Complementing scoreboards with composite indicators: the new business cycle clock

By: Gian Luigi Mazzi[1]

European Commission – Eurostat

gianluigi.mazzi@ec.europa.eu

Abstract:

The traditional way in which statistical agencies disseminate the information is via the so-called dashboards or scoreboards. They constitute a homogenous set of indicators, associated or not with a ranking structure, which aims to describe a given phenomenon or situation. They provide a very complete picture of the phenomenon under investigation but, sometimes, they can deliver quite contradictory information so that it is not necessarily easy to extract a synthetic message. On the other hand, composite indicators are intended to provide a synthetic message on a given phenomenon or to extract synthetic signals which are generally hidden when looking at data itself. This paper shows how dashboards and composite indicators can complement each other to provide a better and clearer picture of a given phenomenon. We apply it to the case of short-term economic monitoring based on Principal European Economic Indicators (PEEIs). We also show how it is possible to disseminate the messages delivered by composite indicators in a friendly and an easily understandable way by means of advanced graphical representations such as the new business cycle clock. Finally, it is shown how the business cycle clock can be an ideal complement of the PEEIs dashboard, being able to answer questions for which a clear answer is not provided by the PEEIs themselves.

1. Introduction

Major macroeconomic data users such as policymakers, analysts, central bankers, media, etc., expect a statistical office to assure the regular dissemination of a timely, reliable, comprehensive and clear picture of the economic situation. Fulfilling this expectation is not an easy task, involving the selection of the most appropriate set of indicators and the best way to display them in an easily understandable way.

The classical way in which statistical offices answer to user requests is the creation of dashboards or scoreboards based on official statistics. While both dashboards and scoreboards have the merit of providing a detailed and often exhaustive picture of the economic situation, they do not necessarily allow for a prompt and easy identification of the key macroeconomic signals. The large number of variables can sometimes lead to confusion, especially amongst non-expert users.

Another possible approach to address user needs is through the construction of composite indicators based on official statistics[2]. Those indicators aim to emphasise the key underlying macroeconomic signals, making them easily understandable to non-experts. Unfortunately, those indicators are particularly sensitive to the selection of component series as well as to the method of their construction. Both the selection of component series and the construction methods are often based on subjective criteria. This situation explains the scepticism of several statistical offices on the use of composite indicators. Nevertheless, recently there has been a growing interest in this kind of indicator, also taking into account that, thanks to some recent studies, there is room for reducing the degree of subjectivity in the construction of composite indicators by replacing it by a set of statistically sound and robust data selection and compilation techniques. One of the main questions raised in this paper is if dashboards and scoreboards on the one hand, and composite indicators on the other, can be seen as alternative ways to describe the economic situation or if they can complement each other to facilitate the understanding of the economic evolution.

The paper is structured as follows: section 2 will describe the main characteristics of dashboards and scoreboards, highlighting their advantages and drawbacks; section 3 will be devoted to methods for prioritising and summarising information, such as ranking and composite indicators techniques, and in particular it will focus on the peculiarities of those methods in the macroeconomic context; section 4 will introduce the main Eurostat macroeconomic dashboards and scoreboards, such as the PEEIs dashboard and the MIP scoreboard, while section 5 investigates the possibility and the usefulness of applying POSET techniques in the macroeconomic context; section 6 will present an alternative way to use composite indicators to detect turning points and cyclical phases, and it will introduce the new Eurostat business cycle clock based on these indicators; section 7 will draw some conclusions.

2. Dashboards and scoreboards

An important task of statistical institutions is to identify the most suitable sets of statistical data to monitor a given phenomenon and to provide these data to users. The identification of such sets of data can be a complex process involving a continuous interaction between stakeholders, policy

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[2] In this respect there are many overlaps with the synthetic indicator approach, and this paper concentrates on composite indicators.

makers and official statisticians. The outcome of such a process can be a decision to develop new statistical indicators or to enhance existing ones in order to answer in the best possible way to the needs and requests of policy makers and stakeholders. The sets of indicators identified in this process can cover a large amount of data and variables coming from different areas of statistical production, being characterised by differences in their construction and classification. In order to make such policy-relevant sets of indicators more useful and understandable, and thereby ensure that they have an impact on the policy formulation cycle, it is essential to identify an attractive and friendly way of presenting them.

In the last years, Eurostat, but also other statistical institutions, have invested a lot of resources in developing advanced graphical and/or tabular ways to present and disseminate large sets of statistical indicators. Without pretending to be exhaustive, one could specifically mention here the Business Cycle Dashboard developed by the CBS Netherlands[3] and the Economic Data Dashboard developed by the ONS[4]. Two ways of presenting large datasets have been identified, taking into account also the specificities of the phenomenon to be described[5]. The first one is represented by the so-called *"dashboards"*, which are graphical and tabular ways to present statistical indicators describing the development over the time of a given social, economic or socio-economic phenomenon. These kinds of tools are particularly useful to monitor some phenomenon, even if no specific quantified political objectives have been defined. Alternatively, the second approach is constituted by the so-called *"scoreboards"*, where the statistical indicators are related to policy objectives and/or thresholds and are presented accordingly. A typical example of the dashboard developed by Eurostat is the PEEIs, while Macroeconomic Imbalance Procedure (MIP) and Sustainable Development Indicator (SDI) sets of indicators are probably the most known examples of EU-level scoreboards.

Both dashboards and scoreboards aim to describe in a very detailed way the phenomenon to be monitored and for this reason they can include a relatively large number of indicators, coming from various statistical domains. One important implication of the development of such sets of indicators has been in enhancing the overall data quality of the constituent statistics, with beneficial effects in terms of coverage, relevance, harmonisation, reliability and timeliness. It is also important to underline that, especially in the social or socio-economic context, both dashboards and scoreboards may contain cardinal as well as ordinal indicators, which has implied additional efforts in finding the best way of presenting non-quantitative variables.

Finally, it should be underlined that while dashboards and scoreboards provide very detailed, precise and often almost exhaustive pictures of a given phenomenon, they do not necessarily allow for a quick and easy identification of the key messages delivered by the constituent indicators. This is especially true when the number of indicators is relatively large. It is not infrequent that, in the same set of indicators, variables move in different directions, complicating a synthetic evaluation of the

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[3] Available at: http://www.cbs.nl/en-GB/menu/themas/dossiers/conjunctuur/publicaties/conjunctuurbericht/inhoud/conjunctuurklok/toelichtingen/conjunctuurdashboard.htm
[4] Available at: http://data.gov.uk/apps/uk-economic-data-dashboard
[5] This paper does not go into the background literature on indicators, but it is interesting to see that the distinction in that literature between "descriptive indicators" and "performance indicators" can be analogous to the common descriptions of dashboards and scoreboards respectively.

phenomenon. As an example, looking at the PEEIs set, it is not evident if, after having exited a recessionary phase, the European economy is growing above or below the trend and how other economic indicators (prices, employment etc) are relevant for this analysis.

3. Prioritising and summarising information

In order to overcome the drawbacks of dashboards and scoreboards, described at the end of section 2, it is important to identify ways of summarising the information from multiple indicators. Summarising information requires the utilisation of tools capturing and highlighting the main driving forces or key events characterising the statistical indicators included in a given dataset. Obviously, within this process, a lot of information related to sectorial behaviours, or to other specificities, is lost, privileging a synthetic picture instead of a detailed one that would be available from a dashboard or scoreboard. There is a wide variety of methods and tools which have been developed to summarise information, stemming from graphical to mathematical techniques, from non-parametric statistical methods to parametric ones and from linear to non-linear approaches.

The most intuitive and popular way to summarise information is the construction of one or more composite indicators built up on the basis of a preselected number of statistical indicators from a given set of indicators. Nevertheless, this approach has been widely criticised, especially outside the macroeconomic area, for several reasons which will be shortly described later in this section. Providing an overview of the available methods and approaches to summarise information, even if in a non-exhaustive way, is a challenging task. Probably the best way to proceed is to start from the intrinsic characteristics of data involved and then identify the most commonly used techniques. It is helpful to distinguish between social and socio-economic phenomena and macroeconomic ones. The main reason for this is that, in the first case, ordinal variables are widely used while, in the second case, mostly quantitative indicators are present.

When considering social or socio-economic phenomena, such as wellbeing, quality of life, etc.; the first important consideration is that the reference variable is usually not measurable in a cardinal way and that a unique measure of such phenomena is not available, even if in an ordinal way. Furthermore, many indicators involved in the measurement of such phenomena are themselves measured in an ordinal scale. This is the case for example of material deprivation, poverty, etc. Despite the specificities of such sets of indicators, composite indicators have been widely used mainly to provide an approximation of the non-measurable and latent reference variable. The construction of composite indicators is usually based on three main steps: variable selection, the definition of the weighting scheme and aggregation. The main criticism on the use of composite indicators in this area mainly involves the three steps described because of the use of statistical techniques originally developed for dealing with quantitative data. This implies that an implicit cardinalisation of the indicators is used by means of rescaling methods which can alter the intrinsic nature of the indicators.

Furthermore, the attempt to reduce subjective intervention in the construction of composite indicators by means of statistical techniques, such as principal components, linear correlation, etc. arguably contradicts the nature of the component indicators and of the latent reference variable which, by their nature, reflect subjective preferences. Starting from such criticism, a variety of alternative methods, avoiding the construction of composite indicators, based on prioritising and

ranking of variables has been developed. By means of ranking techniques it is possible to identify the most significant statistical indicators among a large set in order to summarise information content through a smaller number of indicators. Among these methods, probably the most commonly used one is the partially ordered sets (POSET) which is directly derived from the mathematical sets theory. This method is most commonly used in the social and socio-economic fields, but has also been used outside, for example in finance and in the evaluation of fiscal policy. In section 5 there is a description of the POSET method and how it could be applied to the PEEIs.

In the macroeconomic area, the situation is very different because the reference variable is usually measurable and available. This is the case of Gross Domestic Product or – in a more complex way - in the weighted combination of statistical indicators proposed by the US Conference Board (see A. Ozyildirim; forthcoming). Furthermore, the large majority of indicators are quantitative and, even for some qualitative indicators such as the opinion surveys, well established and widely accepted quantification techniques are available and regularly used. In such a situation, the use of composite indicators is much less subject to criticism, even if there are still ongoing debates on the use of purely aggregation techniques (based on a more or less subjective weighting scheme) versus fully model based composite indicators. Since in the macroeconomic field the reference variable is directly measured, the reason for compiling composite indicators is rather different. Then, composite indicators are not intended to approximate the reference variable but mainly to fill gaps in existing statistics or to highlight hidden phenomena. Composite indicators are usually constructed for:

1. Providing an estimation of the current evolution of the reference variable and/or anticipating it in the near future.
2. Estimating some unobserved components of the reference variable such as the trend and the cycle and providing an estimation of their current and future behaviour.
3. Providing an estimation of the occurrence of rare events such as the cyclical turning points for the current period and the near future.

Macroeconomic composite indicators can be further classified according to the following main criteria: timing, construction method and the reference variable used (a detailed classification of composite indicators is proposed in Carriero and Marcellino; 2011; while a taxonomy is provided in Carriero, Marcellino, and Mazzi; forthcoming). Concerning *timing*, they are usually classified into leading (anticipating the near future), coincident (now-casting the present) and lagging (replicating the past) indicators. It is important to note that the relevance of lagging indicators is mostly for the producers of indicators which use them for an ex-post validation of coincident and leading ones.

Concerning *construction*, indicators can be distinguished into those based on aggregation techniques, on non-parametric techniques (e.g. partially square), on parametric techniques (e.g. dynamic factor models), on linear time-series techniques (e.g. VAR models) and on non-linear time-series techniques (e.g. Markov-switching models). According to the *reference variable*, indicators can be distinguished into those based on a well identified statistical indicator (GDP, IPI, etc.), on a combination of statistical indicators (Conference Board approach), on a historical estimation of the trend and/or of the cycle of a given statistical indicator, or a combination of them, and on a historical sequence, previously established, of turning points based on a single statistical indicator or a combination of them.

Finally, it is interesting to notice that in the macroeconomic context, a special case is constituted by so-called sentiment or climate indicators. The specificity of those two indicators is that they are constructed without an explicit identification of a reference variable, even if they are implicitly strongly related to some quantitative variables such as GDP or the Industrial Production Index (IPI). In section 6, we present a system of coincident indicators for detecting turning points, together with a graphical tool designed for their dissemination in a user-friendly way.

4. Dashboards and scoreboards for macroeconomic analysis

In this section we describe how concepts and principles of dashboards and scoreboards, presented in section 2, have been applied by Eurostat into the macroeconomic field. The common objective of macroeconomic dashboards and scoreboards has been to provide policy makers and analysts with friendly and clear tools for monitoring specific macroeconomic aspects such as short-term evolution and the presence of structural imbalances. We focus here on two applications, namely the PEEIs dashboard for short-term macroeconomic monitoring and the MIP scoreboard for the detection of macroeconomic imbalances.

4.1 The PEEIs dashboard

In October 2007, Eurostat released the so-called "selected PEEIs page". This tool, for the first time, presented - in a single web page and framework - statistical indicators available at different time frequencies and coming from different areas of official statistics. Furthermore, this page provided information on data availability and characteristics such as the link to the last available press release and to the date of the next one, a short description for each statistical indicator in a harmonised form, and full access to metadata. The statistical coverage was constituted by all available PEEIs plus a small number of monetary, financial and balance of payment indicators, as well as the economic sentiment indicator provided by DG ECFIN of the European Commission. The "selected PEEIs page" was available for the euro area and the European Union only.

Despite the relatively small number of indicators, the dashboard provides a good picture of the short-term economic situation. In the following years, the "selected PEEIs page" has represented one of the starting points for the discussion and implementation of wider dashboards, such as the Principal Global Indicators (PGIs) and the UNSD data template, to which Eurostat has actively cooperated.

The relevance of wider dashboards for monitoring the short-term economic situation has of course considerably increased as a consequence of the global financial and economic crisis. The main objective of such wider dashboards is to ensure a regular and almost real-time monitoring of all aspects of the short-term economic situation.

In 2015, Eurostat has decided to replace the "selected PEEIs page" with the new "PEEIs dashboard" which keeps all features of the previous one, plus some new ones like the possibility of direct data downloading, and increases the statistical coverage of the dashboard with respect to indicators (both key and additional indicators) and to Member State data. Table 1 presents the list of all key and additional indicators while figure 1 shows the look and feel of the PEEIs dashboard.

Table 1: Key and additional indicators of the PEEIs dashboard

Domain	Key indicators	Additional indicator
Consumer prices	Inflation HICP – All items	
		Inflation HICP - Energy
		Inflation HICP – Food, alcohol, tobacco
		Inflation HICP - Services
		Inflation HICP – Non-energy industrial goods
GDP	GDP – Current prices	
	GDP – Volume	
		Gross value added volume - industry
		Gross value added volume - construction
		Gross value added volume – trade and transport
		Gross value added volume – information and communication
		Gross value added volume – finance and insurance
		Gross value added volume – real estate
Quarterly national and sector accounts	Households and NPISH final consumption -	
		Households final consumption – Durable goods
		Households final consumption – Semi-durable goods
		Households final consumption – Non-durable goods
		Households final consumption – Services
	Gross fixed capital formation - Volume	
		Gross fixed capital formation – Total construction
		Gross fixed capital formation - Dwellings
		Gross fixed capital formation - Machinery
		Gross fixed capital formation – Transport equipment
		Gross fixed capital formation – ICT equipment
		Gross fixed capital formation – Other machinery
	Household saving rate	
	Non-financial corporations investment rate	
	Government annual deficit/surplus	
		Government quarterly deficit/surplus - SA
		Government quarterly deficit/surplus - NSA
	Government annual gross debt	
		Government quarterly gross debt
International trade and BOP	External trade balance of goods	
	Current account	
		Trade in goods
		Trade in services
	International investment position	
		Foreign direct investment
		Portfolio investment

Labour market statistics	**Unemployment rate - Total**	
		Unemployment rate - Male
		Unemployment rate - Female
		Unemployment rate – 15-24 yrs
		Unemployment rate – 25-74 yrs
	Job vacancy rate	
		Job vacancy rate- Manufacturing
		Job vacancy rate- Industry
		Job vacancy rate- Construction
		Job vacancy rate- Trade and transport
		Job vacancy rate- Information and communication
		Job vacancy rate- Finance and insurance
		Job vacancy rate- Real estate
	Employment rate	
		Employment - Industry
		Employment - Construction
		Employment – trade and transport
		Employment – Information and communication
		Employment – Finance and insurance
		Employment – Real estate
	Labour cost index	
		Labour cost index - Industry
		Labour cost index - Construction
		Labour cost index - Trade
		Labour cost index – Finance and insurance
		Labour cost index – Real estate
Business indicators	**Industrial producer prices**	
		Domestic producer prices – Capital goods
		Domestic producer prices – Intermediate goods
		Domestic producer prices – Consumer durable goods
		Domestic producer prices – Consumer non-durable goods
		Domestic producer prices – Energy
	Industrial import price index	
	Industrial production	
	Retail trade deflated turnover	
		Retail trade deflated turnover – Food and tobacco
		Retail trade deflated turnover – Non food
	Turnover in services	
Housing statistics	**House price index**	
	Building permits	
Business and consumer surveys	**Economic sentiment indicator**	
		Confidence indicator - Consumer
		Confidence indicator - Services
		Confidence indicator – Retail trade
		Confidence indicator - Construction
		Confidence indicator - Industry
Monetary and financial indicators	**3 Months interest rate**	
		Daily market interest rate
	Long term gov't bond yield	
	Euro/National currency exchange rate	
		Real effective exchange rate -42 partners

Figure 1: The PEEIs dashboard[6]

4.2 The MIP scoreboard

The financial and economic crises and the sovereign debt crisis have over, the past years, led to a number of new EU policy initiatives. The Macroeconomic Imbalances Procedure (MIP) is an annual exercise setting out rules for early detection, prevention and correction of macroeconomic imbalances which emerge or persist in the euro area and the EU Member States. An essential tool for a statistical detection of such imbalances is the MIP scoreboard - a set of eleven headline indicators intended to screen internal and external macroeconomic imbalances, covering a time span of ten years for EU Member States. They are complemented by a number of auxiliary indicators, presented in a separate table. After the endorsement of the ECOFIN Council, the MIP scoreboard was released for the first time in February 2012 and enlarged in 2013 with an indicator related to the liabilities of the financial sector.

The MIP scoreboard indicators cover developments in public and private indebtedness, private sector credit flow, asset prices including housing, net investment positions, current accounts balances, real effective exchange rates, world export market shares, unit labour cost and unemployment. The scoreboard is the essential statistical support in the hands of the Commission in the process of detection of macroeconomic imbalances. For each indicator, the most appropriate statistical transformations, such as five years percentage change or three years average, have been identified to smooth the effect of a particular year on indicators development and to highlight the presence of structural imbalances.

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[6] The live page can be viewed from the main Eurostat webpage (http://ec.europa.eu/eurostat) and then following the dedicated PEEIs link.

For the headline indicators, indicative thresholds based on historical data have been set at alert levels; such thresholds can result both in an upper and low alert level for some indicators, and can have different values for euro area and not euro area Member States. Thresholds are not directly displayed in the scoreboard but they are available in the associated graphical representations.

The MIP scoreboard is easily accessible as the homepage of a MIP dedicated section also offering a large set of information and metadata on methodologies, legislation, relevant publications and a complete set of graphical presentations and download facilities.

Table 2 presents the list of all headline and auxiliary indicators while figure 2 presents the look and feel of the MIP scoreboard.

Table 2: Headline and auxiliary indicators of the MIP scoreboard

Domain	Headline indicators	Auxiliary indicators
Balance of Payments	Current Account Balance as % of GDP (3-year average)	
		Net Lending-Borrowing / Current plus capital account as % of GDP
		Direct investments in the reporting economy (flows) as % of GDP
	Net International Investment Position as % of GDP	
		Net external debt as % of GDP
		Direct investments in the reporting economy (stocks) as % of GDP
	Export Market Shares (5 years % change)	
		Export Performance vs. Advanced Economies (5 years % change)
		Export Market Shares, goods and services, volume (y-o-y % change)
Effective Exchange Rate	Real Effective Exchange Rate, 42 trading partners - HIPC/CPI deflator (3 years % change)	
		Real Effective Exchange Rate, EA trading partners (3 years % change)
National Accounts - Main aggregates	Nominal Unit Labour Cost (3 years % change)	
		Nominal Unit Labour Cost (10 years % change)
		Labour Productivity (y-o-y % change)
		Employment (y-o-y % change)
		Real GDP (y-o-y % change)
		Gross fixed capital formation as % of GDP
		Terms of Trade, goods and services (5 years % change)
		Residential Construction as % of GDP
Price Statistics	House Prices Index, deflated (y-o-y % change)	
		Nominal House Prices (3 years % change)
National Accounts - Financial Accounts	Private Sector Credit Flow as % of GDP – Consolidated	
	Private Sector Debt as % of GDP – Consolidated	
		Private Sector Debt as % of GDP – non-consolidated
	Total Financial Sector Liabilities (y-o-y % change)	
		Financial sector leverage (debt-to-equity)
Government Finance Statistics	General Government sector Debt as % of GDP	
Labour Force Statistics	Unemployment Rate (3-year average)	
		Activity Rate (15 -64 years) - (% of total population in the same age group)
		Long -term Unemployment Rate (% of active population in the same age group)
		Youth Unemployment Rate (% of active population in the same age group)
		Young people neither in employment nor in education and training (% total population in the same age group)
Income and living conditions		People at risk of poverty or social exclusion rate (% total population)
		At risk of poverty after social transfers rate (% total population)
		Severely materially deprived people (% total population)
		People living in households with very low work intensity (% total population)
Statistics on research and development		Gross domestic expenditure on R. and D. (GERD) as % of GDP
International Trade		Net Trade Balance of Energy Products as % of GDP

Figure 2: The MIP scoreboard[7]

The data published on this page are regularly updated and may differ from those used for the Alert Mechanism Reports.

📄 2015 Statistical Annex. More on frozen data here.

◉MIP Indicators
◯MIP Auxiliary Indicators

Spain ▼   Download data for country 🟩

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	UNIT	REFERENCE PERIOD					
		2009	2010	2011	2012	2013	2014
Current account balance - % of GDP Quarterly data (Show) Additional data (Show)	3 year avg	-7.7	-5.8	-3.8	-2.5	-0.7	0.7
Net international investment position Quarterly data (Show)	% of GDP	-93.5	-88.6	-91.5	-90.0	-93.8	-93.5
Real effective exchange rate - 42 trading partners[(1)] Additional data (Show)	3 years % change	4.6	-0.3	-2.5	-5.3	-0.4	-1.0
Share of world exports Additional data (Show)	5 years % change	-8.75	-11.53	-7.96	-17.71	-10.34	-11.46
Nominal unit labour cost index Quarterly data (Show) Additional data (Show)	3 years % change	11.8 (p)	5.7(p)	-1.2 (p)	-5.6 (p)	-4.6 (p)	-3.9 (p)
House price index - deflated Quarterly data (Show) Additional data (Show)	1 year % change	-5.80	-3.60	-10.10	-16.80	-9.90	0.40
Private credit flow - consolidated	% of GDP	-1.2	0.9	-3.8	-10.9	-10.6	-7.0
Private debt - consolidated	% of GDP	202.1	201.1	195.9	185.6	173.3	163.1
General government gross debt (EDP) Quarterly data (Show)	% of GDP	52.7	60.1	69.2	84.4	92.1	97.7
Unemployment rate Quarterly data (Show) Additional data (Show)	3 year avg	12.5	16.4	19.7	22.0	24.1	25.1
Total financial sector liabilities	1 year % change	3.7	-2.0	2.8	3.3	-10.5	-1.9

Complementary indicators (Show)

Last update: 14/07/2015 11:05:02

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[7] The live page can be viewed at from the main Eurostat webpage (http://ec.europa.eu/eurostat) and then following the dedicated Macroeconomic Imbalances Procedure link.

4.3 Some limitations of macroeconomic dashboards: the case of PEEIs

In section 2, we have already discussed the fact that, despite their global overview of the situation, the reading of dashboards is not always easy either because they can display contradictory messages and/or because some relevant signals are somewhat hidden. In this subsection we develop these aspects by means of some examples.

If we look at the PEEIs dashboard today, it is quite clear that the message delivered is mainly positive, at least at euro area and European Union level. By looking in further detail we have selected some relevant PEEIs grouped into three main categories: economic growth, price evolution and labour market conditions, which are presented in table 3.

Table 3: Latest evolution of some euro area PEEIs.

	Euro area key short-term indicators					
Economic growth		**2014Q1**	**2014Q2**	**2014Q3**	**2014Q4**	**2015Q1**
	GDP growth rates (Q/Q-1)	0,2	0,1	0,2	0,4	0,4
Consumer prices		**2015M01**	**2015M02**	**2015M03**	**2015M04**	**2015M05**
	HICP (M/M-1)	-1,5	0,6	1,1	0,2	0,2
Business indicators		**2015M01**	**2015M02**	**2015M03**	**2015M04**	**2015M05**
	Industry producer prices (M/M-1)	-1,1	0,6	0,2	-0,1	:
	Production in industry (M/M-1)	0	1	-0,4	0,1	:
	Retail trade deflated Turnover (M/M-1)	0,3	0,1	-0,6	0,7	:
Labour market		**2015M01**	**2015M02**	**2015M03**	**2015M04**	**2015M05**
	Unemployment rate (M/M-1)	11,3	11,2	11,2	11,1	11,1
		2014Q1	**2014Q2**	**2014Q3**	**2014Q4**	**2015Q1**
	Employment rate (Q/Q-1)	0,2	0,3	0,2	0,1	0,1

We notice that GDP is characterised by a constantly positive evolution since the first quarter of 2014, which seems to accelerate since the end of 2014, however the industrial production index and retail trade deflated turnover show a less clear path, with some negative results also in 2015; this could raise some uncertainties amongst users concerning the consolidation of the growth. Furthermore, looking at price evolution, represented by the HICP, it seems that the period of price decrease or stagnation has passed but, comparing those results with the industrial producer price index, this trend appears less evident. The labour market data, represented by the unemployment rate and employment evolution, do not provide a clear insight on the impact of GDP growth.

Another example is provided by the analysis of GDP growth at Member State level during the last five quarters. The evolution of GDP by Member States is shown in Figures 3 and 4, which provide different visualisation approaches. The first one focusing more on the growth itself and the second one, more on the acceleration/deceleration of growth. The message from both approaches is that Member States are not growing in a homogenous way and it is not possible to evaluate which countries might be growing above the trend and which ones below.

Figure 3: GDP growth and average by country from 2013 Q1 to 2015 Q1
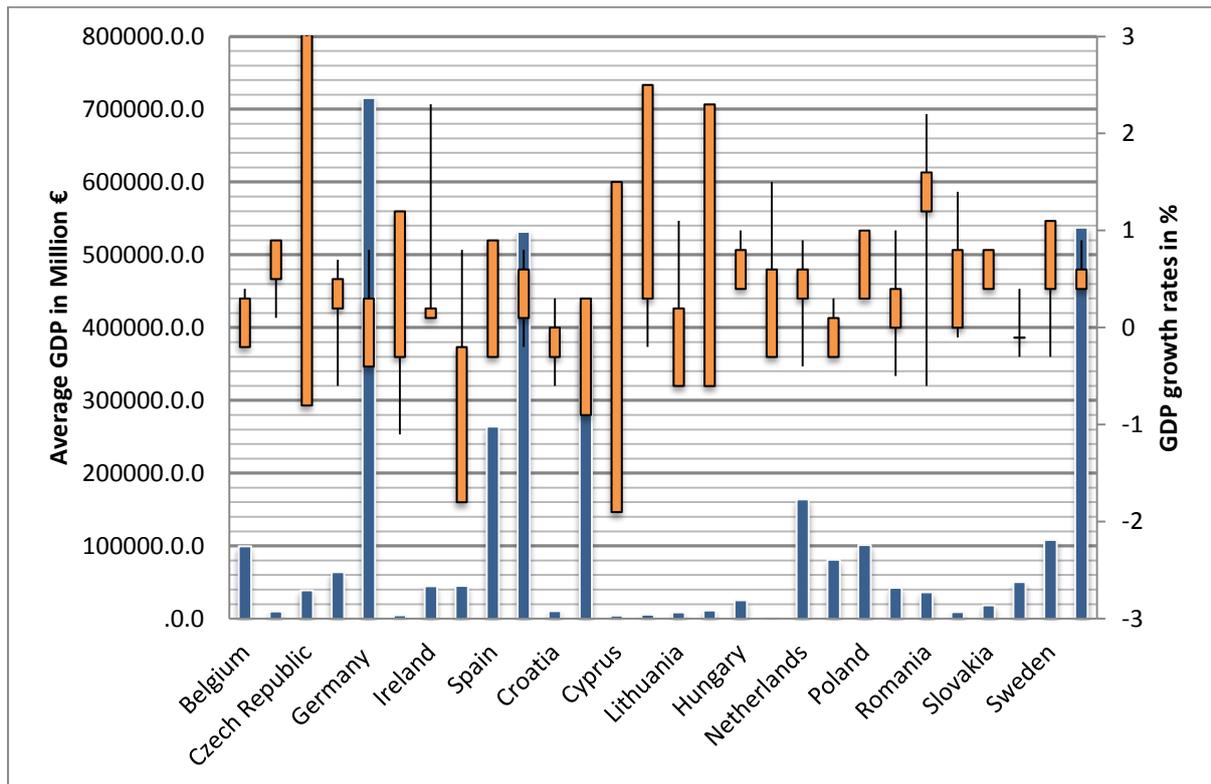
Figure 4: GDP growth acceleration by country from 2014 Q1 to 2015 Q1

GDP average accelerations in last 4 quarters
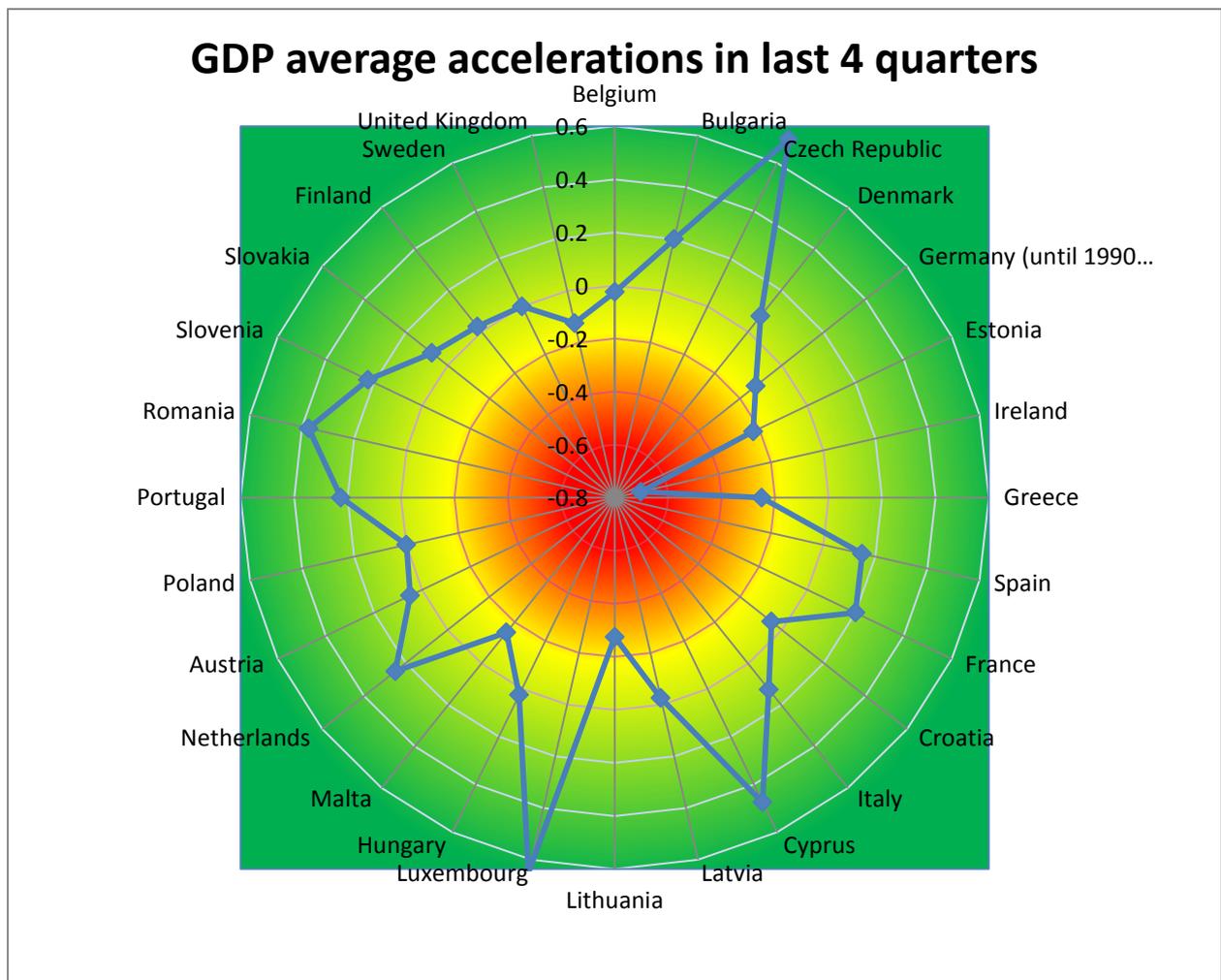
It is therefore important to highlight that, just by looking at the dashboard we are unable to answer some relevant questions related to the current economic situation such as:

- Are the European economies growing below or above the trend?
- How synchronised are European economies?
- Which economies are still in a slowdown or in a recessionary phase in their economic cycle?

Answering the above questions is not necessarily easy and sometimes can imply sophisticated elaboration arguably going beyond the tasks of statistical agencies. Nevertheless, the use of some coincident indicators, such as those presented in section 6, could help in highlighting some hidden aspects of the economic situation. By combining the messages from dashboards and composite indicators, it becomes easier to answer some of the above questions.

5. Using POSET in the macroeconomic context

As already mentioned in section 3, the concept and definition of composite indicators can be subject to criticism, especially when dealing with phenomena which cannot be easily quantified, unless if we make strong and, in some cases, arbitrary assumptions. This is the case of several socio-economic phenomena such as material deprivation, poverty, quality of life, wellbeing, etc. In the recent years, several studies have been conducted aiming to identify alternative ways to replace at least partially the use of composite indicators. Those studies have concentrated their attention on so-called ranking methods, which allow the creation of an order among groups, countries, etc. An excellent overview of the possibilities offered by POSET for ranking multi indicators sets has been proposed by Brüggemann and Patil (2011), while Brüggemann et al. (2014) and Fattore et al. (2011) present very interesting applications of the POSET theory to poverty and material deprivation, respectively. By contrast, Badinger and Reuter (2014) apply the POSET approach to a very different domain, namely the evaluation of fiscal rules across countries.

5.1 The description of the POSET method

In the set and ordering theories, a partially ordered set (POSET) formalises and generalises the intuitive concept of an ordering, sequencing, or arrangement of the elements of a set. A POSET consists of a set together with a binary relation indicating that, for certain pairs of elements in the set, one of the elements precede the other. This ordering is called "partial" since not necessarily for all the elements of a given set is it possible to define a binary relation so that one of them precede another, or vice versa.

A (non-strict) partial order is a binary relation "≤" over a set P which is reflexive, antisymmetric, and transitive, i.e., which satisfies for all x, y, and z in P (Davey and Priestley, 2002; Neggers and Kim, 1988; Schroeder, 2003; Fattore & al., 2011):

1. x ≤ x (reflexivity);
2. if x ≤ y and y ≤ x then x = y (antisymmetry);
3. if x ≤ y and y ≤ z then x ≤ z (transitivity).

If x ≤ y or y ≤ x, then x and y are called comparable, otherwise they are said to be incomparable (written x || y). A partial order P where any two elements are comparable is called a chain or a linear order. On the contrary, if any two elements of P are incomparable, then P is called an antichain. Thus, partial orders generalize the more familiar total orders, in which every pair is related. A finite POSET can be visualized through its Hasse diagram, which depicts the ordering relation.

In order to understand how the POSET theory can be applied to socio-economic phenomena, following Fattore & al. (2011), we consider a set of k ordinal variables, $v_1; \dots ; v_k$, associated to a given socio-economic phenomenon. Each possible sequence of ordinal scores on $v_1; \dots; v_k$ defines a different profile. Profiles can be (partially) ordered in a natural way, by the following dominance criterion:

Definition: Let s and t be two profiles over $v_1; \dots; v_k$; we say that t dominates s if and only if $v_i(s) \leq v_i(t) \ \forall i = 1, \dots, k$, where $v_i(s)$ and $v_i(t)$ are the ordinal scores of s and t on v_i.

Since not all the profiles can be linearly ordered based on the previous definition, they constitute a POSET.

5.2 Possible applications of POSET to the PEEIs

In the large majority of studies, POSET is used when ordinal variables are present to overcome some drawbacks of composite indicators (Fattore & al., 2011). Nevertheless, there are no formal obstacles to the use of such ranking techniques, also in presence of cardinal variables. Obviously, the ordering rules have to be appropriately defined taking also into account the quantitative nature of the variables. Furthermore, the added value associated to the use of those techniques, especially in relation to composite indicators and dashboard/scoreboard, has to be carefully evaluated.

At this preliminary stage we have identified four possible applications of POSET to the PEEIs. The first one aims to detect the presence of cross-sectional effects in financial markets simultaneously to some growth/business cycle phases. By ranking stocks according to their book-to market and capital size, Liew and Vassalou (2000) demonstrated that these cross-sectional factors contain significant information about future GDP growth. Their approach consists in building factors based on rankings, so they do not use rankings directly. The POSET would allow a direct approach. Close to what would be a POSET approach, a direct use of rankings to study cross-sectional effects has been proposed by Billio et al. (2011) and Billio et al. (2012).

In the second one, given an order following which PEEIs can be classified (for example as "good", "medium" or "bad"), we could combine them to explain the economic phases, like expansion, slowdown, recession, etc., each of them associated to a natural number.

In the third one, the ranking of some countries' PEEIs could be used to explain the ranking of countries according to another variable (GDP growth rates, etc.).

Finally, the fourth application could consist in associating a ranking to each of the economic phases. Following Harding and Pagan (2006), a distance between these ranks could be used to measure the diffusion of a crisis. The country ranks could be combined to estimate the economic phase of individual countries or aggregate. Combining past rankings to explain the current economic phase would be interesting to study the synchronisation among countries. It is worth to note that the information provided by the cyclical indicators presented in 6.1 and displayed by the business cycle clock in 6.2 could constitute the ideal input for this application so that, for the first time, composite indicators and POSET can be used together in order to assess relevant cyclical phenomena, such as the synchronisation and the diffusion of turning points.

The results obtained until now are still preliminary and not very conclusive. What has emerged is that the third application is the easiest to implement, even if the results could be quite obvious, so that its added value will be relatively low. By contrast, the first, second and fourth applications appear to be more challenging due to the fact that some quite complex hypotheses have to be formulated but their informational content from analysts' point of view is expected to be relatively high.

6. Turning points detection and the new business cycle clock – an example of composite indicators

In this section we focus our attention on the construction of composite indicators aiming to detect economic turning points in a timely way. Since turning points are relatively rare phenomena, not occurring at regular intervals, and since they indicate discontinuities in the regular path of a time series, non-linear modelling techniques appear the most appropriate ways to deal with them. Since the publication of the seminal paper from Hamilton (1989), Markov-Switching (MS) models have been considered the most reliable tool for turning point detection and have been applied in several studies and research. Alternatively, some other researchers have concentrated their attention on binary regression models such as PROBIT and LOGIT, e.g. Chauvet and Potter (2005) and Harding and Pagan (2011).

Since 2007, Eurostat has been involved in the construction of turning points coincident indicators based on MS models (Anas, Billio, Ferrara, Mazzi; 2008) which more recently have evolved into the use of multivariate MS models (MS-VAR) (Anas, Billio, Ferrara, Mazzi; 2015 and; Anas, Billio, Carati, Ferrara, Mazzi; forthcoming).

The use of MS models at Eurostat has also been empirically validated in comparison to other non-linear models (i.e. Billio, Ferrara, Guégan, Mazzi; 2014). The most appealing feature of the MS model is constituted by the fact that they allow for a different dynamic according to the regime in which the phenomenon under evaluation is situated. In particular, by considering a two regime representation where the regime could be assimilated to expansion and recession, if the economy is in recession at time T, at time T+1 it can either continue to stay in the same regime or to switch to expansion. The probabilities to stay in a phase or to switch phases can be estimated and they determine the expected durations of each phase. Given a threshold usually assumed equal to 0.5 (natural rule), when the recession probability is above/below 0.5, the MS model is expected to stay in the recessionary/expansionary regime the time of the respective duration. Crossing the threshold in any of the two directions indicates the presence of a turning point.

In the subsection 6.1 we will present a step by step approach to the construction of the Eurostat cyclical composite indicators, while subsection 6.2 will be devoted to the description of a new graphical tool, called the business cycle clock, to disseminate the results of these indicators in an easy to read and intuitive way.

6.1 Step by step construction of cyclical composite indicators

Five steps may be identified, as follows.

Step 1: Identification of the cycle to be monitored.

A. Classical Business cycle (Burns and Mitchell definition; 1946), which is very relevant for detecting recessions but not very informative during usually quite long expansion phases.

B. Growth cycle (Output gap), which is very relevant to understand the position with respect to the potential output (trend) and more informative also during the expansion phases of business cycle. It leads to the peaks and troughs of the business cycle but it doesn't detect the start and the end of recessions.

C. Growth rate cycle (Acceleration cycle), which is characterised by the highest number of fluctuations and a high degree of volatility. It leads to the growth cycle peaks and business cycle troughs corresponding to the inflexion points of the classical business cycle. They determine the acceleration and deceleration phases of the economy.

The approach retained by Eurostat consists in jointly monitoring cycles (Anas, Ferrara; 2004) within an integrated framework:

    i.   Growth cycle and Business cycle (ABCD sequence)
    ii.   Also including Acceleration cycle ($\alpha AB\beta CD$ sequence)

The sequence of turning points is presented in figure 5.

Figure 5: Integrated framework for cyclical monitoring
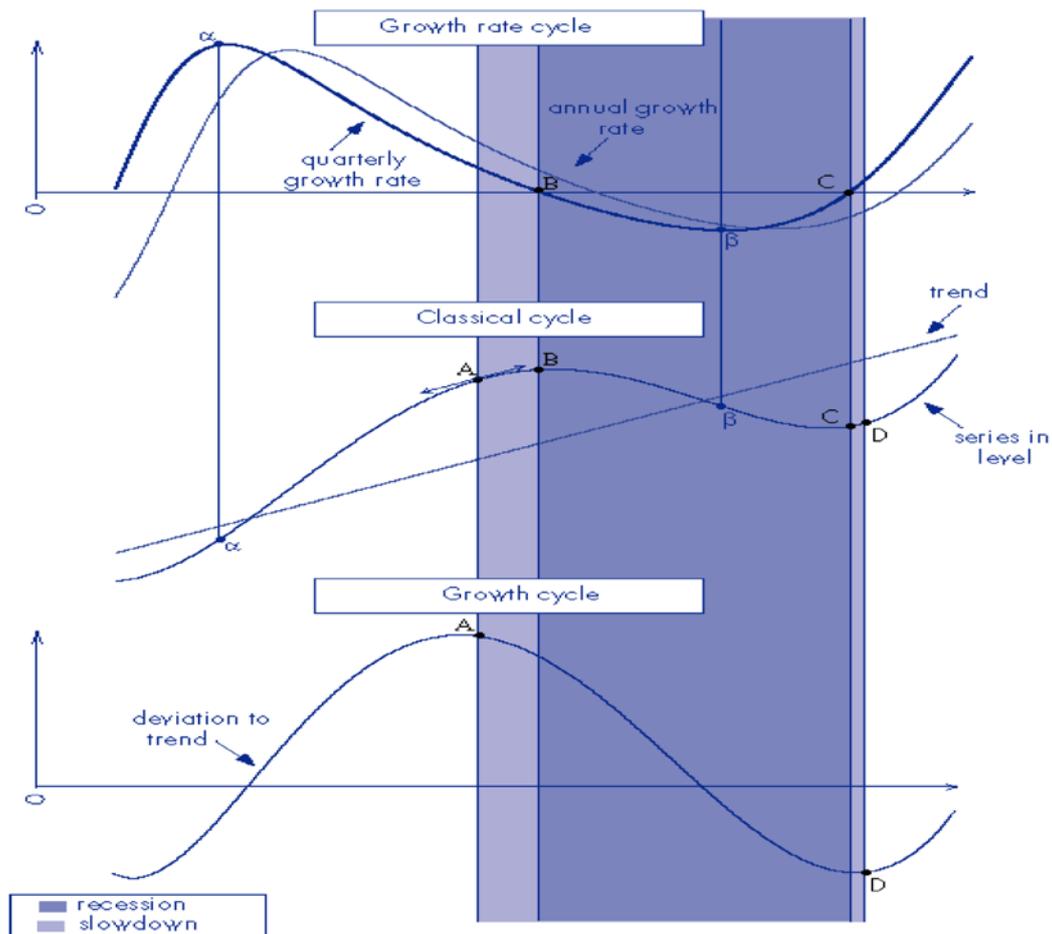
Step 2: An historical dating chronology is computed for the classical cycle, the growth cycle and the acceleration cycle by means of a simple non-parametric dating rule (Harding and Pagan; 2002) applied to GDP, IPI and unemployment rate. The historical dating chronologies are constructed following the αABβCD approach (Anas, Billio, Ferrara, Mazzi; 2008 and Anas, Billio, Carati, Ferrara, Mazzi; forthcoming) and turning points are supposed to remain constant after a given number of years.

Step 3: Creation of a middle-size dataset mainly based on PEEIs and opinion surveys data containing the most appropriate data transformation to highlight cyclical movements.

Step 4: Variable selection based on the ability of timely and precisely detecting turning points within a real-time simulation exercise against the non-parametric historical turning point dating (Step 2).

Step 5: Selected variables are used to identify and estimate a number of autoregressive Markov-Switching models (MS-VAR):

MSIH (K) − VAR (L), where H indicates the presence of heteroskedasticity, (K) is the number of regimes and (L) the number of lags of the autoregressive part.

Remark : Dealing simultaneously with growth cycle and business cycle implies a number of regimes not smaller than 4 , while the heteroskedastic part can or cannot be present depending on the degree of asymmetry of fluctuations.

Step 6: From step 5, N best fitting models are identified, each of them producing a pair of coincident indicators: MS-VAR GCCI (j) and MS-VAR BCCI (j); j=1 …n.

Remark 1: Each composite indicator is defined between 0 and 1, and can be viewed as a composite probability of being in a recessionary phase for the MS-VAR BCCI (j) and in a slowdown phase for the MS-VAR GCCI (j).The recession/slowdown regions are defined on the basis of a threshold, usually equal to 0.5.

Remark 2:

- MS-VAR BCCI (j) > 0.5 = recession
- MS-VAR GCCI (j) > 0.5 = slowdown

By construction, MS-VAR BCCI (j) > 0.5 → MS-VAR GCCI (j) > 0.5, so that the ABCD sequence is always fulfilled.

Remark 3: Note that the indicator for the acceleration cycle cannot be modelled together with the other two for purely mathematical reasons, so that it is based on a simple univariate Markov-Switching model.

Step 7: Within a real-time simulation exercise, the N pair of composite coincident indicators is compared with the non-parametric historical turning point dating.

Step 8: The identification of the best performing pair of coincident indicators is based on the outcome of step 7, using the following criteria:

- Maximisation of the Concordance Index

- Minimisation of the Brier's Score (QPS)

- Minimisation of type-2 errors: detection of false cycles

- Minimisation of type-1 errors: missing cycles

Remark: Due to the trade-off between type-2 and type-1 errors, the simultaneous minimisation of both is unachievable. A conservative approach suggests privileging the minimisation of type-2 errors, i.e. the detection of false cycles.

It may be seen from the steps described above that the compilation of composite indicators is technically demanding, involving the use of multiple assumptions and modelling characterisation.

6.2 The new business cycle clock

The outcome of the cyclical indicators described in 6.1 can be presented either in a graphical or in a tabular form. Figures 6 and 7 show, for the euro area, the evolution of the univariate acceleration cycle coincident indicator (ACCI) and the multivariate growth cycle and business cycle coincident indicators (MS-VAR GCCI and MS-VAR BCCI), respectively. They also show the results of corresponding historical dating chronologies.

Figure 6: Euro Area ACCI univariate
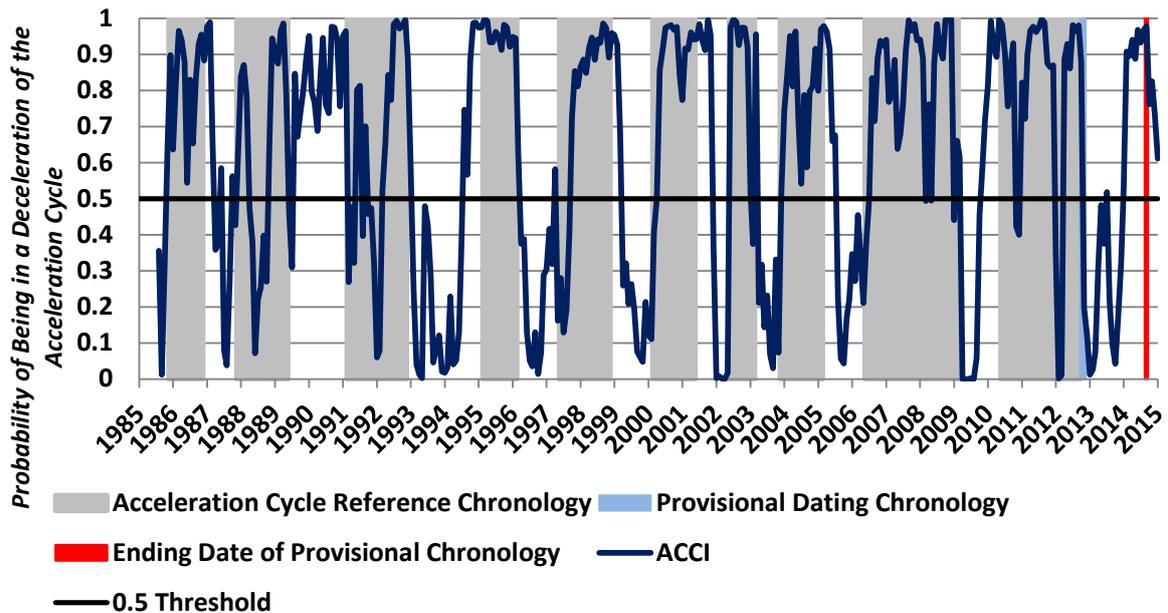
Figure 7: Euro Area MS-VAR BCCI and GCCI multivariate
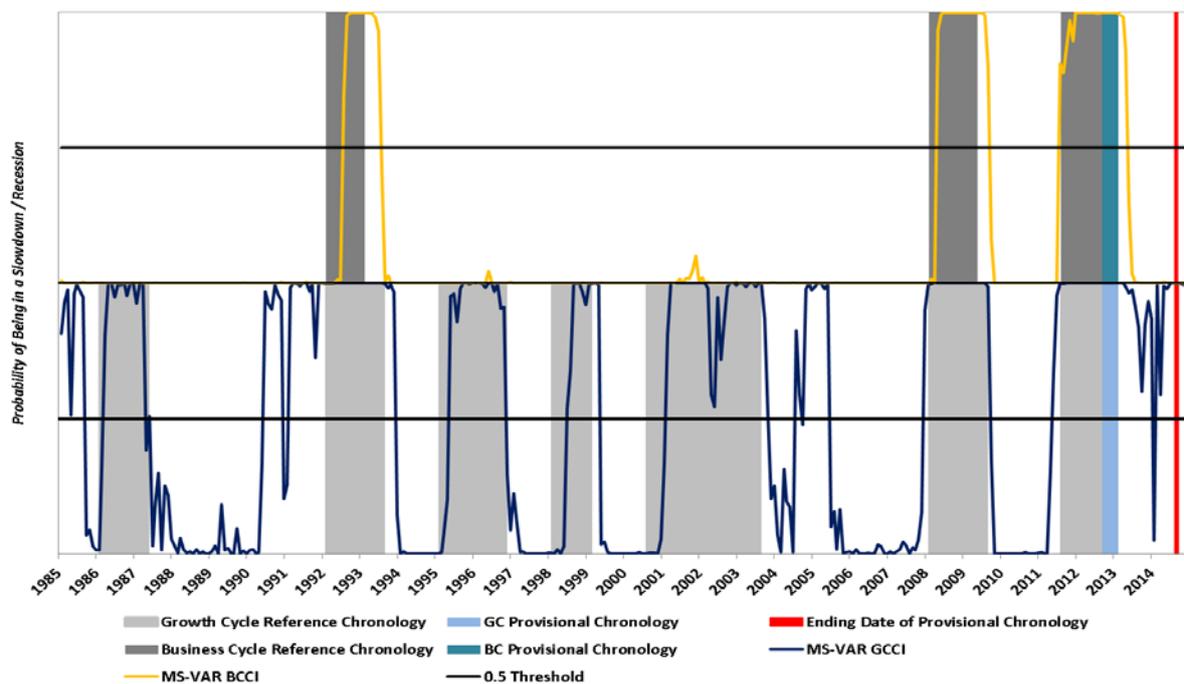
Table 4 summarises the latest euro area peaks and troughs for the three cyclical indicators comparing them with the results of the historical dating chronologies (in grey).

Table 4: Latest Euro Area Peaks and Troughs

		Peak	Trough	Peak	Trough	Peak	Trough	Peak
Growth Cycle	Provisional Dating	*2008 Q1*	*2009 Q3*	*-*	*-*	*2011 Q3*	*2013 Q2*	
	MS-VAR GCCI	*Dec. 2007*	*Sep. 2009*	*-*	*-*	*May 2011*		
Business Cycle	Provisional Dating	*2008 Q1*	*2009 Q2*	*-*	*-*	*2011 Q3*	*2013 Q1*	
	MS-VAR BCCI	*Apr. 2008*	*Sep. 2009*	*-*	*-*	*July 2011*	*May 2013*	
Acceleration Cycle	Provisional Dating	*2006 Q2*	*2009 Q1*	*2010 Q2*			*2012 Q4*	
	ACCI	*June 2006*	*Mar. 2009*	*Dec. 2010*	*Dec. 2011*	*Mar. 2012*	*Oct. 2012*	*Dec. 2013*

While the interpretation of the indicators' outcome is not particularly challenging for sophisticated users, it is quite clear that this is not a friendly way to present the data to a wider audience. Furthermore, since the indicators are presented individually, it is not easy to understand the relations between them so that the global assessment of the cyclical situation, which is the main added value of this system, is often hidden. In order to overcome this, a graphical tool is under development. It is intended to provide an intuitive, easy to read and user-friendly picture of the cyclical situation based on the outcome of indicators, which are not directly displayed but used as the data source to animate the tool.

The tool under development is mainly based in a clockwise representation of the cyclical movements, which by the way is not very innovative. In the last year, several institutions including Eurostat have developed clock-based representations of the cyclical movements. This is the case for the CBS Netherlands with the business cycle tracer, of the DESTATIS business cycle monitor and the OECD business cycle clock. What is really innovative in the Eurostat proposal is that the representation of the cycles within the clock is given by the set of cyclical composite indicators presented in 6.1. The layout of the new business cycle clock we are proposing is presented in figure 8.

*Figure 8: Structure of the new business cycle clock*
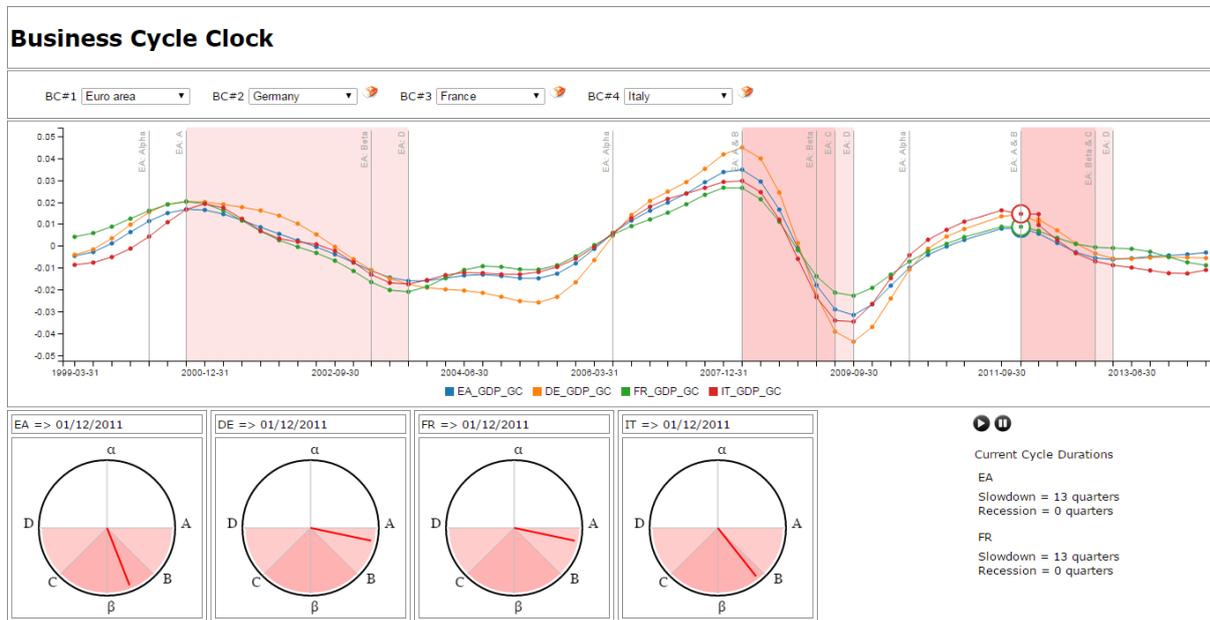
Figure 8 is divided in three main parts: on the top there is an historical graphical representation based on the evolution of GDP; in the lower left corner, one or more clocks are displayed; while in the lower right corner some statistics associated to the cycles are presented. The upper part contains a didactical representation consisting of the GDP deviations from the trend, where the peaks and troughs of the cycles are highlighted. The slowdown phases are represented in pink; the recession phases are represented in dark pink; each point of the αABβCD cycle is represented by a stick. The graph is based on the data obtained by the historical dating describes in step 2 of section 6.1. For this reason it does not contain information for the latest time periods but it provides an historical overview of the cycles over a long time horizon.

It is worth noting that the clock and graph representation are dynamic. A play button sets time running. The current position in the graph representation is highlighted and the clock hand runs.

The clock on the lower left part is structured according to the αABβCD approach, presented in step 1 of section 6.1 (see figure 9).

Figure 9: Clock structure
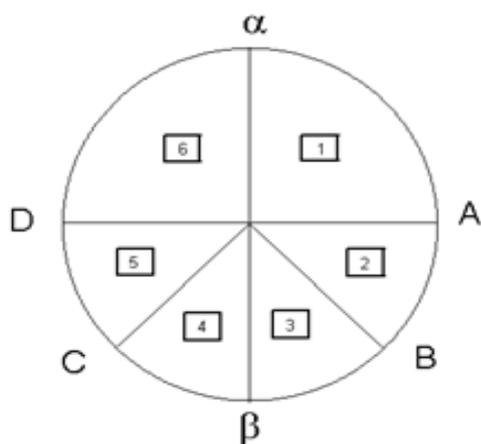
Noon is α, peak of the growth rate cycle; 3 pm is A, peak of the growth cycle; 4.30 pm is B, peak of the business cycle; 6 pm is β, trough of the growth rate cycle; 7.30 pm is C, trough of the business cycle; 9 pm is D, trough of the growth cycle. Those turning points delimitate six sectors in the clock which correspond to various phases of the business cycle. The location of the hand in the clock is based on the values of the three cyclical coincident indicators for the acceleration, growth and business cycles described in 6.1, as well as on their positioning with respect to the 0.5 threshold. Table 5 synthetically presents the characteristics and meaning of the various sectors.

Table 5: The clock sectors and the cyclical composite indicators

		ACCI			
		<0.5		>0.5	
		BCCI		BCCI	
		<0.5	>0.5	<0.5	>0.5
GCCI	<0.5	6 Recovery	/	1 Deceleration	/
	>0.5	5 Expansion	4 Acceleration	2 Slowdown	3 Recession

From table 5, we can say that in sector 1 the economy is growing above the trend but its growth is progressively decelerating. In sector 2, the still positive growth is below the trend while in section 3 the growth becomes negative. In sector 4, the negative growth starts to accelerate approaching the zero. In sector 5, the growth becomes positive but still below the trend, while in sector 6 the economy is growing above the trend and accelerating.

The new business cycle clock aims to assess and compare the situations among different countries. For instance, in Figure 10 we illustrate the comparison of Germany, France and Italy with the Euro Area. The new business cycle clock can display up to 4 countries simultaneously.

Figure 10: Cross-country comparison in December 2011
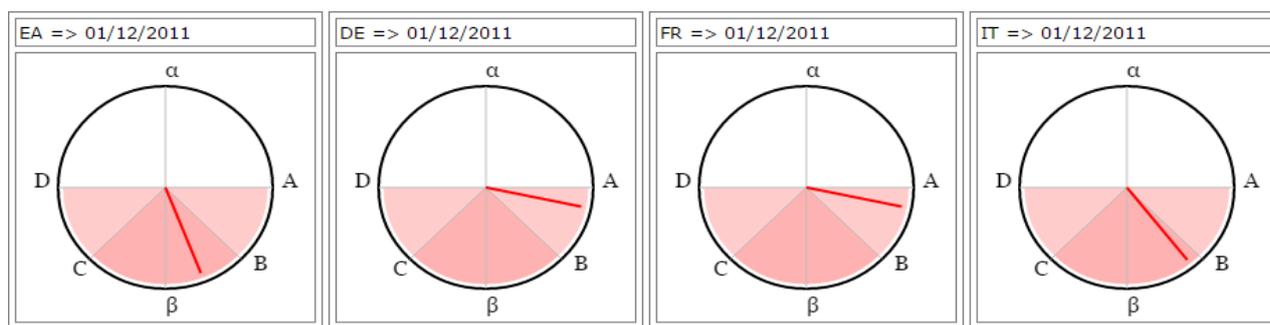
It is worth noting that the new business cycle clock tool will be accompanied by substantial documentation including standard metadata files for the tool itself and for the cyclical indicators as well as methodological notes. The tool and the cyclical indicators will be regularly monitored by Eurostat and a quality assessment will be disseminated annually together with the description of any improvements introduced.

6.3 Using the clock

In this subsection we will try, by using the information delivered by the business cycle clock, to find an answer to some questions raised in the subsection 4.3, to which the PEEIs dashboard could not provide clear evidence. The first question is related to the identification of which economies are growing above the trend and which ones are still below. Since the growth cycle is defined as the deviation from the trend, so that $GC_t = Y_t - Y_t^p$ for t = 1, 2, … T; where GC is the growth cycle, Y is the actual growth and Y^p is the trend, it is possible to show that the growth cycle will cross the trend in A (in a descending phase) and in D (in an ascending phase) of the clock. By drawing a line between A and D we can conclude that, in the sectors of the clock above the line, the economy is growing above trend (sectors 6 and 1), while in the others the economy is growing either below trend or even decreasing. This is shown in figure 11.

Figure 11: The clock and the economic growth
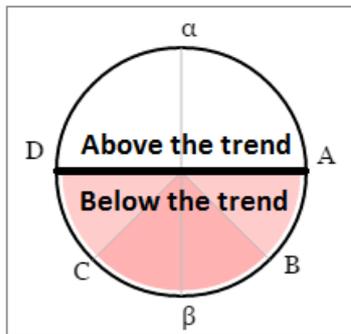
The main difference between staying in sector 6 or in sector 1 is that, in the first case, the economy is growing above the trend and it is still accelerating, while in the sector 1 it has started a deceleration phase while still growing above the trend. By using those results we can analyse, in a comparative way, the growth of some Euro area member countries by referring to Figure 12.

Figure 12: Cyclical situation of the Euro area and some member countries in June 2015
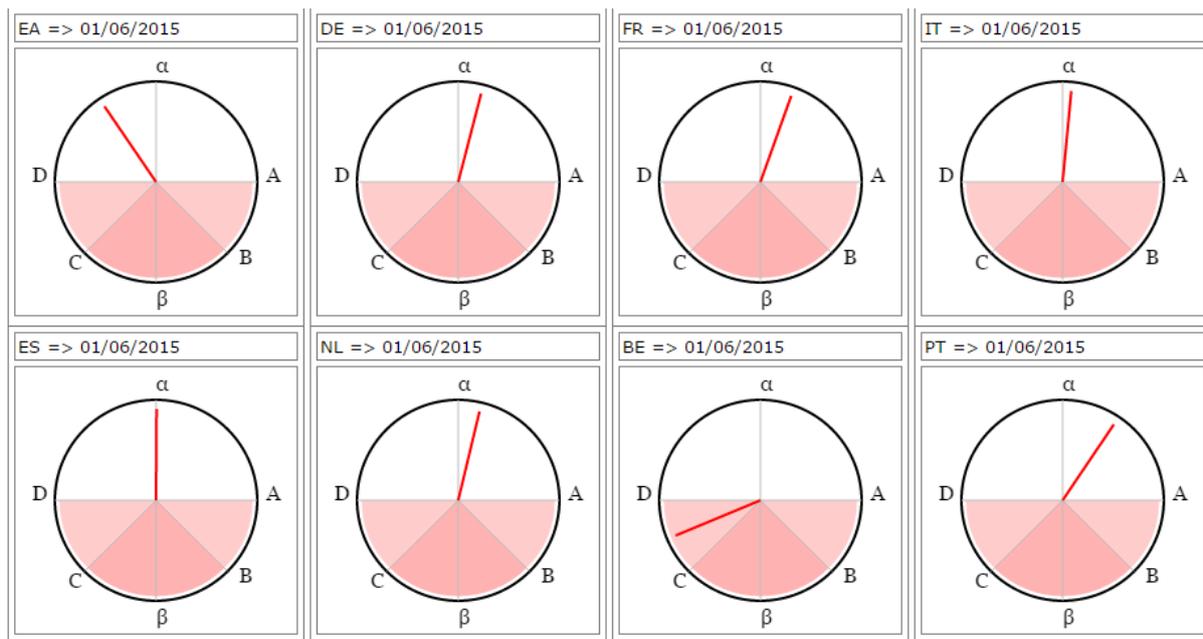
By looking in detail to the various clocks it emerges that almost all economies are growing above trend except Belgium which is still growing below. Furthermore, the Euro area is still in an acceleration phase, while Spain has achieved the peak of the acceleration cycle. For the remaining economies, we can observe that Italy is just at the beginning of the deceleration phase while France, Germany and the Netherlands, as well as Portugal, have a more consolidated deceleration phase. Since for all those economies, the hand is located in the first half of the sector 1, we can also conclude that the risk of reaching point A and therefore starting to grow below the trend, is very low. In this case, by combining the information delivered by the dashboard and the one delivered by the clock, it is possible not only to rank the countries according to the intensity of growth (above or

below the trend) but also to obtain useful insight related to the acceleration or deceleration of their growth.

Another question raised in section 4.3 concerns the degree of cyclical synchronisation among Euro area countries. To answer the question, we analyse the evolution of the cyclical situation, represented by a series of clocks at different points in time.

Figure 13: Analysis of the 2012/2013 recession at Euro area and member countries level
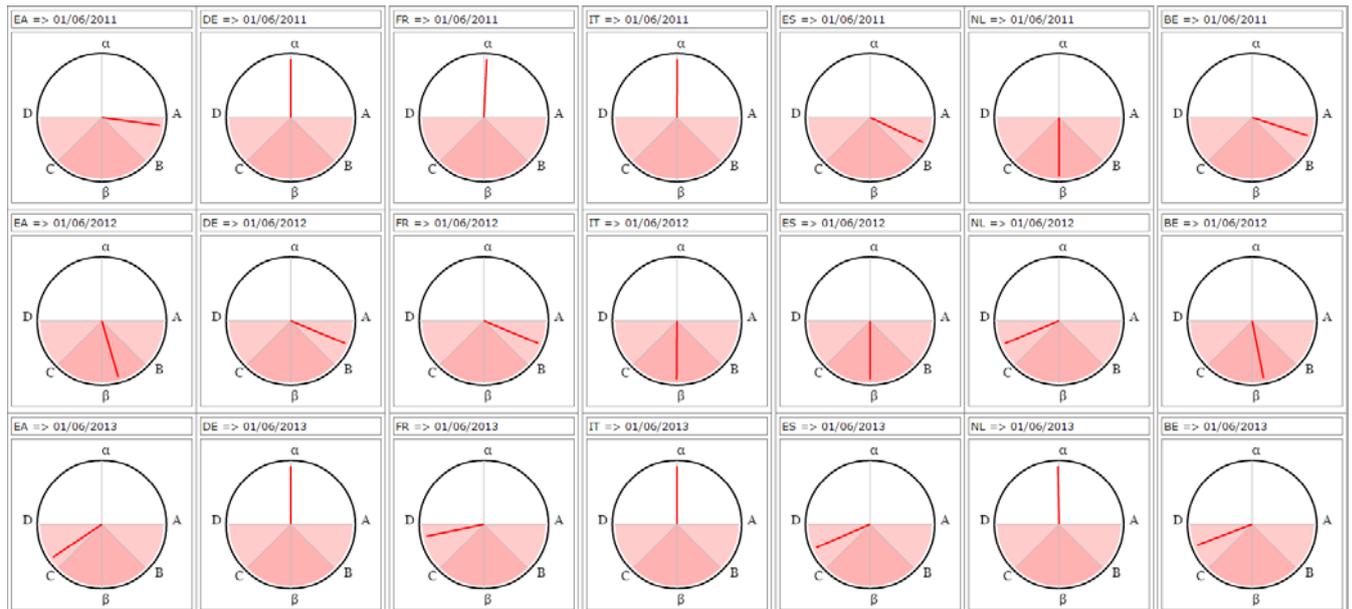
In Figure 13, we consider the Euro area plus six member countries (Germany, France, Italy, Spain, the Netherlands and Belgium). Their cyclical situation is assessed respectively in June 2011, 2012 and 2013. By looking at the countries and Euro area behaviour at the three different points in time, we can observe the following:

− June 2011 shows the immediate entering into slowdown of Spain, Belgium and the Euro area, while Germany, France and Italy are still in expansion; the Netherlands is the only country already in recession, achieving the trough of the acceleration cycle.
− June 2012 shows Spain, Belgium, Italy and Euro area in recession. Germany and France are in slowdown only. The Netherlands exited the recession but remained in slowdown.
− June 2013 shows the exit of Euro area, Spain and Belgium from recession, remaining in slowdown, while France continues to be in slowdown. Germany, Italy and the Netherlands are in expansion.

This analysis shows how, during 2011-2013, the cyclical movements in the Euro area economies were neither synchronised nor diffused. The lack of diffusion is clearly shown by the fact that some economies entered in recession while others just experienced a slowdown. The lack of synchronisation is shown by the fact that peaks and troughs are shifted among economies. This confirms the prevailing idiosyncratic behaviour characterising the Euro area economies, especially after the 2008/2009 financial and economic crisis.

The two cases analysed in this subsection show how, by combining the information contained in the PEEIs dashboard and in the business cycle clock, it is possible to obtain a much better picture of the economic situation. In this way, it has been possible to find answers to some relevant questions and also to obtain insight going beyond the questions themselves, such as the acceleration/deceleration of growth in the first case and the presence/lack of turning point diffusion in the second one.

7. Conclusions

This paper has discussed the characteristics of dashboards, scoreboards and composite indicators, with reference to examples from macroeconomic data published by Eurostat. In each case there are both identified advantages and disadvantages to their use, however it may also be seen that a combination of the approaches – with a close eye on communication to users – can provide a complementary economic picture.

With regard to composite indicators, the biggest challenges appear to be the technical complexity of model/assumption selection, and their appropriate presentation to users. The Business Cycle Clock is one example of a graphical approach to presentation of a complex model. Alternative methods might be explored – for example non-parametric approaches such as POSET – however they are more appropriate in some statistical domains than others.

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