 2009, the same situation applied to only two countries (CY and ES) in 2012. Only for one country (CY) the index has been above the threshold consistently for all four years. Countries that exceeded the critical threshold to the greatest extent are LV and RO in 2009 and CY in 2012.

Figure 1 – The early-warning index of fiscal stress for EU countries, 2009-12

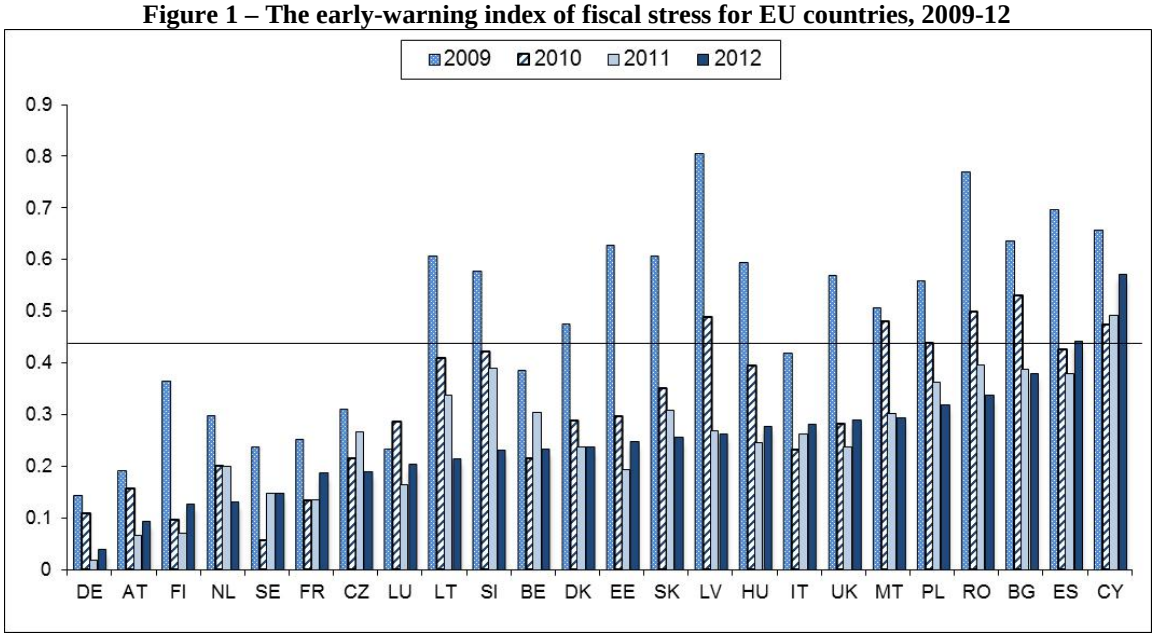
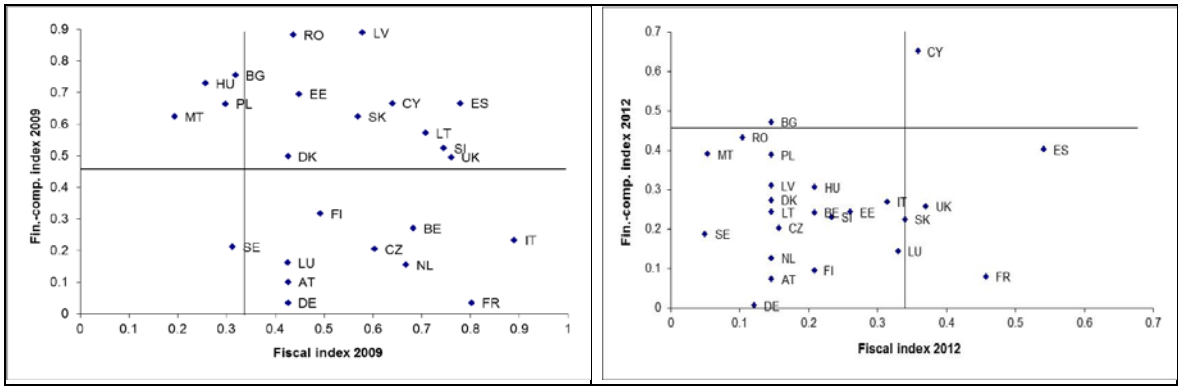


Figure 2 – Fiscal and financial-competitiveness sub-indexes for EU countries, 2009 and 2012



In Figure 2 the two fiscal and financial-competitiveness sub-indexes are reported for all EU countries but those under adjustment programmes (thresholds represented by the two vertical

and horizontal lines). By looking at the two sub-indexes it is possible to get a first idea of where vulnerabilities primarily stem from, either the fiscal or the financial-competitiveness side of the economy or both. The generally improved situation in terms of fiscal stress risks is evident also from Figure 2. While 10 out of 24 countries were above the critical thresholds for both sub-indexes in 2009, only one country (CY) is in the same situation in 2012.

An even more precise picture of the specific sources of vulnerability, key to timely design appropriate risk-containing policies, can be obtained by looking at the individual variables' values relative to the variable-specific thresholds. These are reported for 2011-12 by country in Tables 3 and 4, where values that are beyond variable-specific thresholds are highlighted.

Table 3 – Fiscal variables used in the S0 indicator, 2011-12 values

		Balance (%GDP)	Primary balance (%GDP)	Cycl. adj. balance (%GDP)	Stabil. primary balance (%GDP)	Gross debt (%GDP)	Change gross debt (%GDP)	Short-term debt (%GDP)	Net debt (%GDP)	Gross financing need (%GDP)	Interest grow th rate diff.	Change expend. gen. govt (%GDP)	Change consumpt. gen. govt (%GDP)	Old-age depend. ratio 20 years ahead	Change in proj. age-related expend.(% GDP)
BE	2011	-3.9	-0.4	-3.6	-0.1	97.8	2.2	13.3	81.4	21.1	-0.1	0.8	0.1	37.6	0.1
	2012	-3.1	0.5	-2.3	1.7	99.9	2.2	13.3	82.9	19.7	1.8	1.0	0.3	38.2	0.1
BG	2011	-2.0	-1.4	-1.3	-0.4	16.3	0.1	0.5	-11.3		-2.6	-1.8	-0.5	39.3	-0.2
	2012	-1.5	-0.6	-0.8	0.6	19.5	3.2	0.5	-9.7	3.8	3.5	0.8	0.0	39.7	-0.1
CZ	2011	-3.2	-1.9	-3.3	1.0	40.8	3.0	3.9		9.2	2.6	-0.7	-0.6	34.9	0.0
	2012	-3.5	-2.1	-2.7	1.5	45.1	4.3	3.9		9.8	3.7	0.5	0.1	35.2	0.0
DK	2011	-1.9	0.0	0.5	1.2	46.6	3.7	4.4	0.2	3.4	2.9	0.2	-0.5	38.3	0.1
	2012	-4.0	-2.4	-1.8	0.8	45.4	-1.2	4.4	4.1	6.0	1.8	1.7	0.1	39.0	0.1
DE	2011	-0.8	1.8	-0.9	-0.5	80.5	-1.9	12.6	55.3	15.1	-0.7	-2.4	-0.3	49.5	0.0
	2012	-0.2	2.3	0.0	0.8	81.7	1.2	12.6	58.4	12.8	1.0	-0.1	0.2	51.0	0.1
EE	2011	1.2	1.3	1.0	-0.5	6.1	-0.6	0.0	-0.2		-9.2	-2.4	-1.3	36.3	-0.2
	2012	-1.1	-1.0	-1.4	-0.2	10.5	4.4	0.0	4.3		-3.3	2.9	-0.1	36.6	-0.1
ES	2011	-9.4	-7.0	-7.6	1.6	69.3	7.8	10.7	57.5	21.3	2.7	-1.1	-0.5	37.0	0.0
	2012	-8.0	-5.0	-6.0	3.9	86.1	16.8	10.7	78.6	20.0	5.5	-0.9	-1.0	38.0	0.1
FR	2011	-5.2	-2.6	-4.3	0.2	86.0	3.7	13.2	78.8	19.1	0.2	-0.5	-0.4	40.0	0.0
	2012	-4.6	-1.9	-3.3	1.0	90.0	4.1	13.2	83.7	19.1	1.2	0.3	0.1	40.6	0.0
IT	2011	-3.8	1.0	-3.0	2.8	120.7	1.5	19.1	99.6	24.1	2.4	-0.5	-0.6	42.7	-0.1
	2012	-2.8	2.6	-1.3	6.5	126.5	5.8	19.1	103.1	25.1	5.3	1.0	0.0	43.8	-0.1
CY	2011	-6.3	-3.9	-6.1	0.4	71.1	9.7	8.0		11.4	0.7	-0.1	0.0	31.3	0.2
	2012	-5.2	-1.7	-4.4	4.0	89.7	18.6	8.0		8.5	5.6	0.7	0.0	31.5	0.2
LV	2011	-3.4	-2.0	-1.9	-3.2	42.2	-2.3	3.5	31.1		-7.9	-5.3	-1.1	37.0	-0.4
	2012	-1.7	-0.2	-1.2	-1.1	41.9	-0.3	3.5	30.5	3.6	-2.9	-1.6	-0.6	37.6	-0.2
LT	2011	-5.5	-3.7	-4.9	-2.1	38.5	0.6	2.3	34.0		-6.3	-3.4	-1.7	36.3	-0.2
	2012	-3.1	-1.0	-2.6	0.1	41.6	3.1	2.3	35.8	8.0	0.3	-0.6	-0.9	37.0	-0.1
LU	2011	-0.3	0.1	0.2	-0.8	18.3	-0.9	1.6			-4.2	-0.9	-0.3	31.2	0.1
	2012	-1.9	-1.4	-1.1	0.1	21.3	3.0	1.6		3.7	0.7	2.3	0.7	32.1	0.1
HU	2011	4.3	8.5	5.2	0.4	81.4	-0.5	7.1	78.6	20.8	0.6	-0.2	-1.2	33.9	-0.1
	2012	-2.6	1.6	-1.1	1.6	78.4	-3.0	7.1	72.6	23.4	2.1	-0.6	-0.1	34.3	-0.2
MT	2011	-2.7	0.4	-2.8	0.3	70.9	2.6	5.5			0.5	-0.2	0.0	39.4	0.1
	2012	-2.6	0.6	-2.5	0.6	72.3	1.4	5.5		12.9	0.8	0.3	0.2	39.4	0.1
NL	2011	-4.4	-2.4	-3.5	0.6	65.5	2.3	10.6	31.7	17.6	1.0	-1.3	-0.4	41.7	0.0
	2012	-3.6	-1.7	-2.2	1.2	68.8	3.4	10.6	35.1	13.0	1.8	0.0	0.0	42.6	0.1
AT	2011	-2.5	0.1	-2.5	-0.8	72.4	0.5	2.4	52.1	3.8	-1.2	-2.0	-0.5	40.5	0.1
	2012	-3.2	-0.5	-2.9	0.6	74.6	2.1	2.4	54.1	6.7	0.9	1.1	0.1	41.6	0.1
PL	2011	-5.0	-2.3	-5.0	-1.1	56.4	1.6	0.6	25.7	13.9	-2.2	-1.8	-0.9	35.8	-0.1
	2012	-3.4	-0.7	-2.9	0.2	55.5	-0.9	0.6	26.4	10.3	0.3	-0.8	-0.2	36.1	-0.1
RO	2011	-5.5	-4.0	-5.0	-1.4	33.4	2.9	7.6			-5.0	-2.2	-1.8	30.4	-0.1
	2012	-2.8	-1.0	-1.9	0.2	34.6	1.2	7.6		8.5	0.8	-1.7	-0.3	31.3	0.0
SI	2011	-6.4	-4.5	-5.7	1.3	46.9	8.3	0.5			3.5	0.5	0.1	40.2	0.1
	2012	-4.4	-2.0	-3.0	2.9	54.0	7.1	0.5		9.4	6.2	-1.9	-0.3	41.0	0.2
SK	2011	-4.9	-3.4	-4.9	-0.4	43.3	2.3	1.8		6.3	-0.9	-1.8	-1.4	32.2	0.1
	2012	-4.9	-3.1	-4.9	-0.5	51.7	8.4	1.8		7.6	-1.2	-0.6	-0.7	32.7	0.1
FI	2011	-0.9	0.5	0.3	-1.3	49.0	0.4	6.5	-54.1	5.8	-2.8	-1.0	-0.5	43.4	0.2
	2012	-2.0	-0.6	-0.6	0.0	53.1	4.1	6.5	-51.1	4.6	0.1	0.7	-0.1	43.8	0.3
SE	2011	0.2	1.4	0.3	-0.7	38.4	-1.0	9.8	-18.2	3.0	-1.8	-1.2	-0.2	38.0	0.0
	2012	-0.2	1.0	0.6	0.4	37.4	-1.1	9.8	-17.5	2.9	0.9	0.4	0.1	38.5	0.0
UK	2011	-7.8	-4.6	-6.7	0.5	85.0	5.6	14.6	76.6	15.3	0.6	-1.9	-0.9	35.8	0.0
	2012	-6.2	-3.0	-4.6	1.2	88.7	3.7	14.6	83.7	14.8	1.5	-0.1	0.3	36.4	0.0

Table 4 – Financial-competitiveness variables used in the S0 indicator, 2011-12 values

		YieldCurve	Real GDP grow th	GDP per capita in PPP (% US level)	L.Net intern. investment position (%GDP)	L.Net savings households (%GDP)	L.Private debt (%GDP)	L.Private credit flow (%GDP)	L.Leverage fin. corp.	L.Short debt nonfin. corp. (%GDP)	L.Short debt households (%GDP)	L.Constructi on (%value added)	L.Current account (%GDP)	L.Change real eff exchange rate	L.Change nom. unit labour costs
BE	2011	2.8	1.8	81.3	64.4	6.0	232.3	13.7	6.7	81.1	1.7	5.6	-0.4	0.2	8.0
	2012	2.9	-0.2	79.4	65.7	5.1	235.7	11.6	8.8	77.8	1.7	5.7	-0.3	-1.2	6.2
BG	2011	1.6	1.7	30.8	-95.4	-3.0	170.1	0.1	5.0	40.1	3.0	7.1	-11.2	3.6	33.9
	2012	1.5	0.8	30.8	-85.6	-3.1	146.0	-6.7	4.7	27.9	2.4	6.5	-3.4	3.0	20.3
CZ	2011	2.5	1.9	55.2	-48.2	3.7	76.9	2.1	6.7	12.1	2.1	7.3	-2.8	-1.3	5.7
	2012	2.5	-1.3	53.9	-49.3	2.6	78.1	2.5	7.2	11.2	2.3	6.8	-3.0	-4.7	3.3
DK	2011	1.4	0.8	85.6	10.1	-0.1	244.0	5.6	5.0	31.0	7.4	4.7	3.9	0.3	11.0
	2012	1.2	0.6	84.7	24.5	-0.1	237.6	-2.2	5.1	29.5	6.4	4.8	5.1	-4.6	5.0
DE	2011	1.2	3.0	82.6	34.9	7.0	127.2	3.1	6.1	21.9	3.0	4.5	6.1	-3.9	6.8
	2012	0.9	0.8	82.1	32.6	6.7	127.8	4.8	6.4	24.2	2.8	4.6	5.9	-3.4	5.9
EE	2011	5.6	8.3	45.8	-72.8	0.3	148.5	-4.4	4.4	16.1	1.1	5.9	-0.9	4.0	9.1
	2012	5.9	2.5	46.4	-57.8	-0.1	132.9	6.8	4.2	13.7	0.8	6.4	2.8	0.2	-6.2
ES	2011	4.1	0.4	67.3	-88.9	4.4	227.2	1.4	10.0	17.5	3.2	10.9	-6.3	-1.4	4.9
	2012	4.4	-1.4	65.5	-91.7	2.9	217.9	-4.1	10.3	15.9	3.0	10.1	-4.3	-0.8	-2.1
FR	2011	1.9	1.7	73.4	-7.8	8.0	158.6	1.8	4.7	22.9	2.0	6.1	-1.5	-2.0	7.7
	2012	1.7	0.2	72.2	-15.9	8.1	160.4	4.0	5.9	23.0	1.9	6.2	-1.6	-3.3	6.0
IT	2011	4.0	0.4	68.8	-24.0	3.4	129.1	3.8	9.8	25.1	3.7	6.1	-2.8	-1.1	8.1
	2012	4.4	-2.3	66.1	-20.6	2.8	128.6	2.6	13.3	26.2	3.8	6.1	-2.9	-1.0	4.4
CY	2011	4.4	0.5	63.4	-35.6	4.2	278.1	23.7	17.0	33.8	12.8	8.9	-12.1	-0.4	7.2
	2012	4.7	-2.3	60.5	-71.3	4.4	287.5	16.1	27.4	35.0	12.9	7.8	-8.4	-3.1	8.8
LV	2011	5.0	5.5	40.2	-80.3	-0.2	140.4	-8.7	9.1	19.9	4.9	5.3	-0.5	7.2	-0.3
	2012	3.3	4.3	41.8	-73.3	-2.2	125.1	-2.5	7.8	16.3	4.5	5.5	3.1	6.9	-15.0
LT	2011	3.5	5.9	45.2	-55.4	-2.2	80.3	-5.6	6.6	11.0	1.1	5.9	-3.0	2.3	1.2
	2012	3.4	2.9	46.3	-52.6	-3.2	70.1	-0.8	7.2	10.5	1.1	6.5	0.0	0.9	-8.4
LU	2011		1.7	186.4	96.6		344.9	7.3	0.5	49.6	2.2	6.0	6.9	1.6	19.2
	2012		0.4	181.3	107.8		326.3	2.5	0.6	39.2	2.1	5.8	7.5	5.3	12.5
HU	2011	1.1	1.6	44.7	-112.8	3.0	154.0	-21.6	5.9	38.5	3.9	4.2	-2.2	-6.9	6.4
	2012	1.1	-1.2	43.7	-105.8	2.8	167.3	6.4	6.1	38.4	3.8	4.0	0.6	-6.7	3.7
MT	2011	3.1	1.9	58.0	7.4		209.3	6.8	3.6	60.9	5.5	4.3	-5.8	4.3	8.2
	2012	3.0	1.0	57.6	5.7		209.9	2.2	3.8	43.1	5.4	4.1	-4.3	3.3	5.8
NL	2011	1.6	1.0	89.5	22.6	1.6	225.3	3.3	2.9	23.8	4.0	5.3	5.7	1.1	7.6
	2012	1.3	-0.3	87.7	35.5	2.4	224.6	0.7	3.1	24.3	3.7	5.3	7.5	-0.9	5.8
AT	2011	1.9	2.7	88.1	-8.1	5.5	164.4	6.8	3.6	18.1	5.8	6.7	3.7	-0.2	8.9
	2012	1.7	0.8	87.3	-2.3	4.3	160.7	4.1	4.2	17.7	5.1	6.8	2.2	0.0	5.9
PL	2011	1.4	4.3	44.3	-65.4	4.2	74.2	3.6	4.0	9.6	3.9	8.1	-5.2	3.1	11.3
	2012	1.2	2.4	44.8	-63.5	4.0	79.5	7.1	4.8	10.1	3.6	8.0	-4.6	-1.1	4.3
RO	2011	1.7	2.5	33.5	-63.8		76.4	1.7	6.9	10.4	1.4	11.0	-6.7	1.1	36.5
	2012	2.2	0.8	33.4	-62.5		71.8	1.8	7.0	11.1	1.3	11.1	-4.3	0.8	12.9
SI	2011	3.6	0.6	58.1	-42.8	4.2	128.2	1.8	6.4	28.8	3.8	6.5	-2.5	-0.3	15.9
	2012	3.9	-2.3	56.0	-41.2	3.1	128.3	1.9	7.0	28.8	3.5	6.0	-0.4	1.6	8.3
SK	2011	3.1	3.2	50.2	-63.2	3.7	72.8	3.3	12.0	14.5	2.6	9.1	-4.2	8.5	9.4
	2012	3.1	2.6	50.7	-64.4	3.0	76.3	3.3	12.5	15.6	2.5	9.1	-2.1	1.8	4.4
FI	2011	1.6	2.7	78.7	11.8	1.9	182.8	6.9	4.7	6.9	3.2	6.7	2.0	-6.3	14.4
	2012	1.3	0.1	77.4	13.1	0.6	178.8	4.6	6.8	7.1	3.0	6.8	0.6	-3.1	9.1
SE	2011	0.2	3.9	86.7	-7.4	4.4	232.8	2.8	3.7	3.4	0.0	5.2	7.5	-2.8	5.1
	2012	-0.7	1.1	85.9	-8.3	5.3	232.2	6.3	4.2	3.6	0.0	5.6	6.6	0.4	1.2
UK	2011	2.2	0.9	74.6	-23.8	1.3	209.2	1.9	11.4	47.4	14.0	6.8	-2.1	-9.6	10.0
	2012	1.9	-0.3	73.1	-17.3	1.4	204.6	1.0	13.4	43.1	12.7	6.8	-2.2	-2.9	8.1

5. Conclusions

In recent years, the economic and financial crisis has brought about a renewed interest, especially among policy-makers, in early-warning models that could help identifying vulnerabilities triggering risks. In this paper, the focus is on an early-warning index of fiscal stress based on the signals' approach (along the lines of Baldacci et al., 2011a, and Reinhart et al., 2000). The index presented here incorporates both fiscal and financial-competitiveness variables, including a number of variables used in the scoreboard for the surveillance of macroeconomic imbalances in the EU. Our specific contribution indeed lies in the inclusion of financial-competitiveness variables in an early-warning index for fiscal stress.

Main result of our analysis is that financial-competitiveness variables appear to perform well, better than fiscal variables, in the early detection of fiscal stress, based on historical data. Their signalling power is generally significantly higher, while the share of missed past fiscal stress episodes is substantially lower. Financial-competitiveness variables should therefore enter the analysis, together with fiscal variables, when the aim is to early detect fiscal stress.

The variables common to the scoreboard for the macroeconomic imbalance procedure (MIP) perform particularly well in terms of fiscal stress prediction. The private sector credit flow and the current account (3-year moving average, as from the MIP definition) indeed feature among the best predictors of fiscal stress, together with another macro-financial variable, the yield curve. Other two MIP variables (the net international investment position and the 3-year change in nominal unit labour costs) display relatively good performances. This clearly speaks in favour of introducing such variables in an early-warning index for fiscal stress.

A second important result of our analysis is that the composite indicator incorporating fiscal and financial-competitiveness variables appears to perform substantially better at fiscal stress prediction relative to the individual variables taken in isolation. Indeed, the signalling power of the index is higher than that of the individual variables, both on the fiscal and the financial-competitiveness side. It would therefore be advisable to use such a composite indicator in the early detection of fiscal stress.

In the last part of the paper, we have shown how the methodology object of analysis would apply to EU countries, by presenting results on the overall early-warning index for fiscal stress, the two sub-indexes incorporating fiscal and financial-competitiveness variables respectively and all the variables used in the analysis. All these three "layers" of analysis would turn out to be useful in an exercise aimed at a timely detection of fiscal stress. The overall index, analysed with reference to its critical threshold, highlights whether a certain country is at risk of fiscal stress or not. The two sub-indexes further allow the identification of the broad areas vulnerabilities stem from (either the fiscal or the financial-competitiveness side of the economy, or both), with the analysis at variable level making it possible to precisely identify the specific sources of vulnerabilities, which is of course key to an appropriate design of risk-containing policies.

Annex 1

Table A1 – Variables used to construct the S0 indicator: distribution percentiles and statistical sources

Variable	MIP scoreboard variable or not	p10	Median	p90	Source
Balance, % GDP	no	-7.8	-2.6	2.6	AMECO, WEO
Primary balance, % GDP	no	-3.6	0.4	5.3	AMECO, WEO
Cyclically adjusted balance, % GDP	no	-7.4	-2.9	1.6	AMECO, WEO
Stabilizing primary balance, % GDP	no	-2.8	0.0	3.0	AMECO, WEO
Gross debt, % GDP	yes	14.6	48.4	93.5	AMECO, WEO
Change in gross debt, % GDP	no	-3.6	0.5	6.8	AMECO, WEO
Short-term debt, gov't, % GDP	no	0.5	5.5	17.1	ESTAT
Net debt, % GDP	no	-11.8	37.0	84.2	WEO
Gross financing needs, % GDP	no	1.5	9.5	26.1	BIS, BLOOMBERG, AMECO, WEO
Interest rate-growth rate differential	no	-9.9	0.1	5.0	AMECO, WEO
Change in expenditure of gen. gov't, % GDP	no	-1.9	0.1	2.7	AMECO, WEO
Change in fin. consumption expend. of gen. gov't, % GDP	no	-0.8	0.0	1.2	AMECO
Old-age dependency ratio 20 years ahead	no	18.1	25.1	35.8	ESTAT
Avg yearly change (5 years) in proj. age-related public expend. % of GDP	no	-0.2	0.1	0.3	OECD, WHO, ESTAT, AWG projections
L1.net international investment position, % GDP	yes	-71.6	-17.3	24.3	ESTAT, WEO
L1.net savings of households, % GDP	no	-2.0	3.6	8.5	AMECO
L1.private sector debt, % GDP	yes	48.3	128.2	212.9	ESTAT
L1.private sector credit flow, % GDP	yes	1.0	8.9	21.4	ESTAT
L1.leverage, financial corp.	no	2.9	5.5	11.9	ESTAT, AMECO
L1.short-term debt, non-financial corp., % GDP	no	7.5	19.5	39.6	ESTAT
L1.short-term debt, households, % GDP	no	0.4	2.9	7.5	ESTAT
L1.construction, % value added	no	4.8	6.6	9.2	AMECO
L1.current account (3-year backward MA), % GDP	yes	-7.6	-1.5	4.4	ESTAT, WEO
L1.change (3 years) of real eff. exchange rate, based on exports deflator	no	-5.2	2.6	15.0	AMECO
L1.change (3 years) in nominal unit labour costs	yes	1.3	11.3	53.5	ESTAT, AMECO
Yield curve	no	-1.3	1.1	2.9	AMECO
Real GDP growth	no	-0.9	2.9	6.1	AMECO
GDP per capita in PPP, % of US level	no	36.2	74.1	100.0	AMECO

References

Abiad A. (2003) "Early-warning systems: a survey and a regime-switching approach" *IMF Working Paper* 03/32.

Baldacci E., I. Petrova, N. Belhocine, G. Dobrescu, and S. Mazraani (2011a) "Assessing fiscal stress" *IMF Working Paper* 11/100.

Baldacci E., J. McHugh and I. Petrova (2011b) "Measuring fiscal vulnerability and fiscal stress: a proposed set of indicators" *IMF Working Paper* 11/94.

Berg A., E. Borensztein, and C. Pattillo (2004) "Assessing early warning systems: how have they worked in practice?" *IMF Working Paper* 04/52.

Berg A., and C. Pattillo (1999) "Predicting currency crises: the indicators approach and an alternative" *Journal of International Money and Finance* Vol. 18 (August), pp. 561-86.

Brüggermann A. and T. Linne (2002) "Are the Central and Eastern European transition countries still vulnerable to a financial crisis? Results from the signals approach" *BOFIT Discussion Paper* No. 5, Bank of Finland Institute for Economies in Transition (BOFIT).

Detragiache E. and A. Spilimbergo (2001) "Crises and liquidity: evidence and interpretation" *IMF Working Paper* 01/2.

European Commission (2011) "Public Finances in EMU 2011" *European Economy* 3/2011.

European Commission (2012a) "Fiscal Sustainability Report 2012" *European Economy*, forthcoming.

European Commission (2012b) "Alert Mechanism Report. Report prepared in accordance with Articles 3 and 4 of the Regulation on the prevention and correction of macro-economic imbalances" COM(2012) 68 final of 14/02/2012.

European Commission (2012c) "Scoreboard for the surveillance of macroeconomic imbalances" *European Economy Occasional Paper* No. 92.

Ghosh S., and A. Ghosh (2002) "Structural vulnerabilities and currency crises" *IMF Working Paper* 02/9.

Ghosh A.R., J.D. Ostry, and N. Tamirisa (2009) "Anticipating the next crisis. What can early warning systems be expected to deliver?" *Finance & Development*, Vol. 46, Issue 3, pp. 35-37.

Hastie T., R. Tibshirani, and J. Friedman (2009) "The elements of statistical learning" Springer, second edition.

Hemming R., M. Kell, and A. Schimmelpfennig (2003) "Fiscal vulnerability and financial crises in emerging market economies" *IMF Occational Paper* 218.

IMF (2010) "The IMF-FSB Early Warning Exercise. Design and methodological toolkit" September 2010.

IMF (2012) "IMF-FSB Early Warning Exercise" IMF Factsheet September 2012.

Kaminsky G.L. (1998) "Currency and banking crises: the early warnings of distress" *International Finance Discussion Paper* No. 629, Board of Governors of the Federal Reserve System.

Kaminsky G.L., S. Lizondo, and C.M. Reinhart (1998) "Leading indicators of currency crises" *IMF Staff Papers* Vol. 45, No. 1.

Kaminsky G.L., and C.M. Reinhart (1999) "The twin crises: the causes of banking and balance-of-payments problems" *American Economic Review* vol. 89(3), pp. 473-500.

Kumar M., U. Moorthy, and W. Perraudin (2002) "Predicting emerging market currency crashes" *IMF Working Paper* 02/7.

Manasse P., and N. Roubini (2009) "Rules of thumb for sovereign debt crises" *Journal of International Economics* 78(2009), pp. 192-205.

Manasse P., N. Roubini, and A. Schimmelpfennig (2003) "Predicting sovereign debt crises" *IMF Working Paper* 03/221.

Mulder C., R. Perrelli, and M. Rocha (2002) "The role of corporate, legal and macroeconomic balance sheet indicators in crisis detection and prevention" *IMF Working Paper* 02/59.

Reinhart C.M. (2002) "Default, currency crises and sovereign credit ratings" *NBER Working Paper* 8738.

Reinhart C.M., M. Goldstein and G.L. Kaminsky (2000) "Assessing financial vulnerability, an early warning system for emerging markets: introduction" Institute for International Economics, Washington, DC.

Sturzenegger, F., and J. Zettelmeyer (2006) "Debt Defaults and Lessons form a Decade of Crises" MIT Press, Cambridge.

KC-AI-12-475-EN-N

Publications Office

ISBN 978-92-79-22996-1