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2016 edition

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Probabilistic coincident indicators of the classical and growth cycles for the major Euro area's Member Countries:
A multivariate Markov-switching modelling approach

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Luxembourg: Publications Office of the European Union, 2016

ISBN: 978-92-79-62180-2
ISSN: 2315-0807
doi: 10.2785/430652
Cat. No: KS-TC-16-018-EN-N

Abstract

This paper extends the methodology for a simultaneous detecting of business and growth cycle, already developed for the euro area, to its major member countries. The best performing indicators for each country are identified through a simulation exercise. An indirect pair of turning point detection indicators for the business and growth cycles of the euro area is also derived as a weighted average of the national ones.

Keywords: business cycle analysis; turning point detection; multivariate Markov-Switching models

Acknowledgements: Paper presented at the 31st CIRET conference in Vienna (September 2012). The paper has benefitted from the outcomes of the multi-annual PEEIs project financed by Eurostat.

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1. Introduction

In order to be a useful tool in supporting policy makers, probabilistic coincident indicators of economic cycles have to be accurate in locating turning points and timely in signalling their occurrence. These are the two criteria we followed in constructing the probabilistic coincident indicators of the Euro area's economic cycles that we proposed as part of the PEEI's project. Within this project, we built coincident indicators measuring the probability of recession and slowdown of the Euro area's classical and growth cycles, respectively.

Related to the accuracy criterion stated above, coincident indicators dealing with the classical and growth cycles have to be able to reproduce any relation between these two cycles. In this respect, we draw attention to the so-called ABCD approach (Anas and Ferrara, 2004) to turning points occurrence, which states that turning points of the classical and growth cycles happen in given sequences describing different economic fluctuations. Most important among them is the sequence from which the approach is named after, namely the turning points sequence ABCD. According to this rule a peak of the classical cycle (B) has to be preceded by a peak of the growth cycle (A); in other words, before falling into recession an economy must be experiencing a slowdown. Symmetrically, a trough of the growth cycle (D) has to be preceded by a trough of the classical cycle (C); stated differently, only after having exited from a recession an economy can growth at a pace above its trend.

The probabilistic coincident indicators we initially built to deal with the Euro area's classical and growth cycles were designed without explicitly taking into account the precepts of the ABCD approach. The coincident indicator of the classical cycle (BCCI) and the one of the growth cycle (GCCI) were independently built to locate as accurately as possible the turning points of the respective cycle, but they were not required to comply with the ABCD approach. So, even though this pair of coincident indicators never produced contradictory turning point signals, that is, signals disagreeing with the ABCD approach, we could not prevent that from happening. In order to overcome this potential drawback inherent to the BCCI and GCCI, we proposed to jointly estimate the probabilistic coincident indicators of the classical and growth cycles so that they satisfy by construction the ABCD approach. As it was the case for the BCCI and GCCI, Markov-Switching models were the analytical tool we resorted to also for the ABCD-consistent pair of coincident indicators. However, contrary to the former pair of coincident indicators, for which independent Markov-Switching models were used, the latter one (MS-VAR BCCI and MS-VAR GCCI) was jointly derived from the same multivariate model by partitioning the common latent-state variable into recession and slowdown regimes.

In the process, not only we assured to infer recession/slowdown signals consistent with the ABCD approach, but we also improved the accuracy and timeliness compared to the previous pairs of coincident indicators.

Encouraged by the satisfactory results achieved in dealing with the economic cycles of the Euro area as a whole, we felt the urgency of attempting the same approach for its major Member Countries, namely Belgium, Finland, France, Italy, Germany, the Netherlands, Portugal and Spain.

The purpose of this paper is to present the coincident indicators we propose for the Member Countries above, how we obtained them in a way that complies with the ABCD approach and assess their accuracy in locating recessions and slowdowns of their classical and growth cycles, respectively.

The structure of the paper is as follows. The first section presents the methodological framework. The description of the data we used is the topic of the second section. The pair of coincident indicators obtained for each Member Country is presented in the third section. Finally, these coincident indicators are combined to define an indirect pair of coincident indicators for the Euro area's classical and growth cycles.

2. Methodology

2.1. Modelling Framework

Markov-Switching models, pioneered by Hamilton (1989), were the analytical tool we used to construct probabilistic coincident indicators of the Euro area's economic cycles throughout the PEEI's project. We chose this class of models as they proved suited to detect a certain type of non-stationarity present in economic series. Moreover, as a by-product of the parameters estimation, a set of probabilities is obtained, which can naturally be interpreted as the probabilities of a given economic phase occurring. This is exactly what the probabilistic coincident indicators aim to measure.

The intercept specification of a multivariate autoregressive Markov-Switching model is shown in equation (1) below. In this model, a different dynamic of the observable variable(s) $\boldsymbol{y}_t$ is achieved by allowing the intercept term, the autoregressive parameters and the variance-covariance matrix to depend on a latent state-variable, S_t:

$$\boldsymbol{y_t} = \boldsymbol{a_i S_t} + \sum_{j=1}^{p} \beta_j \boldsymbol{S_t y_{t-j}} + \boldsymbol{\varepsilon_t}, \qquad \boldsymbol{\varepsilon_t} \sim \mathrm{N}_{\boldsymbol{m}}(\boldsymbol{\Sigma S_t}), t = 1, \dots . T, \tag{1}$$

where $\boldsymbol{y}_t$ is a m×1-vector.

The common latent state-variable that governs the changes in regime of the intercept term, the autoregressive coefficients and the variance-covariance matrix follows a first-order Markov chain with M regimes and constant transition probabilities:

$$P(S_t = j | S_{t-1} = i, S_{t-2}, S_{t-3}, \dots .) = P(S_t = j | S_{t-1} = i) = p_{i,j}, \quad i, j = 1, \dots, M \tag{2}$$

where the transition probabilities measure the odds of either staying in the same regime or to switch to another one from time *t-1* to time *t*.

The estimation of the model parameters is performed via the Expectation Maximization (EM) algorithm ([6]). As a by-product of the estimation procedure one obtains the so-called filtered probabilities, which measure the probability of a given regime j occurring at each date t given only the information available at that time:

$$P\left(S_t = j \middle| \hat{\theta}, y_t, \dots, y_1\right), \quad j = 1, \dots, M \tag{3}$$

where θ is the vector of model parameters.

The definition of filtered probabilities in (3) is that of a probability estimated in real-time, in the sense that only the data available at each point in time are considered in the information set and not the whole sample data ([7]).

As we will see later, from an economic cycle perspective, each state of the latent Markov-chain can be interpreted as a phase of an economic cycle. Consequently, the filtered probabilities related to that regime can be thought of as the real-time probabilities of the associated economic phase occurring. It is the interpretation of filtered probabilities as probabilities of a given phase of an economic cycle that paves the way to the construction of the probabilistic coincident indicators of the classical and growth cycles.

([6]) For our application we used the EM algorithm proposed by Krolzig (1997) and coded in the OX package MSVAR.

([7]) The concept of smoothed probabilities corresponds to when the whole sample data is used to estimate the probabilities of a given regime j happening at time t.

The cornerstone of the approach we propose to deal with the classical and growth cycles lies in the association between the regimes of the latent Markov-chain are the phases of these two cycles, so that the resulting probabilistic coincident indicators satisfy the ABCD sequence. The idea is simple, the regimes of the latent state-variable are portioned so that:

i. the first M_{BC} ($1 \leq M_{BC} < M$) regimes of the latent state-variable are assumed to represent recessions of the classical cycle;

ii. the same first MBC regimes plus the following H regimes, collectively denoted as $M_{GC} \equiv M_{BC} + H$, where $M_{BC} < M_{GC} < M$, are assumed to identify the slowdowns of the growth cycle ([8]).

Following the associations above, recession probabilities are defined as the sum of the filtered probabilities of the first M_{BC} regimes, whereas slowdown probabilities are obtained by adding up the filtered probabilities of the first M_{GC} states.

In this way, by construction, recession probabilities are always not greater than slowdown probabilities; thereby, when the economy is suffering a recession of the classical cycle it must also be experiencing a slowdown of the growth cycle, although the latter does not imply the former.

Symmetrically, probabilities of being in an expansion of the classical cycle are always greater or equal to the probabilities of experiencing an upturn of the growth cycle; this means that when the economic is growing it must also be out of the recession, though when the recession is over the slowdown could be still lingering.

In this way, the principles of the ABCD approach are straightforwardly incorporated in the association between states of the latent Markov-chain and economic phases.

Finally, the probabilistic coincident indicator of the classical cycle is defined as the recession probabilities of the M_{BC} regimes and the coincident indicator of the growth cycle is set equal to the slowdown probabilities of the M_{GC} regimes:

$$MS-VAR\ BCCI_t = \sum_{j=1}^{M_{BC}} P\left(S_t = j \middle| \hat{\theta}, y_t, \ldots, y_1\right) \quad (4)$$

$$MS-VAR\ GCCI_t = \sum_{j=1}^{M_{BC}} P\left(S_t = j \middle| \hat{\theta}, y_t, \ldots, y_1\right) \quad (5)$$

Given the probabilistic coincident indicators in (4) and (5), recession and slowdown signals can be derived by applying a decision rule. The most natural one, which we borrowed from Hamilton (1989), detects either a recession or slowdown signal when the corresponding coincident indicator crosses the 0.5 threshold, which is the natural probabilistic divide for two mutually exclusive events (recession/expansion or slowdown/upturn). As a result of how coincident indicators are built, a recession signal is always anticipated by, or is at most contemporaneous to, a slowdown signal; an expansionary signal is always followed by, or at least concurrent to, an upturn signal. Finally, turning points occurrence can be inferred from either the slowdown/recession or upturn/expansion binary signals.

As we have just showed, it is the fact that the states of the common latent variable are partitioned and related to the phases of either classical or growth cycles what guarantees by construction the fulfilment of the ABCD approach. On the contrary, the coincident indicators we had previously built, namely the BCCI and GCCI, were obtained from separate Markov-Switching models that were ruled by independent Markov-chain, so that recession and slowdown regimes could be not related one another.

The interpretation of the latent state-variable in economic terms, that is, the association between regimes of the Markov-chain and economic phases is treated in a later section, when the results for each Member Country are presented.

([8])Since the regimes of the latent Markov-chain are mutually exclusive, if we were to associate only the H regimes to the slowdown phases of the growth cycle, we would be asserting that there is a probability of being in a recession without being in a slowdown, which is not consistent with the succession of economic fluctuations implied by the ABCD turning points sequence.

2.2. Model and Variables Selection Strategy

In order to come up with the probabilistic coincident indicators of the classical and growth cycles for each Member Country, the modeling framework discussed above had to be completed with a strategy to select the model specification, the set of endogenous variables and the regimes association that allow achieving the highest accuracy in identifying the phases of the two cycles.

First of all, we remark the fact that endogenous variables in model (1) have to be stationary. As most of macroeconomic variables are indeed I(1) variables, stationarity is achieved by taking their differences. Different orders of differentiation could lead to a more or less accurate location of the economic cycles. Therefore, a point related to the variables selection is the choice of the differentiation order.

As for the model specification, despite the general specification (1) allows the autoregressive parameters to be a function of the latent Markov-chain, we restricted it so that the autoregressive part of the model is of order 0, which obviously makes the dependency on the latent variable irrelevant. This choice is based on the empirical experience we gained in building coincident indicators of the Euro area's cycles, which showed that removing the autoregressive part allows to attain a higher accuracy and timeliness in locating turning points. Given this restriction and following the notation firstly introduced by Krolzig (1997), we denote the two model specifications admitted as MSIH(M)-VAR(0) and MSI(M)-VAR(0). The first one concisely symbolizes that the intercept (I) and volatility (H) switch from one regime to another and both of them are ruled by a common latent M-state Markov-chain. The second alternative does allow only the intercept to be state-dependent.

The number of regimes of the discrete state-variable is assumed to take value in the range between 3 and 5. The choice of the lower bound was naturally constrained as we want to have a sufficient number of regimes as the phases of the cycles on which inference is to be drawn. In this case, the first regime is associated to the recessions of the classical cycle and the first and second regimes to the slowdowns of the growth cycle. The upper bound was set at 5 as it is difficult to envisage the occurrence of more than 5 economic regimes.

Given the number of state of the latent Markov-chain, probabilistic coincident indicators of the classical and growth cycles are defined as in (4) and (5), respectively. Thereby, the next step is to decide the number of regimes associated to the classical (M_{BC}) and growth cycles (M_{GC}).

With respect to the set of endogenous variables, these are described in the following section.

As for the differentiation order of the endogenous variables, we take differences in the discrete domain {1, 3, 6, 12}. The growth rate over the corresponding number of months is its economic interpretation.

We finally note that differenced endogenous variables were standardized so that all variables are on the same scale.

All in all, the restrictions we placed on the construction of the coincident indicators concern:

i. the model specifications allowed, MSI(M)-VAR(0) and MSIH(M)-VAR(0),

ii. the number of regimes of the Markov-chain {3,4,5} and

iii. the differentiation orders {1, 3, 6, 12} of the endogenous variables.

Bounded by the above restrictions, we still have to define whether to prefer a homoscedastic or heteroscedastic specification, the number of regimes of the Markov-chain, the set of endogenous variables and their order of differentiation that allows achieving the highest accuracy in locating the economic cycles of each Member Country. The major challenge we faced was that the choices above are not independent; on the contrary they are interrelated.

The selection strategy we come up with to settle this issue is presented in what follows. The first possibility could have been to invoke an economic theory and select a-priori the model specification, the endogenous variables, their order(s) of differentiation, the number regimes and their association to the economic cycles. However, we lacked of such a theory. In the absence of that, we opted for a-posteriori approach based in constructing all the coincident indicators possible from combining the elements above, gauging their accuracy in locating the fluctuations of the classical and growth cycles and finally retaining the combination that allows attaining the highest accuracy.

An automatized iterative procedure was set up to go through the huge set of combinations ([9]) of model specifications, endogenous variables, differentiation orders and regimes associations. Among the huge number of combinations considered we retained, in a first stage, the ones that return the pair of coincident indicators most accurate in locating the recession/slowdown periods of the respective cycle. Once the set of possible alternatives is so narrowed down to a more manageable number, the selection process is completed with a judgmental assessment left to the researcher. In the appendix we present for each Member Country the reduced set of coincident indicators, whereas in the next section we discuss in more detail the pair of coincident indicators we finally singled out.

The accuracy in locating the turning points of either cycle is measured by computing two statistics that are widely used in business cycle analysis. The first one is the classical Quadratic Probabilistic Score (Brier, 1950), which is defined as follows:

$$QPS = \frac{1}{T}\sum_{t=1}^{T}(Coincident\ Indicator_t - RC_t) \quad (6)$$

where, *Coincident Indicator* is either the probabilistic coincident indicator of the classical or growth cycle; RC_t is a binary variable that represents the reference dating chronology of either the classical or growth cycle, which is equal to 1 during a recession/slowdown, respectively, and 0 otherwise. The benchmarks we used are the turning points dating chronologies of the classical and growth cycles computed within the PEEI's project. These dating chronologies are described in the next section.

In addition to the QPS, a second accuracy criterion was used, namely the Concordance Index (CI). The Concordance Index, originally proposed by Harding and Pagan (2002), is defined as follows:

$$CI = \frac{1}{T}[\sum_{t=1}^{T} I_t \times RC_t + \sum_{t=1}^{T} -I_t \times RC_t] \quad (7)$$

where RC_t is the reference dating chronology described above and I_t is a binary random variable that assumes value 1 if the coincident indicator of either cycle provides a recession/slowdown signal.

It should be noted that the reference dating chronologies have a quarterly frequency, whereas the coincident indicators are built with a monthly frequency. Therefore, in order to compare them and compute the QPS and CI statistics, we assumed that the benchmark's turning point dates occur in the middle month of the corresponding peak/trough dates.

([9]) Formally, we considered the combinations without repetition of the elements above.

3. DATA

The major challenge we faced was to obtain good quality and long enough time-series for all the eight countries considered in this analysis: Belgium, Finland, France, Germany, Italy, the Netherlands, Portugal and Spain. Despite several sources are available for many of these Member Countries, we decided to rely only on data provided by Eurostat as this is more in the spirit of the PEEI's project.

For each Member States considered in this analysis, Table 1 below summarizes the variables we used, their sources and the date from when available. On the one hand, data limitations and, on the other hand, the pursuit of coincident indicators of similar composition across countries, were the reasons for choosing the same variables for all the eight Member States.

We highlight the fact that the variables we considered pertain to the real economy as well as to the soft one.

Table 1: Member Countries' selected data

Variable	Source	Belgium	Finland	France	Germany	Italy	the Netherlands	Portugal	Spain
Industrial Production Index	Eurostat	1970:01	1990:01	1970:01	1970:01	1970:01	1970:01	1970:01	1980:01
Harmonized Unemployment Rate	Eurostat	1983:01	1988:01	1983:01	1991:01	1983:01	1983:01	1983:01	1986:04
Employment Expectations (Manufacturing)	DG- EcFIN	1985:01	1993:01	1985:02	1985:01	1985:01	1985:01	1987:01	1987:04
Construction Confidence Indicator	DG- EcFIN	1989:05	1985:01	1985:01	1985:01	1985:01	1985:01	1989:01	1989:01
Financial Situation (Consumer)	DG- EcFIN	1985:01	1995:01	1985:01	1985:01	1985:01	1985:01	1986:06	1986:06
Retail	DG- EcFIN	1985:01	1989:01	1985:01	1985:01	1985:10	1986:01	1989:01	1988:09
Economic Sentiment Indicator	DG- EcFIN	1985:01	1985:01	1985:01	1985:01	1985:01	1985:01	1987:01	1987:04

Source: Authors' calculations

All the time-series are seasonally adjusted. Also in this case we chose seasonally adjusted variables as we empirically showed that once removed the seasonal component, Markov-Switching models produce less noisy filtered probabilities.

Of all the combinations that can be obtained from the set of variables above, we considered only a subset as endogenous variables of the Markov-Switching models. Due to the relevance of the Industrial Production Index as proxy for the GDP, we forced every model to include the former variable as endogenous variable. Given this restriction, Table 2 summarizes the combinations of endogenous variable we considered in this analysis.

Table 2: Combinations of endogenous variables for the multivariate Markov-Switching modes

3 Variables		4 Variables		5 Variables	
1.	IPI, BUIL, CONS				
2.	IPI, BUIL, INDU	12.	IPI, BUIL, CONS, RETA		
3.	IPI, BUIL, RETA	13.	IPI, BUIL, INDU, CONS		
4.	IPI, CONS, RETA	14.	IPI, BUIL, INDU, RETA		
5.	IPI, INDU, CONS	15.	IPI, INDU, CONS, RETA	22.	IPI, BUIL, INDU, CONS, RETA
6.	IPI, INDU, RETA	16.	IPI, UR, BUIL, CONS	23.	IPI, UR, BUIL, CONS, RETA
7.	IPI, UR, BUIL	17.	IPI, UR, BUIL, RETA	24.	IPI, UR, BUIL, INDU, CONS
8.	IPI, UR, CONS	18.	IPI, UR, CONS, RETA	25.	IPI, UR, BUIL, INDU, RETA
9.	IPI, UR, ESI	19.	IPI, UR, INDU, BUIL	26.	IPI, UR, INDU, CONS, RETA
10.	IPI, UR, INDU	20.	IPI, UR, INDU, CONS		
11.	IPI, UR, RETA	21.	IPI, UR, INDU, RETA		

Source: Authors' calculations

A second issue related to the data was the availability of reference dating chronologies of both the classical and growth cycles for each of the eight Member Countries (10). As we aimed at estimating probabilistic coincident indicators that satisfy the ABCD sequence advocated in the eponym approach, we had to validate their accuracy on a benchmark that complies with that approach. In the period since the inception of the Euro area, we could count on the turning points dating chronologies produced in the Quarterly Cyclical Assessments of the Euro Area. The main two advantages in using these dating chronologies are, first, that they comply with the ABCD approach; second, they are recognized by Eurostat since they are produced as part of the PEEIs project. Unfortunately, the period before the accession to the Euro area is not covered in the Quarterly Assessments. We therefore resorted to a different source, the paper by Anas, Billio and Ferrara (2007), where the dating chronologies of both the classical and growth cycles for the Euro area as well as its major Member Countries are computed. In this work, dating chronologies are defined for both the business cycle, which is based on GDP, and for the industrial cycle. Given that advanced economies in the Euro area are in a post-industrialization phase, we consider the business cycle more representative than the industrial cycle. Therefore, the dating chronologies obtained from the GDP are taken as benchmark for all Member Countries considered in our analysis, with the exception of Portugal, for which only the industrial cycle was available.

The reference turning points dating chronologies are summarized in Table 3 below. Despite dating chronologies are available from the 1970s, we reported the turning points dates only since 1990. This is because, in the construction of the Member States' coincident indicators, we focused on the last two decades. The reason for restricting the time horizon is twofold. First, data availability, as the minimum common date since when all the variables are available is 1991. Second, we consider the last two decades more representative of current economic cycles in the Euro area than earlier periods; this is because, during this horizon Member Countries witnessed the accession to the Euro area, which could underpin a deeper, although perhaps not fully reached yet, level of integration among them.

Finally, we required a sufficient number of recessions and slowdowns so that it was possible to construct representative coincident indicators of the classical and growth cycle. As shown in Table 3 below, all the Member States we analysed suffered at least two recessions and five slowdowns in the last twenty-two years.

(10) Turning points dating chronologies of the Finland's classical business and growth cycles were not available before 1999. Given the short span of time for which dating chronologies are defined, we discarded Finland from our analysis.

Table 3: **Turning points dating chronologies of the Euro area's and seven of its Member Countries' business and growth cycles according to the ABCD approach**

Turning Point	Euro area	Belgium	France	Germany	Italy	the Netherlands	Portugal	Spain
Peak A	-	1990Q1	1990Q1		1990Q1		1990M10	
Trough D	-	1991Q1	1991Q1		1990Q4		-	
Peak A	1991Q1	1992Q1	1992Q1	1992Q1	1992Q1	1991Q4	-	1991Q4
Peak B	1992Q1	1992Q1	1992Q1	1992Q1	1992Q1	-	1991M2	1992Q1
Trough C	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1	-	1993M6	1993Q1
Trough D	1993Q3	1993Q2	1993Q3	1993Q2	1993Q2	1993Q4	1993M10	1993Q3
Peak A	1995Q1	1995Q1	1995Q1	1995Q1	1995Q2	1995Q1	1996M3	1995Q2
Trough D	1996Q4	1996Q2	1997Q2	1997Q1	1996Q4	1997Q1	1997M6	1996Q4
Peak A	1998Q1	1997Q4	1998Q1	1997Q4	1997Q4	1998Q1	1998M6	1997Q2
Peak B	-	1998Q2	-		-	-	-	-
Trough C	-	1998Q4	-		-	-	-	-
Trough D	1999Q1	1999Q1	1999Q1	1999Q1	1999Q1	1999Q1	2000M2	1998Q3
Peak A	2000Q3	2000Q2	2000Q3	2000Q3	2000Q4	2000Q4	2000M5	2000Q1
Peak B	-	2000Q4	-	2002Q3	2001Q1	-	2002M5	-
Trough C	-	2001Q4	-	2003Q2	2001Q3	-	2003M5	-
Peak B	-	-	-	-	2002Q3	-	-	-
Trough C	-	-	-	-	2003Q2	-	-	-
Trough D	2003Q4	2003Q3	2003Q4	2005Q2	2003Q4	2003Q3	2003M5	2004Q1
Peak A	2007Q4	2008Q1	2007Q4	2008Q1	2008Q1	2008Q1	2008M1	2008Q1
Peak B	2008Q1	2008Q2	2008Q1	2008Q1	2008Q1	2008Q1	2008M2	2008Q1
Trough C	2009Q2	2009Q1	2009Q1	2009Q1	2009Q2	2009Q2	2009M2	2009Q4
Trough D	2009Q3	2009Q2	2009Q3	2009Q3	2009Q3	2009Q3	2009M5	2009Q4
Peak A	2011Q2	2011Q3	2011Q2	2011Q3	2011Q2	2010Q4	2010M8	2011Q1
Peak B	2011Q3	-	-	-	2011Q2	2011Q1	2010M8	2011Q2
Trough C	-	-	-	-	-	2011Q4	-	-

Source: Authors' calculations

4. RESULTS

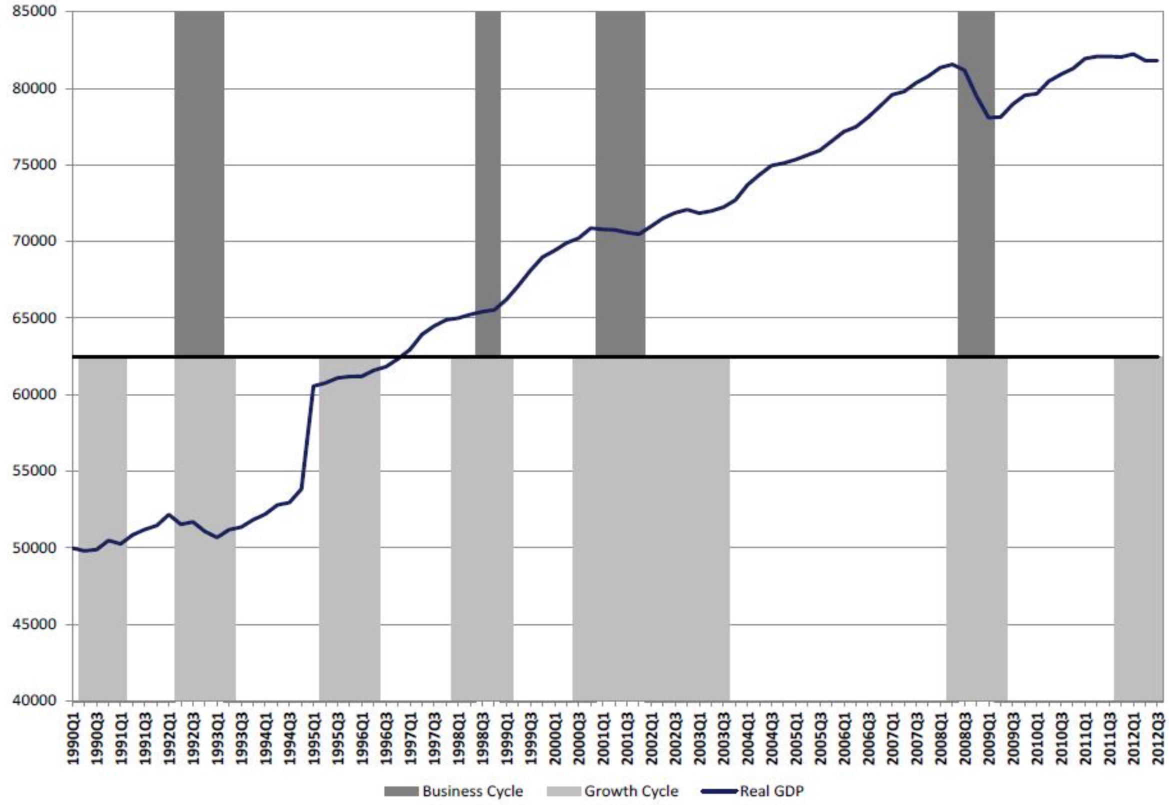
In this section we present, for each Member Country, the pair of probabilistic coincident indicators we propose to locate the recessions and slowdowns of their classical and growth cycles, respectively.

In the appendix, we briefly discuss the other pairs of coincident indicators that were selected from the automatic procedure and that were judgmentally discarded in favour of the coincident indicators presented here.

4.1 Belgium

Between 1990 and mid-2012, Belgium experienced four recessions. Consistently with the ABCD approach, each recession of the classical cycle was comprised in a slowdown of the growth cycle. In addition, the reference dating chronology of the growth cycle includes three other slowdowns that did not turn into full-fledged recessions.

Figure 1: **Recessions and slowdowns implied by the Belgian reference dating chronologies of the classical and growth cycles**



Source: Authors' calculations

Table 4 below shows the definition of the probabilistic coincident indicators of the classical and growth cycles that we propose to locate the fluctuations of these two cycles.

A 4-regime Markov-Switching model that allows only for state-dependent intercept is the specification we retained. This model is fitted to the five variables in Table 4, two of which belong to the real economy and the remaining three are business surveys. The differentiation order of each variable is showed in round parentheses. The coincident indicator that expresses the probability of a recession of the classical cycle is defined as the filtered probabilities of the first regime. In order to deal with the slowdowns of the growth cycle, the sum of the filtered probabilities of the first two regimes is necessary.

Table 4: **Model specification, endogenous variables, sample period and assumptions on the association between regimes of the latent Markov-chain and recession/slowdown phases**

	Model A
Model	MSI(4)-VAR(0)
Endogenous Variables	1. IPI(6) 2. UR(3) 3. BUIL(6) 4. INDU(3) 5. RETA(3)
Sample	1990:01 – 2012:07
Recession Regime(s)	R1
Slowdown Regime(s)	R1+R2

Source: Authors' calculations

Parameter estimates in Table 5 help us in interpreting the proposed coincident indicators in a business cycle perspective. We draw attention on the state-dependent intercept as its coefficients describe the level of the endogenous variables in every regime of the Markov-chain and as such indicate in what directions these were moving and by how much.

Table 5: **Parameter estimates of Model A**

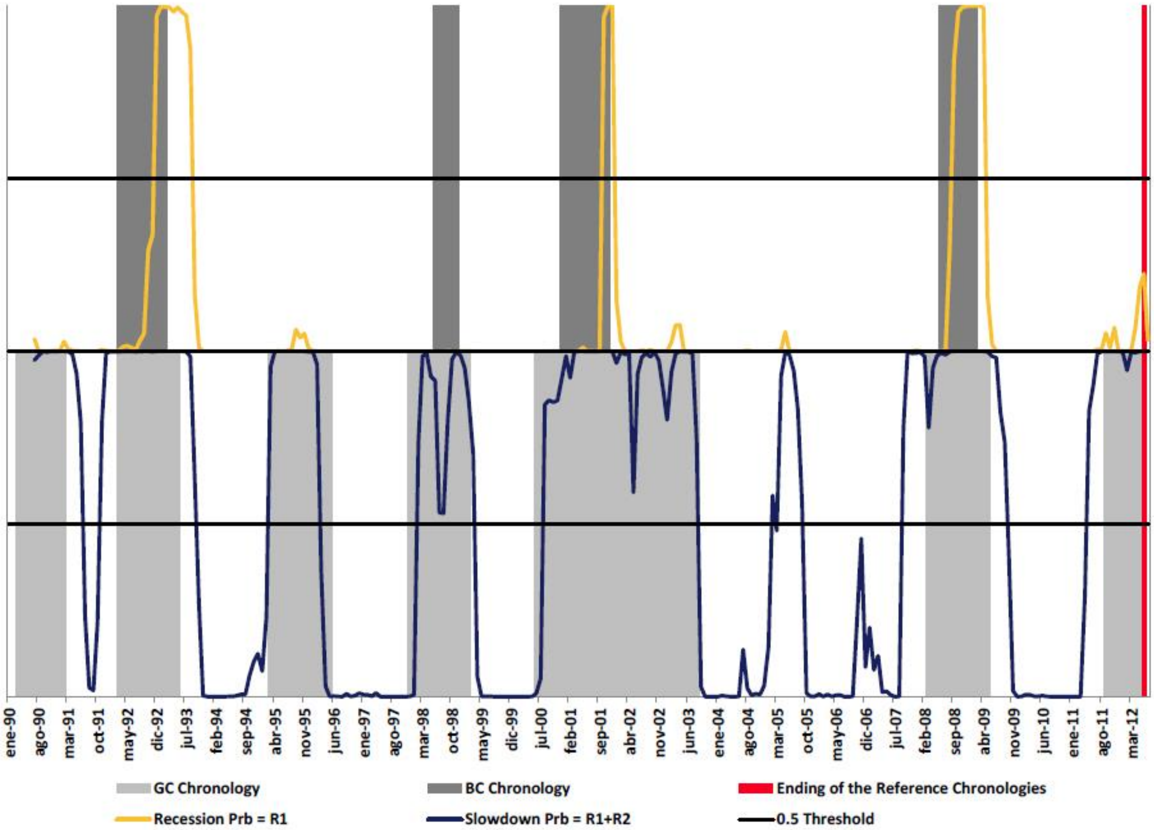
Variable	Intercept				Volatility
	R1	R2	R3	R4	
IPI(6)	-1.62	0.02	0.34	0.17	0.86
UR(3)	-1.33	-0.09	-0.30	1.49	0.68
BUIL(6)	-1.27	-0.54	0.74	0.70	0.68
INDU(3)	-0.97	-0.50	0.66	0.67	0.79
RETA(3)	-0.78	-0.26	0.34	0.45	0.93

Source: Authors' calculations

For all the endogenous variables, the intercept attains its minimum value at the first regime and, since such minimum is negative, we can interpret this regime as reflecting recessions of the classical cycle. As for the second regime, with the exception of the IPI's equation, whose intercept coefficient is close to 0, the remaining equations are characterized by a negative intercept, although not so low as in the first regime. Regimes 3 and 4 exhibit positive intercepts for all the variables, with the exception of the coefficient of unemployment rate in the third state. Following our discussion on regimes association above, the first and second states are bundled together and related to periods in which the economy was slowing down. The other two regimes represent phases of expansion of either the classical or growth cycles.

Both recession (MS-VAR BE.BCCI) and slowdown (MS-VAR BE.GCCI) probabilities are drawn in Figure 2, where they are compared to the dating chronology of the classical and growth cycles, respectively.

Figure 2: **Recession and slowdown probabilities of the Belgian classical and growth cycles, respectively, estimated by fitting a MSI(4)-VAR(0) model to IPI(6), UR(3), BUIL(6), INDU(3), RETA(3).**

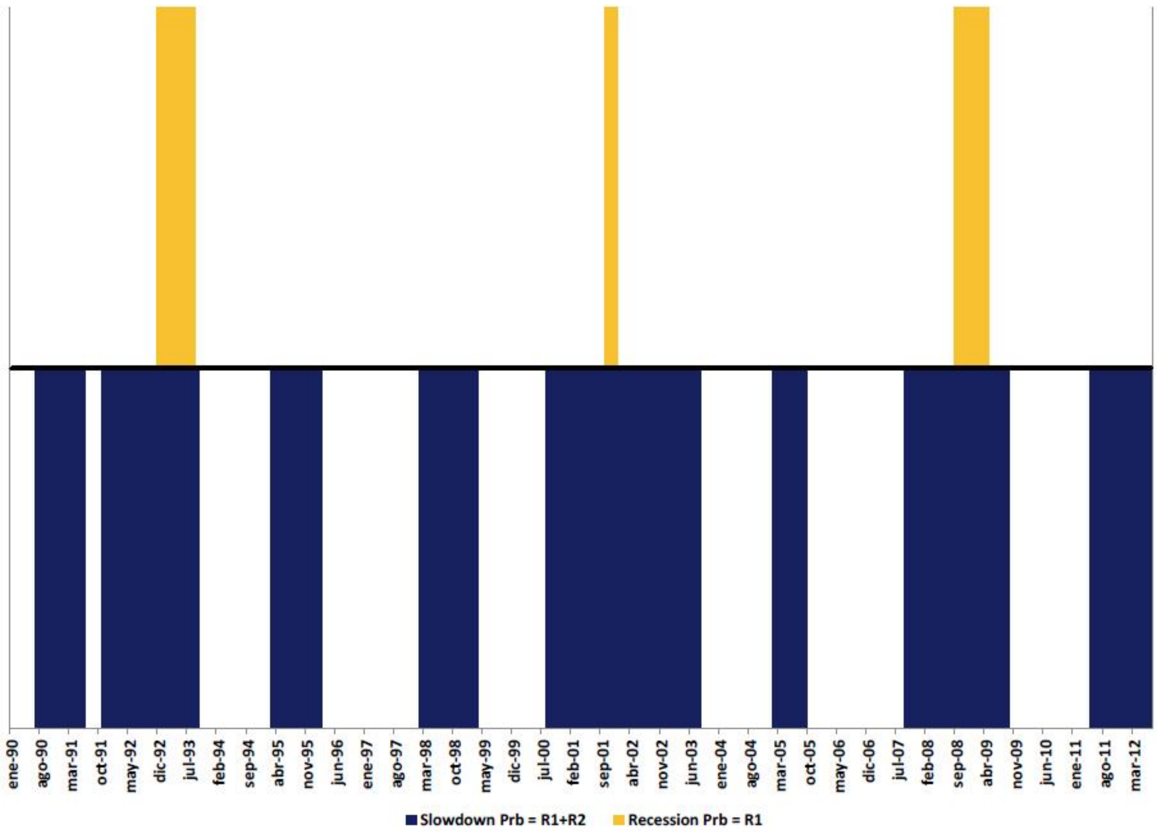


Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

Slowdown and recession signals are obtained from the above probabilistic coincident indicators by applying the simple 0.5 natural rule. They are graphically shown in Figure 3. Additionally, we also require both slowdown and recession signals to comply with a simple censoring rule according to which, in order to be retained, they have to be sustained for at least three consecutive months.

Figure 3: **Recession and slowdown signals of the Belgian classical and growth cycles, respectively, derived from the proposed coincident indicators**



Source: Authors' calculations

The turning points of the classical and growth cycles implied by the recession and slowdown signals, respectively, are summarized in Table 6, where they are compared to the reference dating chronologies.

Table 6: **Turning points dating chronologies of the Belgian classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators**

Turning Point	Reference Dating Chronology	Model A
Peak A	1990Q1	-
Trough D	1991Q1	1991M6 (+4)
Peak A	1992Q1	1991M10 (-4)
Peak B	1992Q1	1992M11 (+9)
Trough C	1993Q1	1993M8 (+6)
Trough D	1993Q2	1993M9 (+4)
Peak A	1995Q1	1995M2 (+0)
Trough D	1996Q2	1996M2 (-3)
Peak A	1997Q4	1998M1 (+2)
Peak B	1998Q2	-
Trough C	1998Q4	-
Trough D	1999Q1	1999M3 (+1)
Peak A	2000Q2	2000M7 (+2)
Peak B	2000Q4	2001M9 (+10)
Trough C	2001Q4	2001M12 (+1)
Trough D	2003Q3	2003M8 (+0)
Peak A	-	2005M1
Trough D	-	2005M9
Peak A	2008Q1	2007M8 (-6)

Turning Point	Reference Dating Chronology	Model A
Peak B	2008Q2	2008M8 (+3)
Trough C	2009Q1	2009M4 (+2)
Trough D	2009Q2	2009M9 (+4)
Peak A	2011Q3	2011M4 (-4)

Source: Authors' calculations

In round parentheses, it is shown the distance (in months) between the turning points dates implied by the coincident indicators and the peaks and troughs dates of the reference dating chronologies ([11]).

Finally, Table 7 shows the accuracy statistics of the pair of coincident indicators in locating the fluctuations of the Belgian classical and growth cycles.

Table 7: Accuracy statistics of the proposed coincident indicators of the Belgian classical and growth cycles

Coincident Indicator	Available from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1990:07	BC	.132	.860	7.4	0	3.0	0	0	1
		GC	.139	.845	0.7	2.4	2.2	0.5	1	0

Note: Lag and early statistics are average measures express on a monthly basis.
Source: Authors' calculations

The coincident indicator of the classical cycle (MS-VAR BE.BCCI) misses the recession experienced in 1998. However, this could be considered as a drawback of less importance as this contraction was brief (2 quarters) and shallow. Despite the recession between 2000Q4 and 2001Q4 was a more prolonged and slightly sharper one, the MS-VAR BE.BCCI almost misses it entirely. The really severe recessions of the early 1990s and 2008-2009 are correctly detected. However, the two peaks that preceded these two recessions are located with an average delay of 6 months.

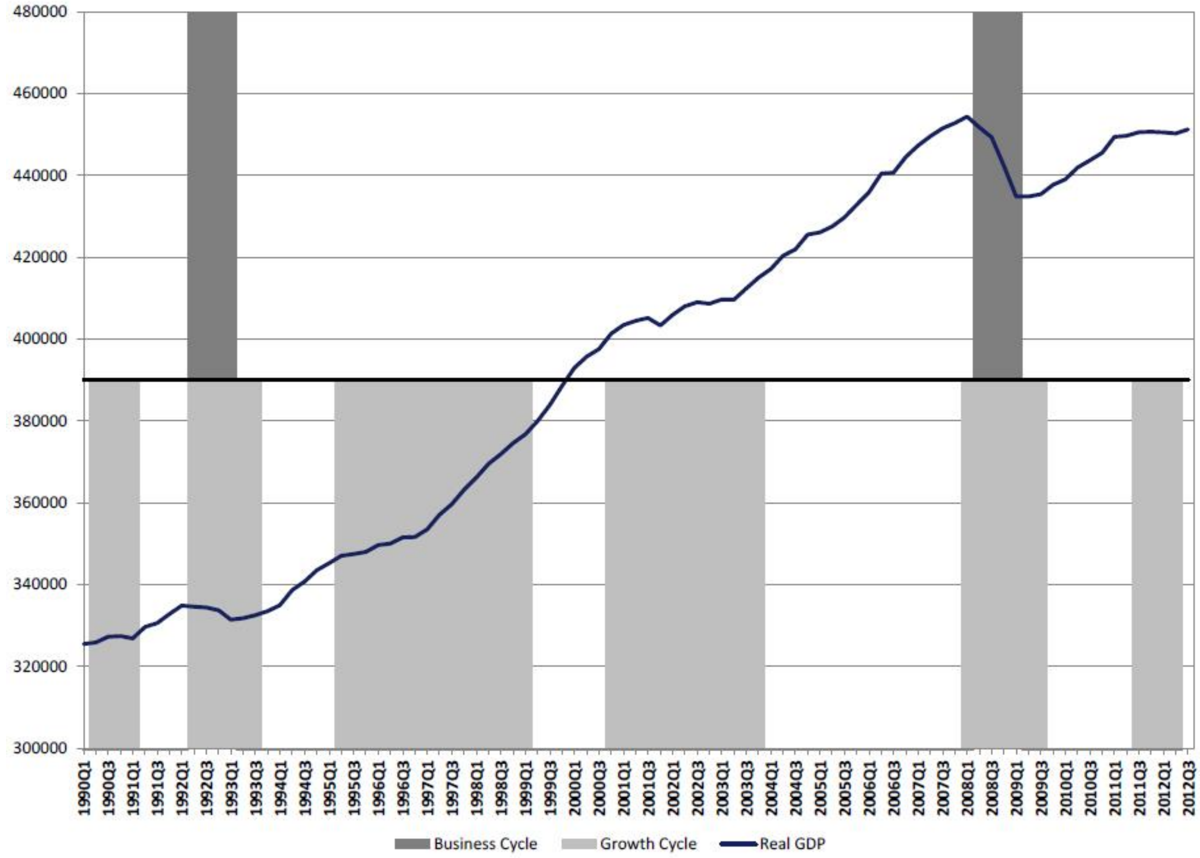
For what regards the growth cycle, the proposed coincident indicator (MS-VAR BE.GCCI) does not miss any of the seven slowdowns observed in Belgium. Moreover, the coincident indicator is more accurate in locating the start of the slowdowns compared to the case of the classical cycle; on average, the delay is of only 0.7 months. A false slowdown signal is produced in 2005.

4.2. France

In the period between 1990 and mid-2012, the French economy experienced six slowdowns. Two of them turn into full-fledged recessions, one in 1992-1993 and the second in 2008-2009. As for the recent sovereign-debt crisis that has mired into recession several countries in the Euro area, so far France has only witness a slowdown in its growth rate.

([11]) In the same way as for computing the QPS and CI statistics, the middle month of each quarter in which a turning point is located in the reference dating chronologies is assumed to be the actual date.

Figure 4: Recessions and slowdowns implied by the French reference dating chronologies of the classical and growth cycles



Source: Authors' calculations

A pair of coincident indicators of the classical and growth cycles is jointly constructed as summarized in Table 8. These are obtained by fitting a MSIH(4)-VAR(0) model to five variables, two pertaining to the real economy and three business surveys. The coincident indicator of the classical cycle (MS-VAR FR.BCCI) is defined as regime 1's filtered probabilities. The coincident indicator of the growth cycle (MS-VAR FR.GCCI) is the sum of regime 1 and regime 2's filtered probabilities.

Table 8: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model B
Model	MSIH(4)-VAR(0)
Sample	1990:01 – 2012:08
Endogenous Variables	1. IPI (6) 2. UR (1) 3. BUIL(3) 4. CONS (1) 5. RETA (12)
Recession Regime(s)	R1
Slowdown Regime(s)	R1+R2

Source: Authors' calculations

Table 9 shows the parameter estimates. The sign of the state-dependent intercept supports the association between regimes of the latent Markov-chain and economic cycles we proposed above. With the exception of the consumer confidence indicator, the first regime is characterised by the lowest values of the intercept term, which is negative for all variables. This suggested the association between regime 1 and recessions of the classical cycle. Negative intercepts are estimated for the second state but not for the remaining two regimes. Thereby, one could interpret the second regime as describing slowdowns of the growth cycle.

Table 9: Parameter estimates of Model B

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(6)	-1.87	-0.23	0.34	0.69	1.68	0.47	0.57	0.54
UR(1)	-1.06	-0.21	0.02	0.71	0.86	0.98	0.93	0.64
BUIL(3)	-1.54	-0.59	0.39	1.09	0.65	0.65	0.63	0.44
CONS(1)	-0.18	-0.24	0.22	0.21	0.98	1.09	0.85	0.96
RETA(12)	-0.80	-0.59	0.42	0.66	1.23	0.65	0.98	0.62

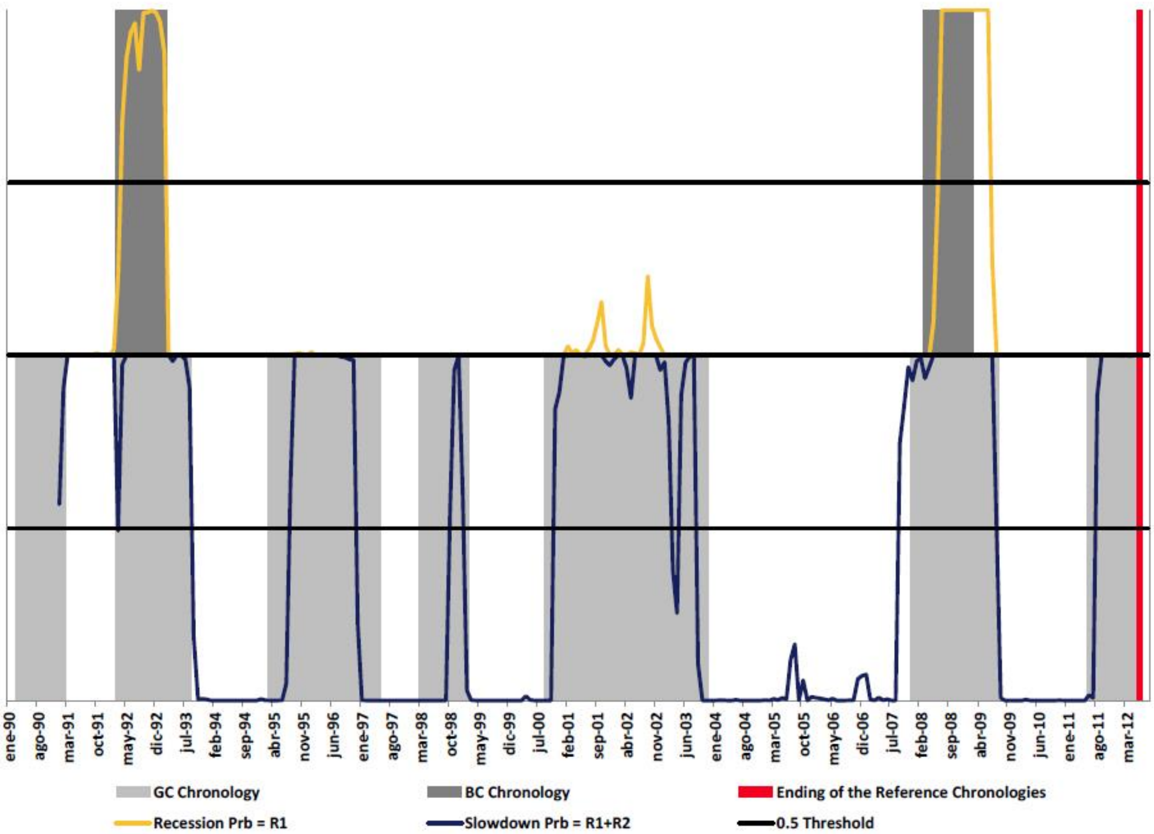
Source: Authors' calculations

Figure 5 shows both coincident indicators, the MS-VAR FR.GCCI in the lower panel and MS-VAR FR.BCCI in the upper panel, and compares them with the reference dating chronologies of the growth and classical cycle, respectively.

As for the two recessions of the classical cycle, they are correctly detected by the MS-VAR FR.BCCI.

In the same way, the MS-VAR FR.GCCI correctly identifies the last six slowdowns of the growth cycle. The slowdown observed between 1990Q1 and 1991Q1 is not located by this coincident indicator as it only covers a later period. A false slowdown is detected in 1991.

Figure 5: Recession and slowdown probabilities of the French classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(6), UR(1), BUIL(3), CONS(1), RETA(12).

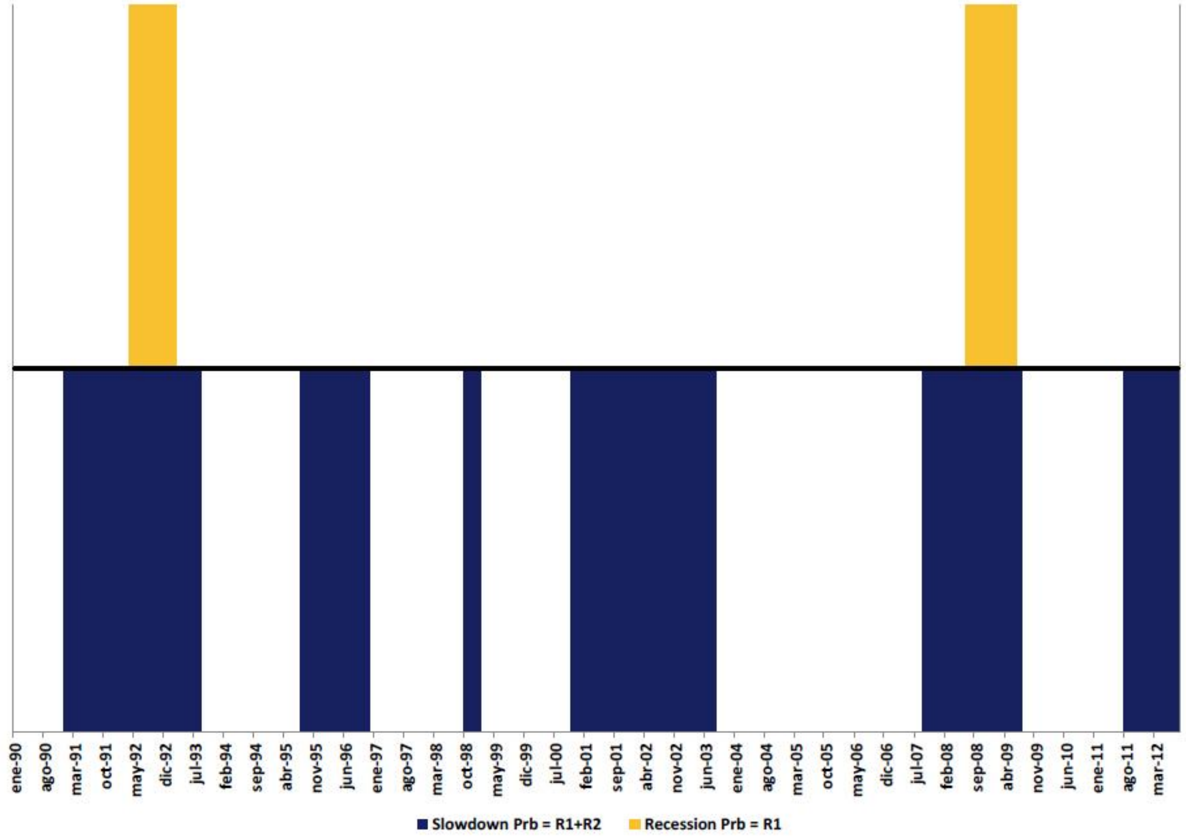


Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

The 0.5 natural decision rule and a 3-month censoring rule are used to transform the probabilistic coincident indicators of the French classical and growth cycles into recession and slowdown signals, respectively. They are shown in Figure 6 below, where it is apparent how the ABCD turning points sequence is correctly detected two times.

Figure 6: Recession and slowdown signals of the French classical and growth cycles, respectively, derived from the proposed coincident indicators



Source: Authors' calculations

The peak and trough dates implied by the recession and slowdown signals are summarised in Table 10, where they are compared to the reference dating chronologies of the classical and growth cycle, respectively.

Table 10: Turning points dating chronologies of the French classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators

Turning Point	Reference Dating Chronology	Model B
Peak A	1990Q1	-
Trough D	1991Q1	-
Peak A	1992Q1	-
Peak B	1992Q1	1992M3 (+1)
Trough C	1993Q1	1993M2 (+0)
Trough D	1993Q3	1993M8 (+0)
Peak A	1995Q1	1995M7 (+5)
Trough D	1997Q2	1996M11 (-6)
Peak A	1998Q1	1998M9 (+7)
Trough D	1999Q1	1999M1 (-1)
Peak A	2000Q3	2000M10 (+2)
Trough D	2003Q4	2003M8 (-3)
Peak A	2007Q4	2007M8 (-3)
Peak B	2008Q1	2008M6 (+4)
Trough C	2009Q1	2009M6 (+4)
Trough D	2009Q3	2009M7 (-1)
Peak A	2011Q2	2011M7 (+2)

Source: Authors' calculations

Finally, the comparison between the proposed pair of coincident indicators and the reference dating chronologies is quantified through the accuracy statistics in Table 11.

The MS-VAR FR.BCCI does not miss any of the two recessions of the classical cycle, nor does it produce false recession signals. The average delay in locating the peaks of the classical cycle is of 2.5 months.

The coincident indicator of the growth cycle is slightly less accurate than the MS-VAR FR.BCCI in detecting the beginning of slowdowns. The MS-VAR FR.GCCI misses one slowdown and returns a false slowdown signal. Nonetheless, these two drawbacks are confined to the period before 1992.

Table 11: Accuracy statistics of the proposed coincident indicators of the French classical and growth cycles

Model	Coincident Indicator from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model B	1991:01	BC	.031	.965	2.5	0	2.0	0	0	0
		GC	.162	.826	3.2	0.6	0	2.2	1	1

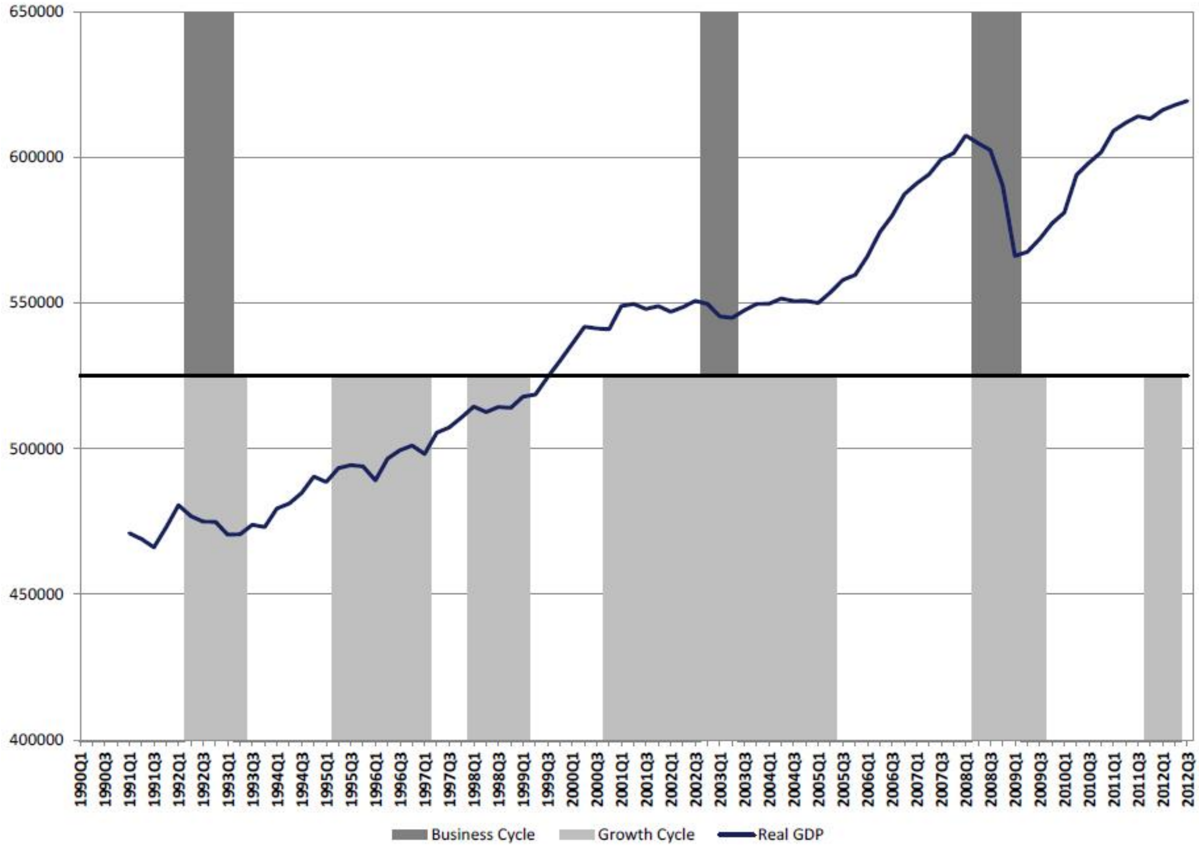
Note: Lag and early statistics are average measures express on a monthly basis.

Source: Authors' calculations

4.3. Germany

Since its reunification, Germany fell into two recessions, the first one between 1992 and 1993, the second one between 2008 and 2009. During the same period, six slowdowns of the growth cycle are observed.

Figure 7: Recessions and slowdowns implied by the German reference dating chronologies of the classical and growth cycles



Source: Authors' calculations

The proposed coincident indicators of the classical and growth cycles are obtained by fitting a MSIH(4)-VAR(0) model to the five variables in Table 12. Recessions of the classical cycle are associated to the first regime of the latent Markov-chain. The first two regimes of the state- variable are together representative of the slowdowns of the growth cycle.

Table 12: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model C
Model	MSIH(4)-VAR(0)
Endogenous Variables	1. IPI(3) 2. UR(3) 3. BUIL(3) 4. CONS(6) 5. RETA(12)
Sample	1991:01 – 2012:08
Recession Regime(s)	R1
Slowdown Regime(s)	R1+R2

Source: Authors' calculations

The association between states of the Markov-chain and economic phases above is suggested and backed by parameter estimates in Table 13. Regime 1 can be straightforwardly related to recessions of the classical cycle as the state-dependent intercept is negative and attains at this regime the lowest value for all the five endogenous variables.

Slowdowns of the growth cycle are likewise described by the second regime; intercept coefficients are negative for this regime, while the remaining states are characterised by positive sign coefficient terms. Regimes 3 and 4 could be related to expansionary phases of either the classical and growth cycles.

Table 13: Parameter estimates of the Model C

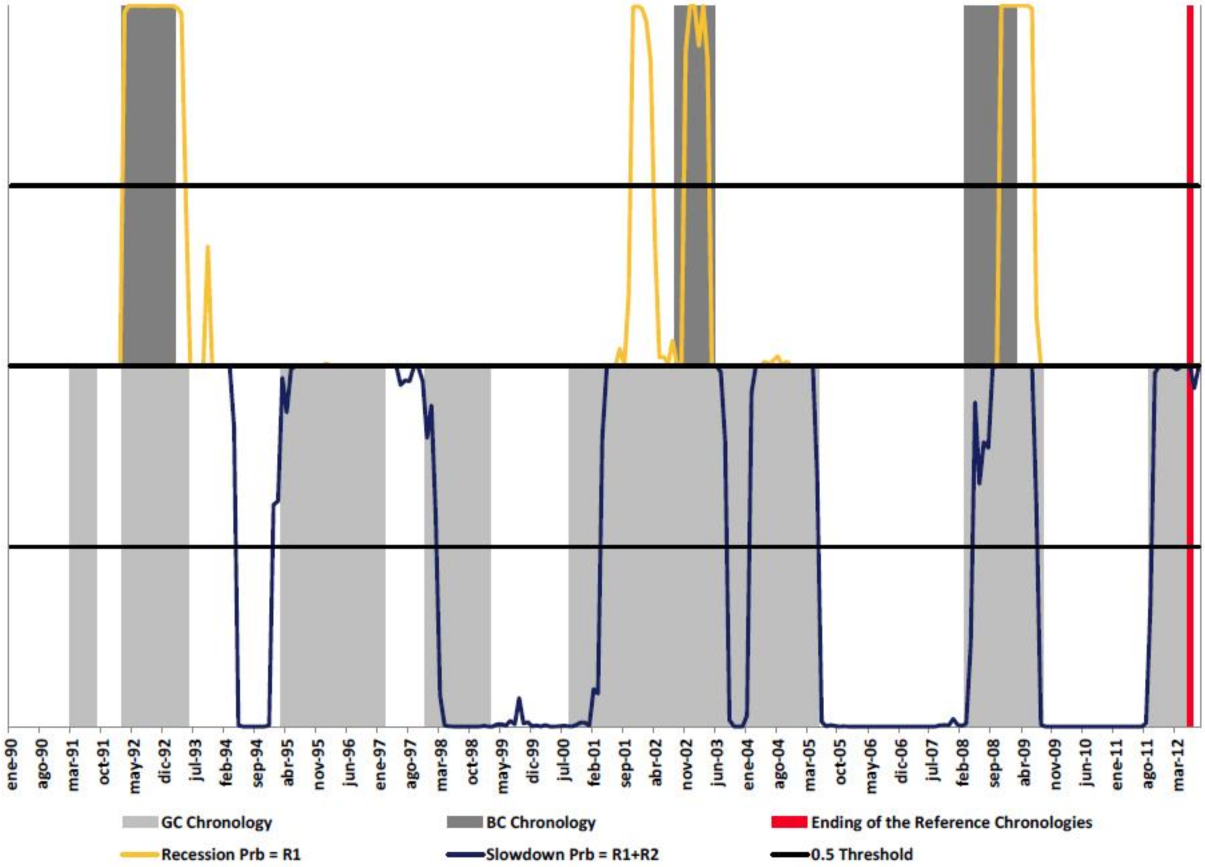
Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(3)	-1.38	-0.11	0.31	0.67	1.69	0.57	0.55	0.60
UR(3)	-1.20	-0.47	0.55	1.26	0.37	0.80	0.43	0.45
BUIL(3)	-0.53	-0.19	0.25	0.52	1.01	0.90	0.78	1.02
CONS(6)	-1.31	-0.22	0.41	1.05	0.78	0.62	0.87	0.78
RETA(12)	-1.25	-0.31	0.13	1.22	0.63	0.74	0.60	0.55

Source: Authors' calculations

The coincident indicator of the classical cycle (MS-VAR DE.BCCI), defined as regime 1's filtered probabilities, is shown in Figure 8. It correctly locates the three recessions in which the German economy has fallen since 1990. However, it detects a recession between 2001 and 2002 that was not identified in the reference dating chronology of the classical cycle.

For what regards the growth cycle, the MS-VAR DE.GCCI correctly detects five out of the six slowdowns observed in the Germany. However, the slowdown of the early '90s lingers far after the trough date in the reference dating chronology: the trough date implied by the MS-VAR DE.GCCI is 1994M4, whereas the benchmark placed it in 1993Q2. The coincident indicator of the growth cycle misses the slowdown caused by the Asian crisis in 1997-1998.

Figure 8: **Recession and slowdown probabilities of the German classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(3), UR(3), BUIL(3), CONS(6), RETA(12)**

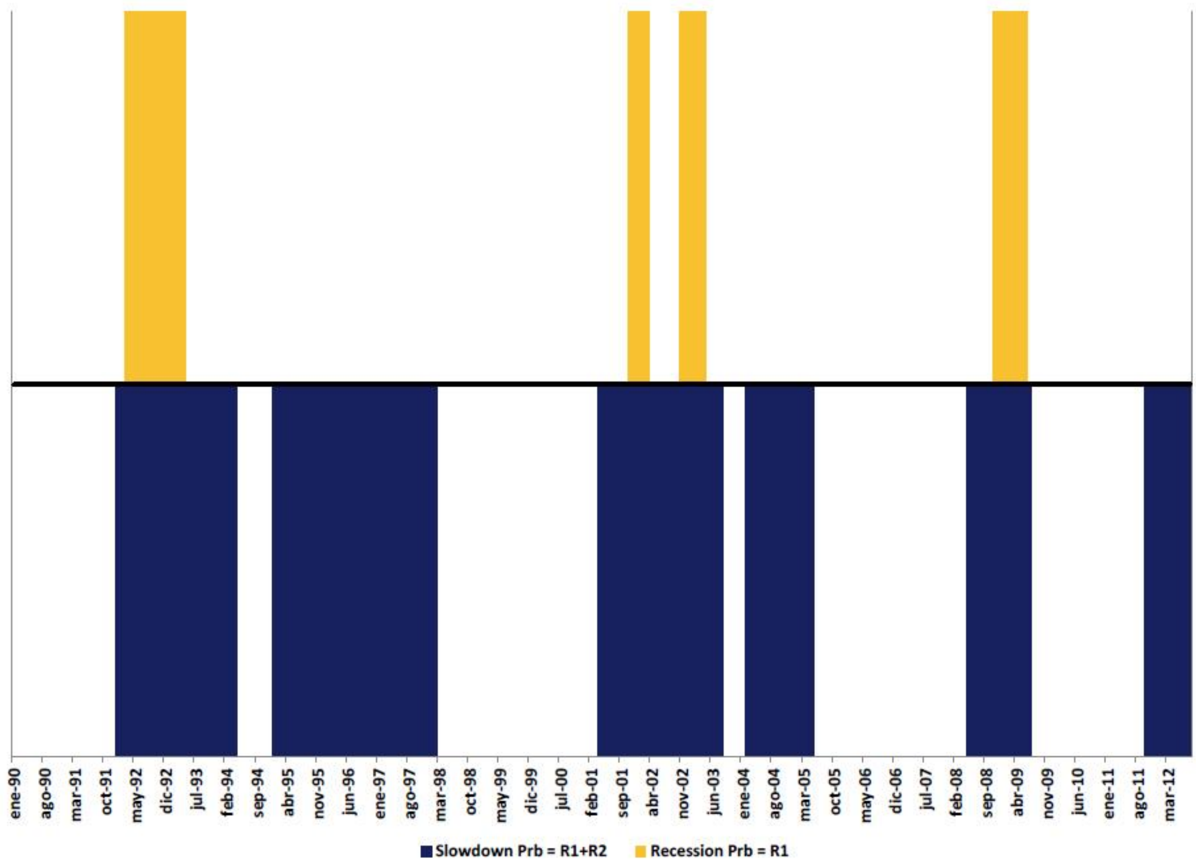


Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

Recession probabilities are mapped into recession signals and slowdown probabilities into slowdown signals by applying the 0.5 natural rule. Recession and slowdown signals in Figure 9 are also required to last at least three consecutive months.

Figure 9: Recession and slowdown signals of the German classical and growth cycles, respectively, derived from the proposed coincident indicators.



Source: Authors' calculations

Peaks and troughs dates of the classical and growth cycles implied by the recession and slowdown signals are reported in Table 14. Turning points of the reference dating chronologies are the benchmark to which they are compared to.

Table 14: Turning points dating chronologies of the German classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators

Turning Point	Reference Dating Chronology	Model C
Peak A	1992Q1	-
Peak B	1992Q1	1992M2 (+0)
Trough C	1993Q1	1993M4 (+2)
Trough D	1993Q2	1994M4 (+11)
Peak A	1995Q1	1994M12 (-2)
Trough D	1997Q1	1998M2 (+12)
Peak A	1997Q4	
Trough D	1999Q1	
Peak A	2000Q3	2001M3 (+7)
Peak B	-	2001M10
Trough C	-	2002M3
Peak B	2002Q3	2002M10 (+2)
Trough C	2003Q2	2003M4 (-1)
Trough D	-	2003M8
Peak A	-	2004M1
Trough D	2005Q2	2005M5 (+0)
Peak A	2008Q1	2008M4 (+2)
Peak B	2008Q1	2008M10 (+8)
Trough C	2009Q1	2009M6 (+4)

Turning Point	Reference Dating Chronology	Model C
Trough D	2009Q3	2009M7 (-1)
Peak A	2011Q3	2011M9 (+1)

Source: Authors' calculations

The accuracy of the MS-VAR DE.BCCI and MS-VAR DE.GCCI in detecting turning points of the classical and growth cycles reference chronologies is measured in Table 15. Peaks of the classical cycle are located with an average delay of 3.4 months. The coincident indicator of the growth cycle is more accurate in detecting peaks of the growth cycle.

Table 15: **Accuracy statistics of the proposed coincident indicators of the German classical and growth cycles**

Model	Coincident Indicator from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model C	1992:01	BC	.090	.911	3.4	0	2.0	0.4	1	0
		GC	.200	.789	2.5	0.5	5.8	0.3	0	1

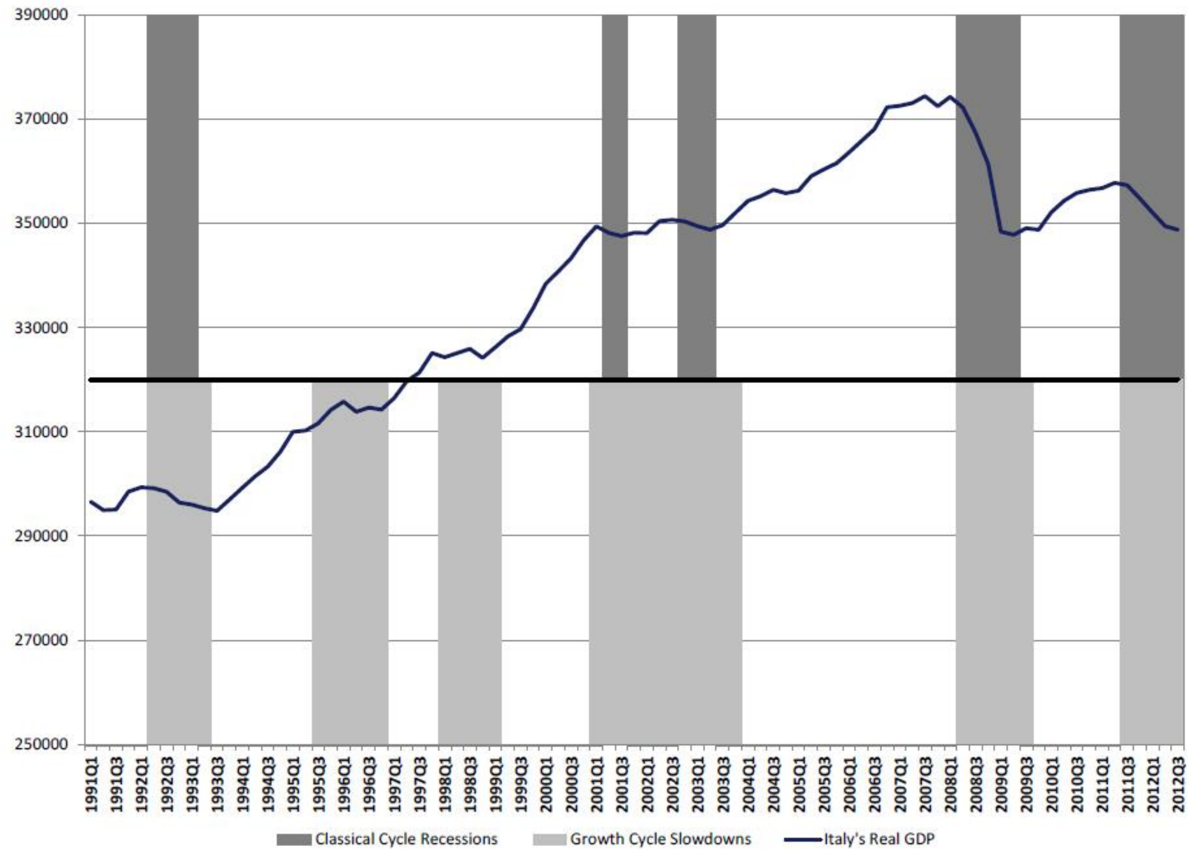
Note: Lag and early statistics are average measures express on a monthly basis.

Source: Authors' calculations

4.4. Italy

Italy suffered five recessions and seven slowdowns between 1990 and mid-2012 (Figure 10). In particular, Italy experienced a double-dip recession between 2000Q4 and 2003Q4. This contraction event is particularly challenging for the coincident indicators to identify as it implies the occurrence of the turning points sequence A-BC-BC-D.

Figure 10: **Recessions and slowdowns implied by the Italian reference dating chronologies of the classical and growth cycles**



Source: Authors' calculations

Table 16 presents the definition of the coincident indicators we construct to identify the classical and growth cycles in Italy. A Markov-Switching model with a 5-regime latent variable is the selected model. Both the intercept term and the variance-covariance matrix are function of the latent Markov-chain. Endogenous variables include IPI and unemployment rate, as well as 3 surveys. Recessions of the classical cycle are made to correspond with the first regime of the state- variable. Slowdowns of the growth cycle are associated to the combination of first and second regimes.

Table 16: **Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases**

	Model B
Model	MSIH(5)-VAR(0)
Endogenous Variables	1. IPI(6) 2. UR(6) 3. BUIL(1) 4. INDU(6) 5. RETA(6)
Sample	1990:01 – 2012:08
Recession Regime(s)	R1
Slowdown Regime(s)	R1+R2

Source: Authors' calculations

Parameter estimates in Table 17 reveal that the sign of regime 1 intercept is negative for all the five endogenous variables; moreover, with the exception of the industrial confidence indicator, the minimum of the intercept term is attained at regime 1. Based on that, regime 1 is straightforwardly interpreted as signifying the recessions of the classical cycle.

Intercept signs are slightly mixed for the remaining four regimes. However, with the exception of the unemployment rate, second regime's intercepts have a negative sign, and positive for the remaining three regimes. Thereby one can reasonably associate slowdowns of the growth cycle to the second regime of the latent Markov-chain.

Table 17: **Parameter estimates of Model B**

Variable	Intercept					Volatility				
	R1	R2	R3	R4	R5	R1	R2	R3	R4	R5
IPI (3)	-1.01	-0.21	0.32	0.36	0.71	1.47	0.59	0.66	0.59	0.58
UR (3)	-1.06	0.20	0.22	0.37	-0.10	1.05	0.67	0.72	0.92	1.03
INDU (12)	-0.49	-0.92	-0.10	0.72	1.59	0.69	0.74	0.41	0.36	0.90
CONS (12)	-1.02	-0.37	-0.02	0.52	1.34	0.60	0.55	0.54	0.70	1.35
RETA (3)	-0.35	-0.14	0.14	0.03	0.53	0.64	1.50	0.41	0.63	1.61

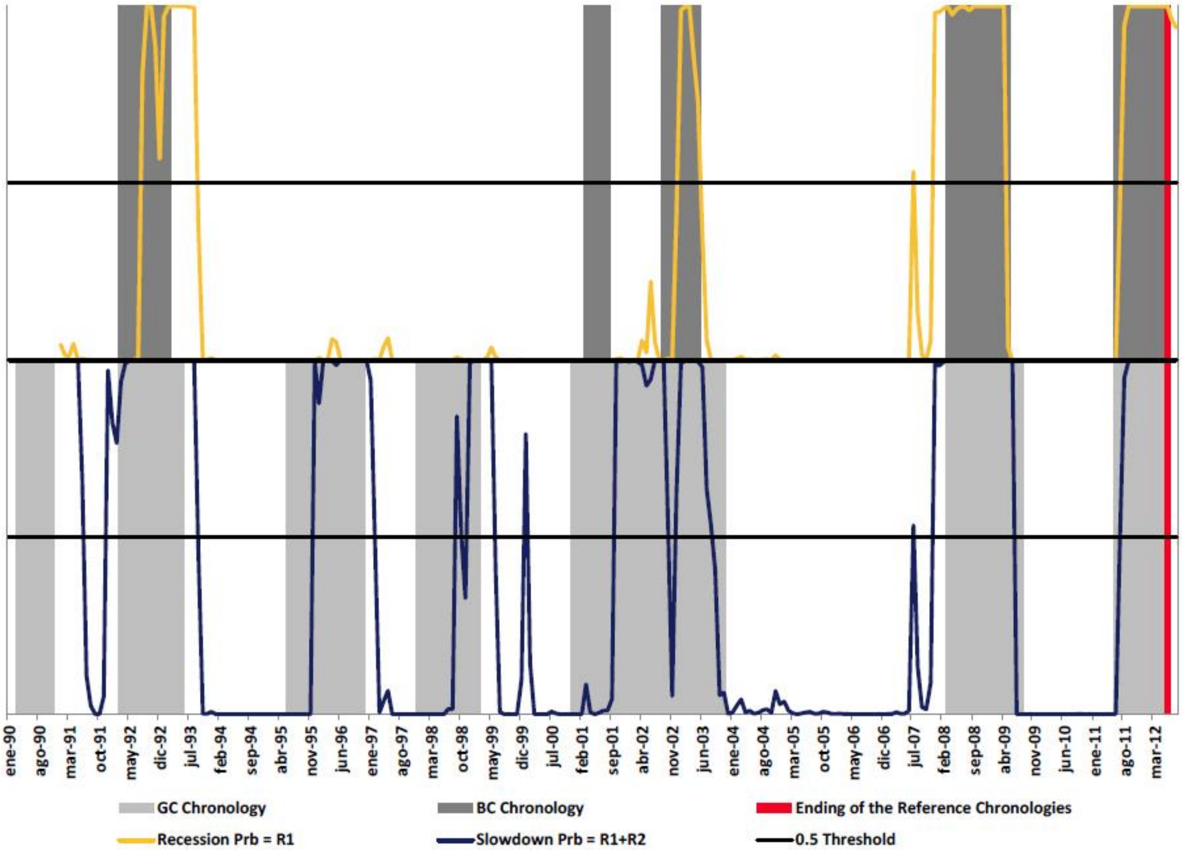
Source: Authors' calculations

The recession and slowdown probabilities of the coincident indicator of the classical and growth cycles are illustrated in Figure 11, where they are compared with the respective dating chronologies.

The coincident indicator of the classical cycle (MS-VAR IT.BCCI) correctly locates 4 out of the 5 recessions in which the Italian economy has fallen from 1990 to mid-2012. It misses the first contraction of the double-dip recession of the early 2000s. This could be due to the fact that this recession was short, it latest just 2 quarters, and by far less severe than the other contractions.

All the 7 slowdowns of the growth cycle are correctly detected by the adjoint coincident indicator of the growth cycle (MS-VAR IT.GCCI).

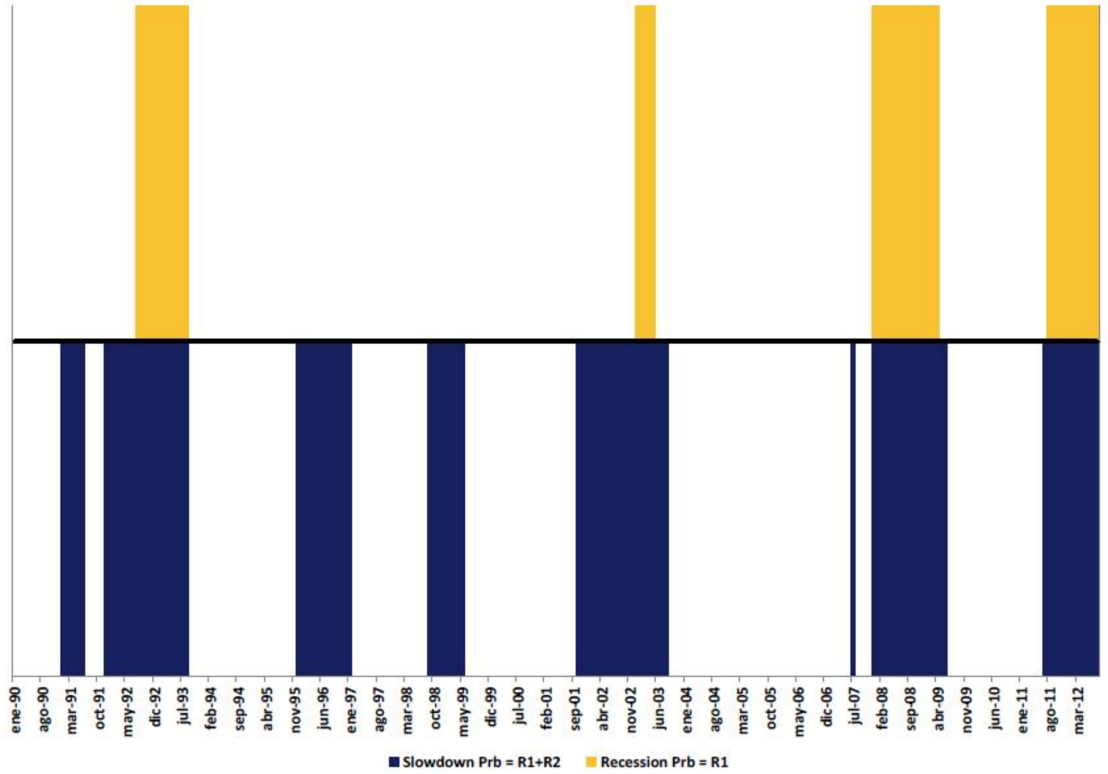
Figure 11: **Recession and slowdown probabilities of the Italian classical and growth cycles, respectively, estimated by fitting a MSIH(5)-VAR(0) model to IPI(3), UR(3), INDU(12), CONS(12), RETA(3).**



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.
Source: Authors' calculations

Binary recession and slowdown signals are derived from the pair of probabilistic coincident indicators above by applying the natural 0.5 rule. Signals that not lasted at three months were discarded by applying a simple censoring rule. The resulting censored signals are shown in Figure 12.

Figure 12: Recession and slowdown signals of the Italian classical and growth cycles, respectively, derived from the proposed coincident indicators.



Source: Authors' calculations

Peak and trough dates implied by the recession and slowdown signals are summarized in Table 18, where they are compared to the turning points dates of the reference dating chronologies.

Table 18: Turning points dating chronologies of the Belgian classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators.

Turning Point	Reference Dating Chronology	Model B
Peak A	1990Q1	-
Trough D	1990Q4	1991M6 (+7)
Peak A	1992Q1	1991M11 (-3)
Peak B	1992Q1	1992M7 (+5)
Trough C	1993Q1	1993M8 (+6)
Trough D	1993Q2	1993M8 (+3)
Peak A	1995Q2	1995M11 (+6)
Trough D	1996Q4	1997M1 (+2)
Peak A	1997Q4	1998M8 (+9)
Trough D	1999Q1	1999M5 (+3)
Peak A	2000Q4	2001M9 (+10)
Peak B	2001Q1	-
Trough C	2001Q3	-
Peak B	2002Q3	2002M12 (+4)
Trough C	2003Q2	2003M5 (+0)
Trough D	2003Q4	2003M8 (-3)
Peak A	2008Q1	2007M11 (-2)
Peak B	2008Q1	2007M11 (-2)
Trough C	2009Q2	2009M4 (-1)
Trough D	2009Q3	2009M6 (-2)
Peak A	2011Q2	2011M6 (+1)
Peak B	2011Q2	2011M7 (+2)

Source: Authors' calculations

The coincident indicators' accuracy in locating the phases of the classical and growth cycles is measured in Table 19.

Table 19: Accuracy statistics of the proposed coincident indicators of the Italian classical and growth cycles

Model	Coincident Indicator from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model B	1991:01	BC	.102	.891	2.8	0.5	2.0	0.3	0	1
		GC	.203	.787	4.3	0.8	2.5	0.8	0	0

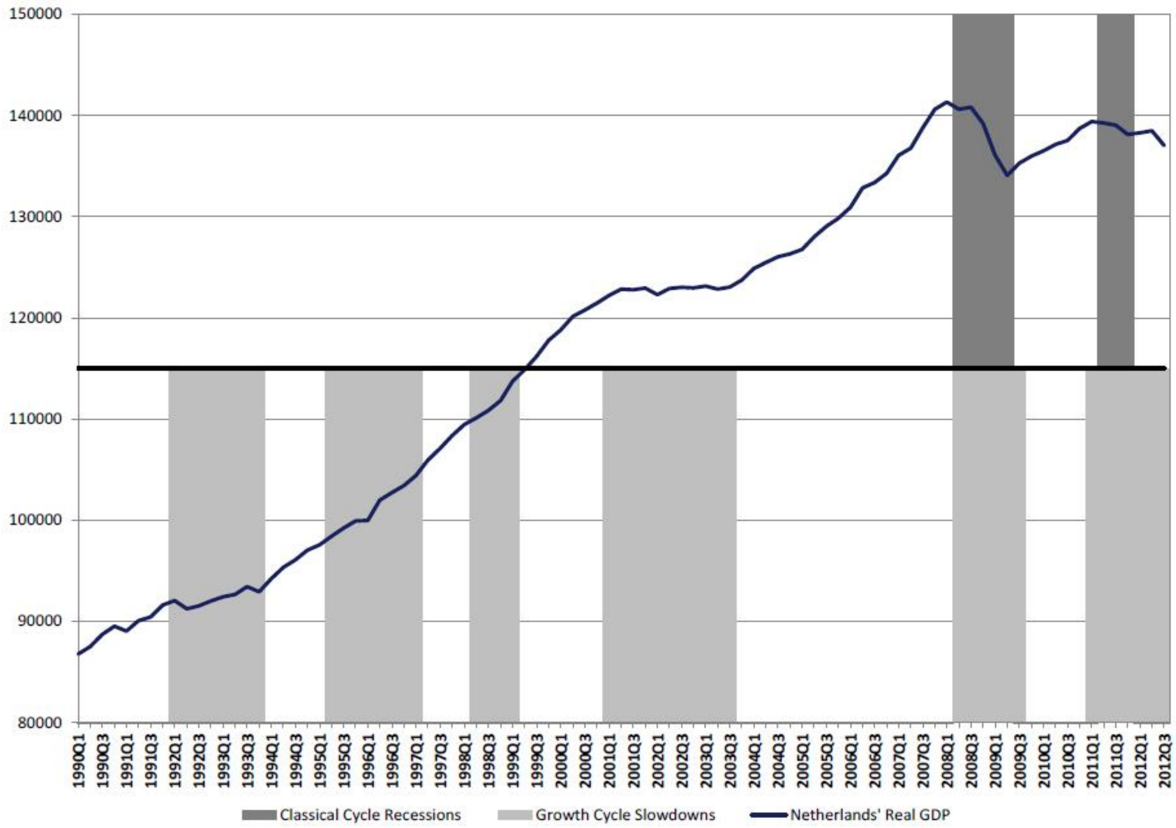
Note: Lag and early statistics are average measures express on a monthly basis.
Source: Authors' calculations

4.5. The Netherlands

Contrary to the other Member Countries we analysed in this paper, the Netherlands' economy was almost completely spared by the recession that hit the Euro area in the early 1990s. On the other hand, similarly to the majority of the other Member Countries, the Netherlands fell in a severe recession in 2008-2009 and in a shorter and less sharp contraction in 2011.

In the period between 1990 and mid-2012, six slowdowns of the growth cycle are observed in the Netherlands', the last two of which resulted in as many recessions.

Figure 13: Recessions and slowdowns implied by the Dutch reference dating chronologies of the classical and growth cycles.



Source: Authors' calculations

Probabilistic coincident indicators of the Netherlands' classical and growth cycles are obtained by fitting a MSIH(4)-VAR(0) model to the five variables showed in Table 20. Only one of the five endogenous variables is related to the real economy, namely the IPI. Recessions of the classical cycle are associated to the first regime of the latent Markov-chain. The first and second regimes together identify slowdowns of the growth cycle.

Table 20: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A
Model	MSIH(4)-VAR(0)
Endogenous Variables	1. IPI (12) 2. BUIL (6) 3. INDU(3) 4. CONS (1) 5. RETA (1)
Sample	1990:01 – 2012:08
Recession Regime(s)	R1
Slowdown Regime(s)	R1+R2

Source: Authors' calculations

Table 21, where parameter estimates are reported, shows that the interpretation above is backed by the sign of state-dependent intercept. Regime 1 is the state at which the intercept term assumes its lowest (negative) values for all the five equations, which is consistent with a recession of the classical cycle. Regime 2's intercept coefficients are negative for all the five variables, although not as negative as the ones corresponding to the first regime. Positive intercept terms are estimated for the other two regimes. Thereby, regime 2 could though of describing periods of downturn.

Table 21: Parameter estimates of Model A

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(12)	-1.52	-0.37	0.30	0.92	1.37	0.68	0.76	0.84
BUIL(6)	-1.21	-0.64	0.49	0.74	1.95	0.64	0.49	0.50
INDU(3)	-0.79	-0.32	0.09	1.35	2.37	0.65	0.53	0.34
CONS(1)	-0.17	-0.14	0.09	0.38	1.32	1.02	0.92	0.89
RETA(1)	-0.25	-0.17	0.12	0.17	1.38	0.94	0.77	1.53

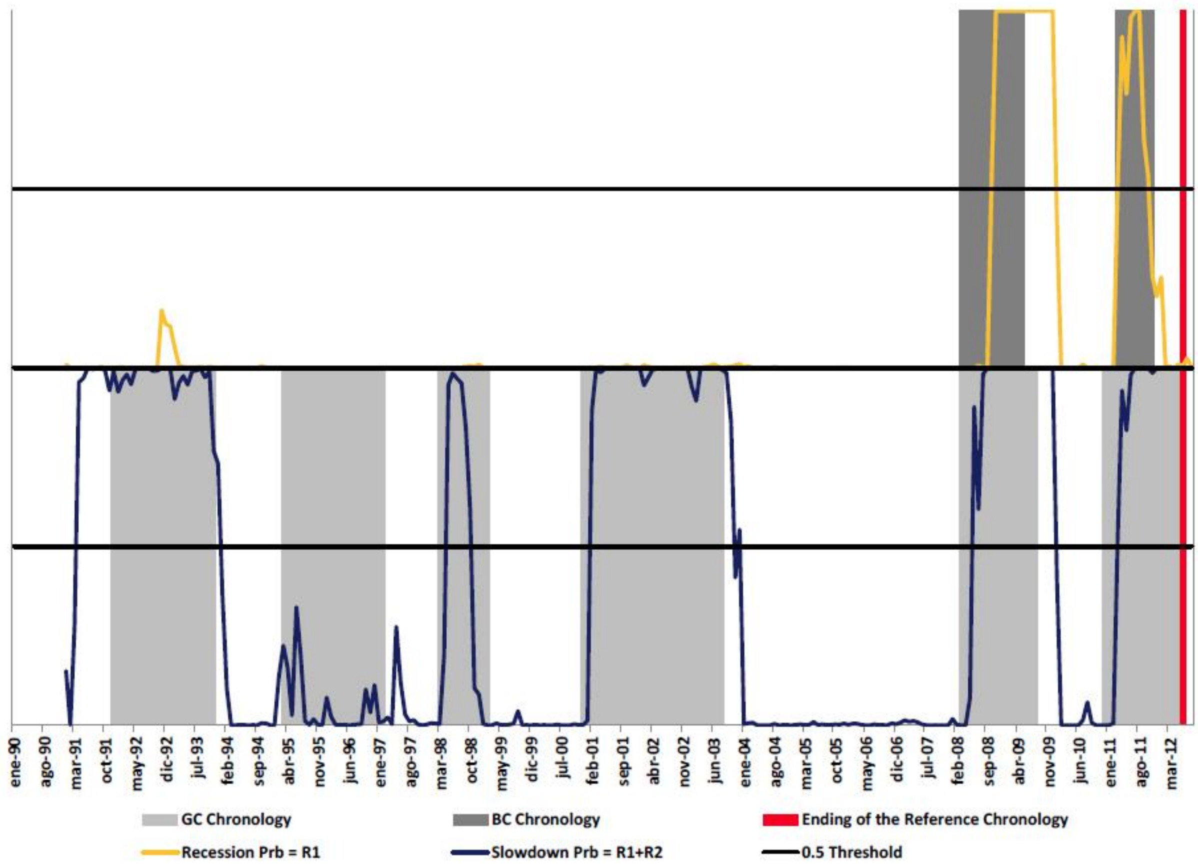
Source: Authors' calculations

Coincident indicators of the classical and growth cycle so constructed are illustrated in Figure 14, where they are compared to the respective dating chronology.

The two recessions of the classical cycle are correctly located by the MS-VAR NL.BCCI. Five out of the six slowdowns of the Netherlands' growth cycle are identified by the MS-VAR NL.GCCI. The slowdown between 1995 and 1997 is utterly missed by the coincident indicator of the growth cycle, though it was only a minor deceleration of the economy.

Neither false recession nor false slowdown signals are returned by the proposed pair of coincident indicators.

Figure 14: **Recession and slowdown probabilities of the Dutch classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(12), BUIL(6), INDU(3), CONS(1), RETA(1)**

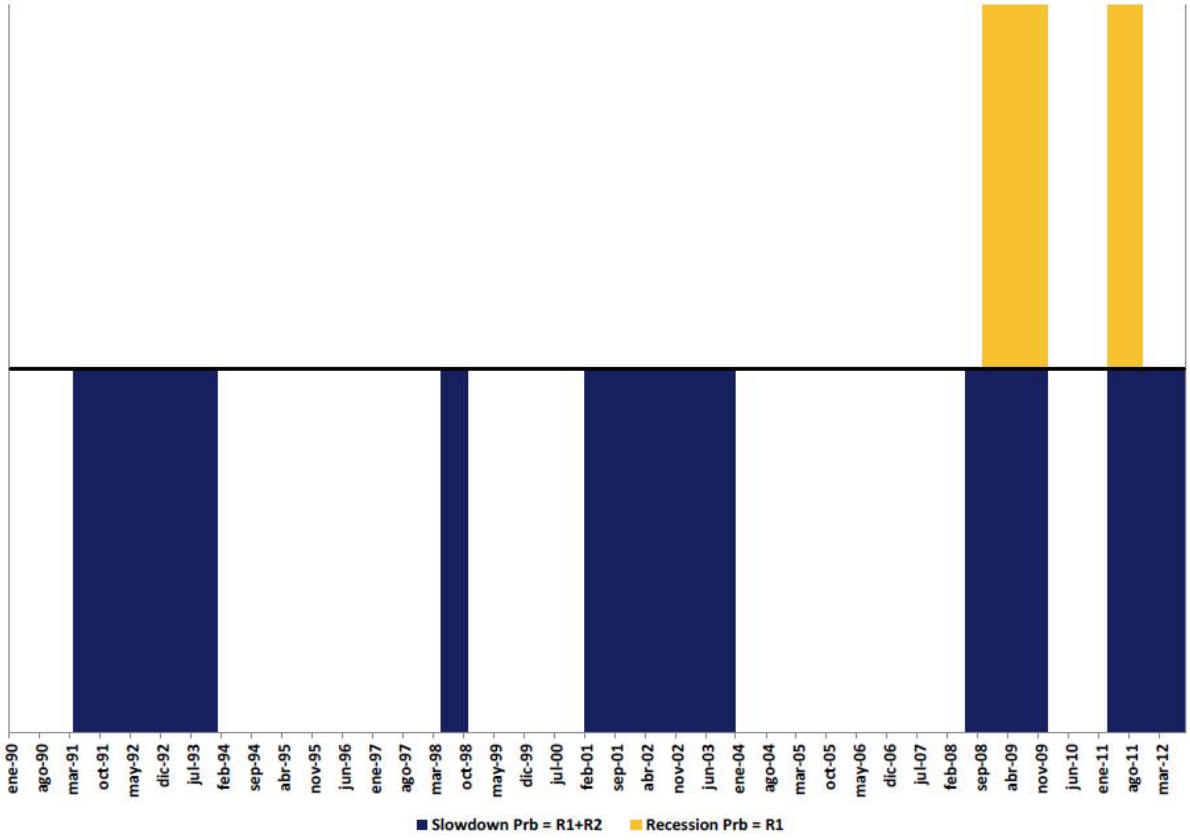


Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

Recession and slowdown signals are derived from the coincident indicators by applying the 0.5 natural decision rule. The signals so obtained are further required to satisfy a 3-month censoring rule. They are shown in Figure 15.

Figure 15: Recession and slowdown signals of the Dutch classical and growth cycles, respectively, derived from the proposed coincident indicators



Source: Authors' calculations

Turning points dates implied by the recession and slowdown signals are summarised in Table 22, where they are compared to the peaks and troughs dates of the respective reference dating chronologies.

Table 22: Turning points dating chronologies of the Dutch classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators

Turning Point	Reference Dating Chronology	Model A
Peak A	1991Q4	1991M3 (-8)
Peak B	-	-
Trough C	-	-
Trough D	1993Q4	1993M12 (+1)
Peak A	1995Q1	-
Trough D	1997Q1	-
Peak A	1998Q1	1998M4 (+2)
Trough D	1999Q1	1998M10 (-3)
Peak A	2000Q4	2001M1 (+2)
Trough D	2003Q3	2003M12 (+4)
Peak A	2008Q1	2008M5 (+3)
Peak B	2008Q1	2008M9 (+7)
Trough C	2009Q2	2009M12 (+7)
Trough D	2009Q3	2009M12 (+4)
Peak A	2010Q4	2011M2 (+3)
Peak B	2011Q1	2011M2 (+0)
Trough C	2011Q4	2011M10 (+1)
Trough D	-	-

Source: Authors' calculations

Coincident indicators' accuracy with respect to the benchmark chronologies is measured via the QPS and CI statistics reported in Table 23.

Table 23: Accuracy statistics of the proposed coincident indicators of the Dutch classical and growth cycles

Coincident Indicator	Coincdent	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1991:01	BC	.061	.942	3.5	0	4.0	0	0	0
		GC	.195	.791	2.0	1.6	2.3	0.8	0	1

Source: Authors' calculations

The coincident indicator of the growth cycle is more accurate in locating the peaks of the reference chronology than the MS-VAR NL.BCCI. However, the former misses one slowdowns of the growth cycle, whereas the latter correctly locates the two recessions of the classical cycle.

4.6. Portugal

As previously noted, business cycle reference chronologies were not consistently available for the case of Portugal. Thereby we considered the classical and growth cycle dating chronologies based on the industrial production as proxies for the business cycles.

Table 24 presents the definition of the coincident indicators we propose to locate the fluctuations of the Portuguese classical and growth cycles. A five-regime Markov-Switching model is fitted to five variables, one related to the real economy and the remaining four business surveys. Recessions of the classical cycles are assumed to be described by the first and second regimes of the latent state-variable. Slowdowns of the growth cycles are identified by the third regime.

Table 24: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model B
Model	MSI(5)-VAR(0)
Endogenous Variables	1. IPI(6) 2. BUIL(3) 3. INDU(3) 4. CONS(12) 5. RETA(1)
Sample	1990:01 – 2012:08
Recession Regime(s)	R1+R2
Slowdown Regime(s)	R1+R2+R3

Source: Authors' calculations

Parameter estimates in Table 25 reveal that the association provided above between regimes and economic cycles can be justified by the signs of the state-dependent intercept. All the five endogenous variables present a negative intercept in the first two regimes; the natural interpretation is of these regimes as recessions of the classical cycle. Three out of the five equations have a negative, though close to zero, intercept at the third regime. Despite some mixed signals, the remaining two regimes mostly present positive intercepts. The contrast between the third and the last two regimes suggests that the slowdown of the growth cycle can be associated to the former one, whereas expansions of either cycle are related to the latter ones.

Table 25: Parameter estimates of the Model B

Variable	Intercept					Volatility
	R1	R2	R3	R4	R5	
IPI(6)	-2.30	-0.53	0.02	0.41	-0.02	0.86
BUIL(3)	-0.43	-0.58	0.15	0.19	0.59	0.92
INDU(3)	-3.57	-0.44	-0.09	0.30	1.41	0.73
CONS(12)	-0.98	-1.22	-0.05	1.21	-0.08	0.52
RETA(1)	-1.03	-0.22	-0.02	0.08	0.52	0.98

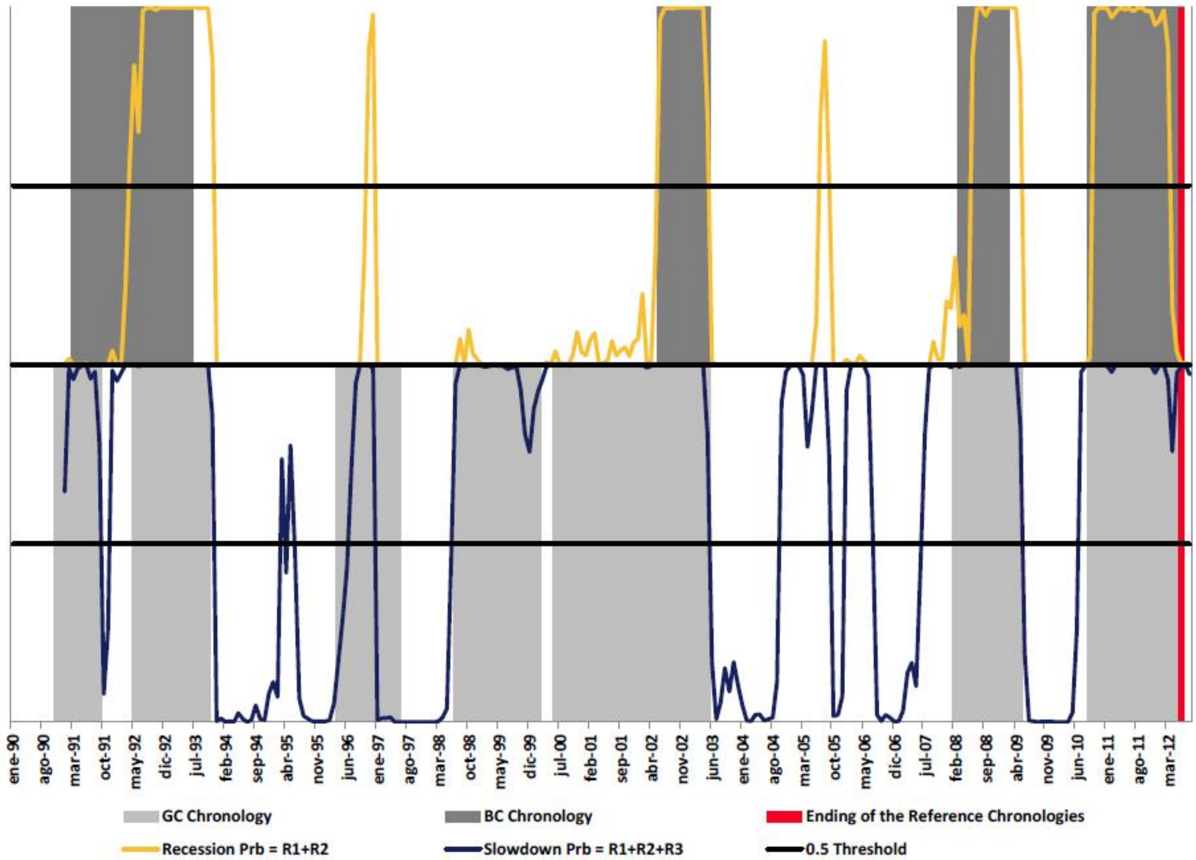
Source: Authors' calculations

The coincident indicator of the classical cycle (MS-VAR PT.BCCI) is drawn in the upper panel of Figure 16. The lower panel shows the slowdown probabilities of the growth cycle (MS-VAR PT.GCCI) estimated from the selected model. The areas in the background represent recessions and slowdowns of the two cycles according to the reference dating chronologies.

All the four recessions in which the Portuguese economy has fallen since 1990 are clearly identified by the MS-VAR PT.BCCI. Two short-lived false recession signals are produced by this coincident indicator.

Slowdown probabilities of the MS-VAR PT.GCCI rise close to one in concurrence with all the six slowdowns present in the reference dating chronology of the growth cycle. In addition to that, three false slowdown signals are produced by this coincident indicator.

Figure 16: Recession and slowdown probabilities of the Portuguese classical and growth cycles, respectively, estimated by fitting a MSI(5)-VAR(0) model fitted to IPI(6), BUIL(3), INDU(3), CONS(12), RETA(1)

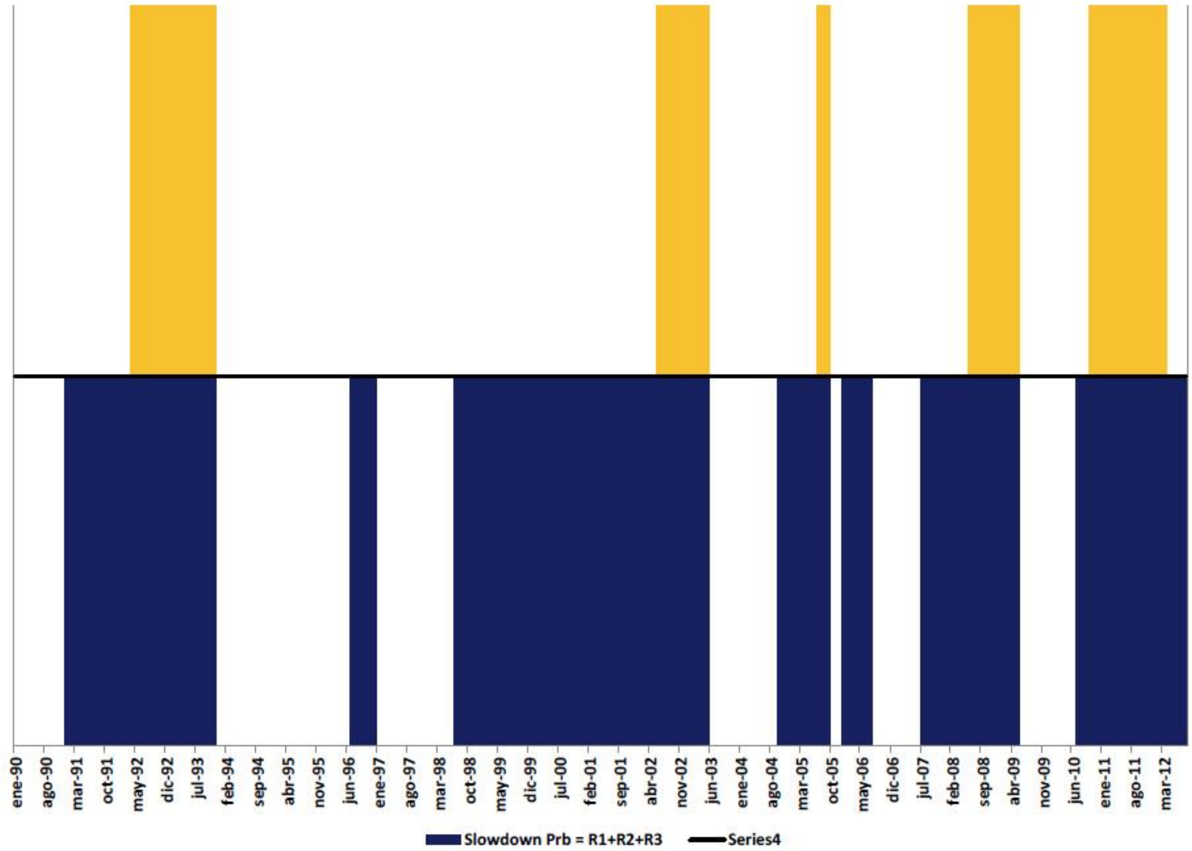


Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

Recession and slowdown probabilities are transformed into binary signals of a recession or slowdown occurring, respectively. First, the natural 0.5 rule is applied and then phases shorter than 3 months are ruled out by imposing a simple censoring rule. These signals are shown in Figure 17.

Figure 17: Recession and slowdown signals of the Portuguese classical and growth cycles, respectively, derived from the proposed coincident indicators



Source: Authors' calculations

Turning points of the reference dating chronologies and implied by the two coincident indicators proposed here are compared in Table 26.

Table 26: Turning points dating chronologies of the Portuguese classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators

Turning Point	Reference Dating Chronology	Model B
Peak A	1990M10	-
Peak B	1991M2	1992M3 (+13)
Trough C	1993M6	1993M11 (+5)
Trough D	1993M10	1993M11 (+1)
Peak A	1996M3	1996M6 (+3)
Trough D	1997M6	1996M12 (-6)
Peak A	1998M6	1998M6 (+0)
Trough D	2000M2	-
Peak A	2000M5	-
Peak B	2002M5	2002M5 (+0)
Trough C	2003M5	2003M5 (+0)
Trough D	2003M5	2003M5 (+0)
Peak A	-	2004M9
Peak B	-	2005M6
Trough C	-	2005M9
Trough D	-	2005M9
Peak A	-	2005M12
Trough D	-	2006M7
Peak A	2008M1	2007M6 (-7)
Peak B	2008M2	2008M5 (+3)

Turning Point	Reference Dating Chronology	Model B
Trough C	2009M2	2009M5 (+3)
Trough D	2009M5	2009M5 (+0)
Peak A	-	-
Trough D	-	-
Peak A	2010M8	2010M6 (-2)
Peak B	2010M8	2010M9 (+1)
Trough C	-	2012M3

Source: Authors' calculations

Finally, the accuracy of both MS-VAR PT.BCCI AND MS-VAR PT.GCCI in detecting recessions and slowdowns of the classical and growth cycles is computed in Table 27.

Table 27: **Accuracy statistics of the proposed coincident indicators of the Portuguese classical and growth cycles**

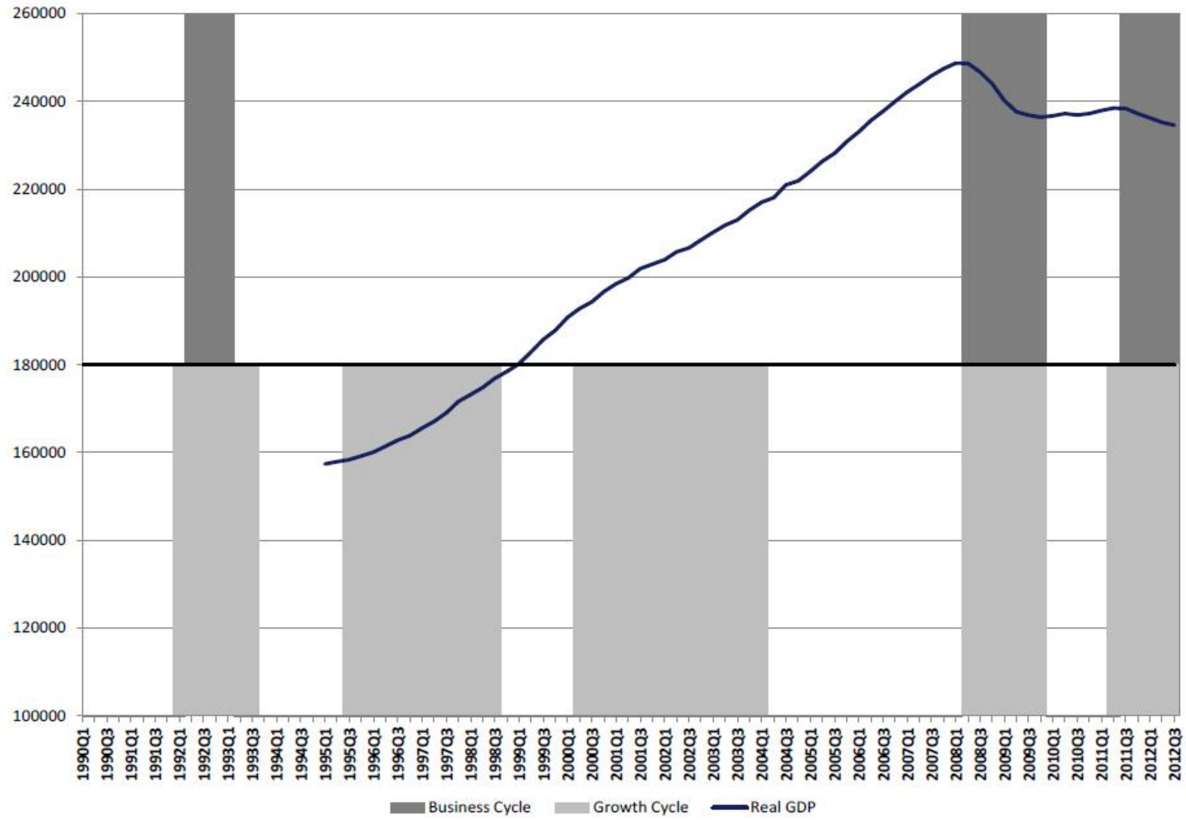
Coincident Indicator	Available from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model B	1991:01	BC	.117	.872	4.3	0	2.7	0	1	0
		GC	.170	.814	0.6	1.8	0.3	1.5	3	0

Source: Authors' calculations

4.7. Spain

The Spanish economy fell into three recessions between 1990 and mid-2012. Over the same period, it experienced five slowdowns of the growth cycle. Despite the 2008-2009 financial crisis and the ongoing sovereign debt crisis caused two complete recession sequences ABCD, the recovery since the end of the last complete recession was so sluggish that these fluctuations could be almost described by the turning points sequence A-BC-BC-D.

Figure 18: **Recessions and slowdowns implied by the Spanish reference dating chronologies of the classical and growth cycles**



Source: Authors' calculations

The most accurate coincident indicators we came up with to locate these economic fluctuations are built as described in Table 28. A coincident indicator of the classical cycle (MS-VAR ES.BCCI) and one of the growth cycle (MS-VAR ES.GCCI) are obtained by fitting a 4-regime Markov- Switching model that allows for state-dependent intercept and heteroskedasticity to the five variables listed in Table 28. IPI and unemployment rate are the two variables belonging to the real economy; the remaining three variables are business surveys.

As for the interpretation of the states of the latent Markov-chain in terms economic cycles, regime 1 is assumed to coincide with recessions of the classical cycle; regimes 1 and 2 are together associated to the slowdowns of the growth cycle.

Table 28: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model D
Model	MSIH(4)-VAR(0)
Endogenous Variables	1. IPI (12) 2. UR (12) 3. BUIL (3) 4. INDU (6) 5. CONS (12)
Sample	1990:01 – 2012:08
Recession Regime(s)	R1
Slowdown Regime(s)	R1+R2

Source: Authors' calculations

Parameter estimates in Table 29 mostly supports the interpretation above. For four out of the five variables in the model, the lowest value of the state dependent intercept is at the first regime. This suggests the first regime describes recessions of the classical cycle. Moreover, regime 2's intercept term is negative, though not as much as regime 1's, for all the variables except the unemployment rate, which is the most difficult variable to explain. All the other variables have a consistent positive sign in third and fourth regimes. It follows that the second regime could be related to the slowdowns of the growth cycle.

Table 29: Parameter estimates of Model D

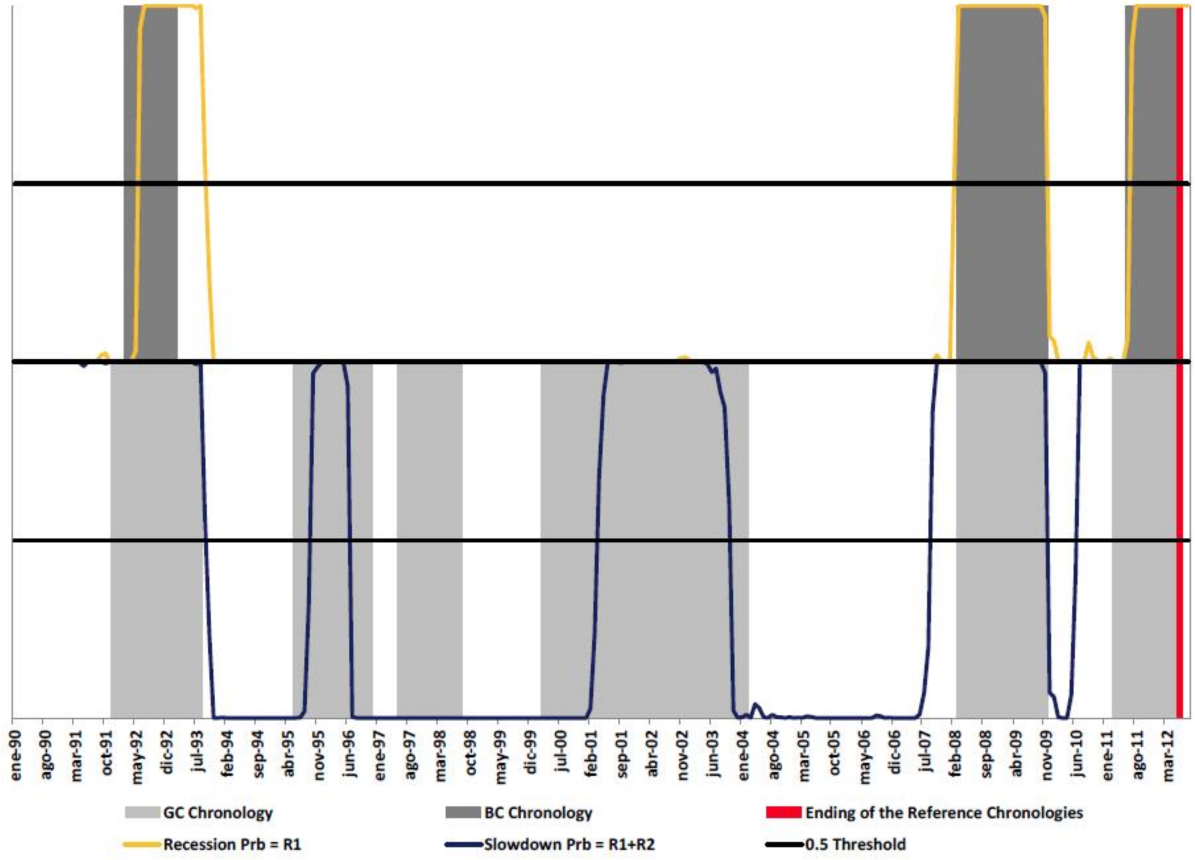
Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(12)	-1.47	-0.06	0.51	0.95	1.08	0.34	0.43	0.75
UR(12)	-1.52	0.05	0.76	-0.35	0.84	0.42	0.33	0.84
BUIL(3)	-0.09	-0.31	0.17	0.44	0.72	0.89	1.07	1.16
INDU(6)	-0.79	-0.18	0.16	1.58	1.14	0.76	0.55	0.46
CONS(12)	-0.84	-0.25	0.21	1.44	1.44	0.54	0.30	0.78

Source: Authors' calculations

The two coincident indicators of the classical and growth cycle that are obtained from the model above are drawn in Figure 19. Graphical inspection reveals that the coincident indicator of the classical cycle (MS-VAR ES.BCCI) locates with a remarkable accuracy the last two recessions. It suffers some delay in detecting the recession between 1992 and 1993.

Five out of the six slowdowns of the growth cycle are correctly located by the coincident indicator of the growth cycle (MS-VAR ES.GCCI). The slowdown caused by the Asian crisis in 1997-1998 is missed by this coincident indicator. Also for the case of Spain, this seems to be only a minor drawback as this slowdown represented a negligible deceleration in the path of economic growth.

Figure 19: Recession and slowdown probabilities of the Spanish classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(12), UR(12), BUIL(3), INDU(6), CONS(12)

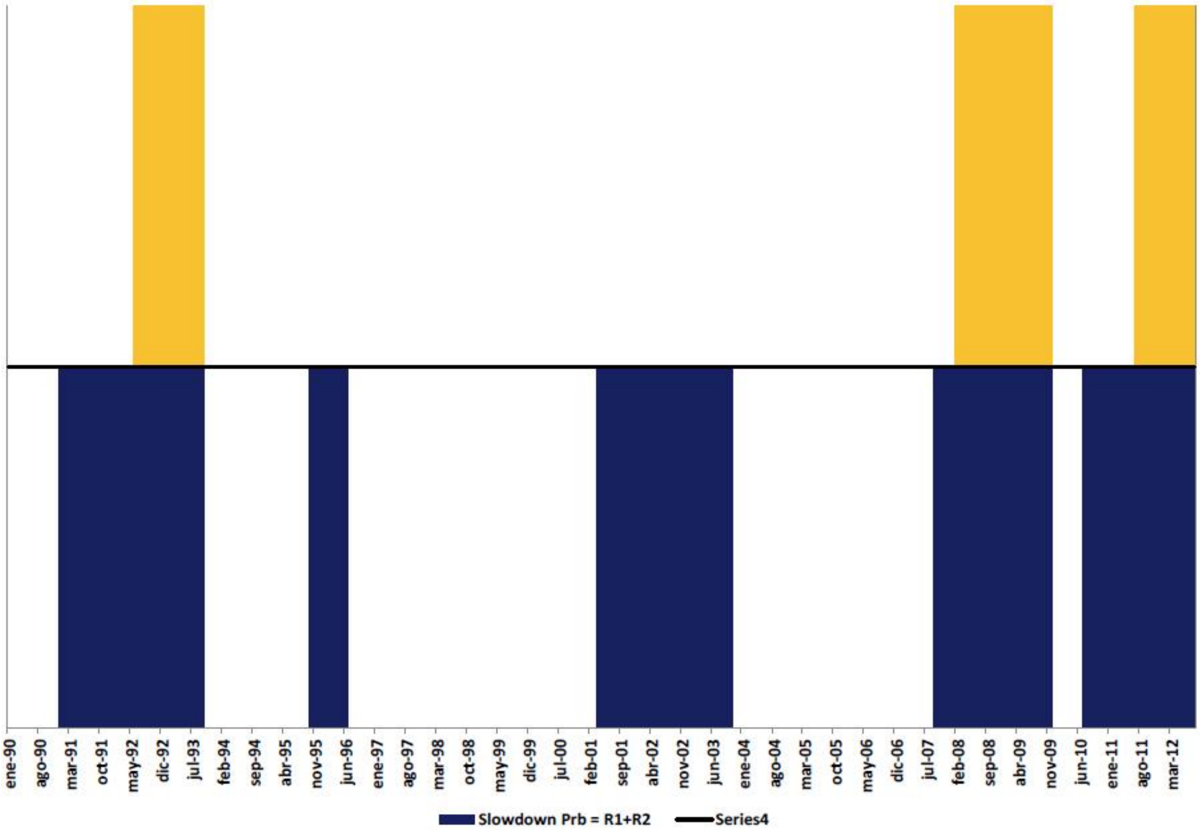


Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

The 0.5 natural decision rule is used to map the probabilistic coincident indicators to recession and slowdown signals. Additionally, the signals so obtained are forced to satisfy a 3-month censoring rule. The final signals are shown in Figure 20.

Figure 20: Recession and slowdown signals of the Spanish classical and growth cycles, respectively, derived from the proposed coincident indicators



Source: Authors' calculations

Turning points of the classical and growth cycles implied by the recession and slowdown signals are summarised in Table 30, where they are compared to the peak and trough dates of the reference dating chronologies.

Table 30: Turning points dating chronologies of the Spanish classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators

Turning Point	Reference Dating Chronology	Model D
Peak A	1991Q4	-
Peak B	1992Q1	1992M5 (+3)
Trough	1993Q1	1993M9 (+7)
Trough D	1993Q3	1993M9 (+1)
Peak A	1995Q2	1995M9 (+4)
Trough D	1996Q4	1996M6 (-5)
Peak A	1997Q2	-
Trough D	1998Q3	-
Peak A	2000Q1	2001M3 (+13)
Peak B	-	-
Trough C	-	-
Trough D	2004Q1	2003M10 (-4)
Peak A	2008Q1	2007M8 (-6)
Peak B	2008Q1	2008M1 (-1)
Trough C	2009Q4	2009M11 (+0)
Trough D	2009Q4	2009M11 (+0)
Peak A	2011Q1	2010M6 (-8)
Peak B	2011Q2	2011M6 (+1)

Source: Authors' calculations

Accuracy statistics are computed in Table 31. These statistics confirm the insight we got from Figure 19, that is, that MS-VAR ES.BCCI is on average only 1.3 months delayed in detecting the peaks of the classical cycle.

Table 31: Accuracy statistics of the proposed coincident indicators of the Spanish classical and growth cycles

Coincident Indicator	Available from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model D	1991:01	BC	.041	.953	1.3	0.3	3.5	0	0	0
		GC	.254	.740	4.3	3.5	0.3	2.3	0	1

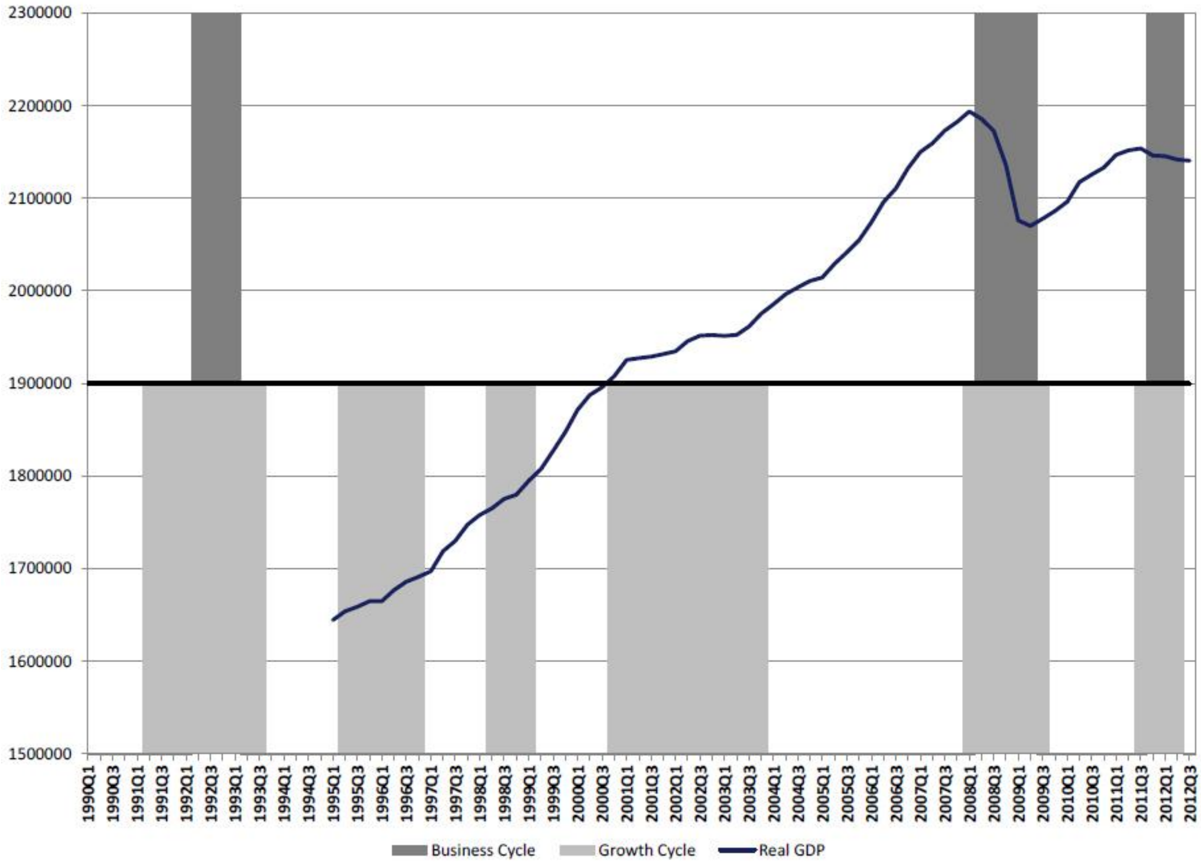
Source: Authors' calculations

4.8. Indirect Coincident Indicators of the Euro area's classical and growth cycles

As of 2012Q3, the combined real GDP of the seven Member Countries considered in this study accounts for 89% of the Euro area 17's GDP. Given the high representativeness of these countries, we pursue also the indirect construction of coincident indicators of the Euro area's classical and growth cycles as weighted average of the corresponding Member Countries' coincident indicators.

According to the reference dating chronology of the classical cycle, Euro area suffered three recessions between 1990 and mid-2012. Consistently with the ABCD approach, each recession of the classical cycle was comprised in a slowdown of the growth cycle. In addition, the reference dating chronology of the growth cycle includes three other slowdowns that did not turn into full- fledged recessions.

Figure 21: Recessions and slowdowns implied by the Euro area reference dating chronologies of the classical and growth cycles

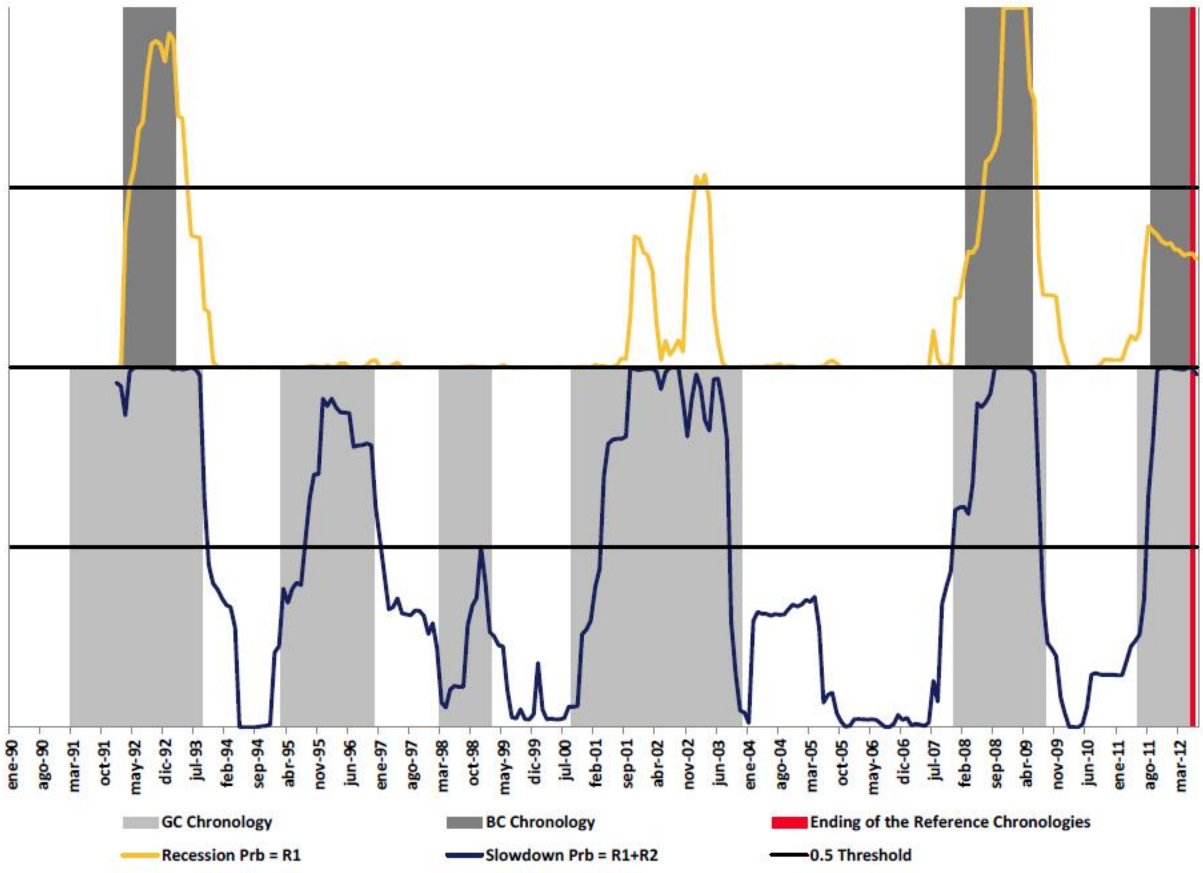


Source: Authors' calculations

The indirect coincident indicators of the Euro area's classical and growth cycle are defined as the weighted average of the Member States' coincident indicators. The participation of a country to the Euro area's GDP is the weight given to each Member States; we remark the fact that we used dynamic weights that reflect how the role of each country varied over time.

The recession probabilities expressed by the indirect coincident indicators of the Euro area's classical cycle are drawn in the upper panel of Figure 22. The lower panel shows the slowdown probabilities. The areas in the background represent recessions and slowdown implied by the dating chronology of the classical and growth cycles, respectively.

Figure 22: **Recession and slowdown probabilities of the Euro area classical and growth cycles, respectively, estimated as a weighted average of the corresponding coincident indicators of the main seven Member Countries**



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

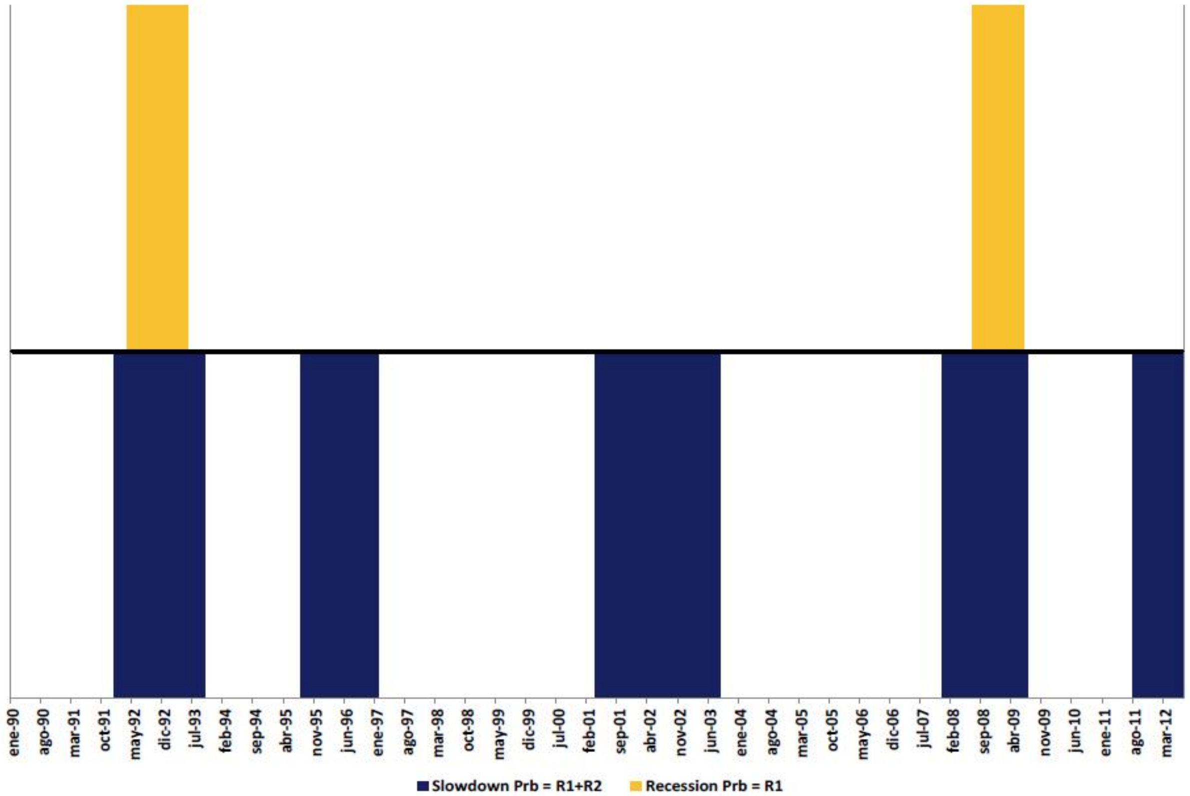
Two out of the three recessions suffered in the Euro area since 1990 are clearly located by the indirect coincident of the classical cycle. As for the last contraction that started in 2011Q3, recession probabilities rise to 0.4 in August 2011 for then stabilizing at around 0.3 until August 2012. The indirect coincident indicator of the classical cycle fails to straightforwardly locate the current recession is due to the fact that France and Germany's coincident indicators of the classical cycle have remained close to 0 since the end of the 2008-2009 recession. It is worth noting that the reference dating chronologies have not yet identified a recession in either of the two countries since the one caused by the financial crisis.

The indirect coincident indicator of the Euro area's classical cycle rises slightly above or close to the 0.5 threshold for the first three months in 2003, which almost amounts to a false recession.

As for the growth cycle, five out of the six slowdowns identified by the reference dating chronology are clearly detected by the indirect coincident indicator. Only the slowdown observed in 1998 is missed. However, this was only a minor decrease in the growth trend. No false slowdowns are produced by the indirect coincident indicator of the Euro area's growth cycle.

Slowdown and recession signals are obtained from the above probabilistic coincident indicators by applying the simple 0.5 natural rule. They are graphically shown in Figure 23. Additionally, we also require both slowdown and recession signals to comply with a simple censoring rule according to which, in order to be retained, they have to be sustained for at least three consecutive months.

Figure 23: Recession and slowdown signals of the Euro area classical and growth cycles, respectively, derived from the proposed coincident indicators



Source: Authors' calculations

The turning points of the classical and growth cycles derived by the recession and slowdown signals, respectively, are summarized in Table 32, where they are compared to the reference dating chronologies.

Table 32: Turning points dating chronologies of the Euro area classical and growth cycles according to the ABCD approach and turning point signals derived from the proposed coincident indicators

Turning Point	Reference Dating Chronology	Indirect Coincident Indicators
Peak A	1991Q1	-
Peak B	1992Q1	1992M3 (+1)
Trough C	1993Q1	1993M5 (+3)
Trough D	1993Q3	1993M9 (+1)
Peak A	1995Q1	1995M7 (+5)
Trough D	1996Q4	1997M1 (+2)
Peak A	1998Q1	-
Trough D	1999Q1	-
Peak A	2000Q3	2001M3 (+7)
Trough D	2003Q4	2003M8 (-3)
Peak A	2007Q4	2007M11 (+0)
Peak B	2008Q1	2008M6 (+4)
Trough C	2009Q2	2009M6 (+1)
Trough D	2009Q3	2009M7 (-1)
Peak A	2011Q2	2011M7 (+2)
Peak B	2011Q3	-

Source: Authors' calculations

Finally, Table 33 shows the accuracy statistics of the pair of coincident indicators in locating the fluctuations of the Euro area classical and growth cycles.

Table 33: Accuracy statistics of the proposed coincident indicators of the Euro area classical and growth cycles

Coincident Indicator	Available from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Indirect	1992:01	BC	.052	.915	2.5	0	2.0	0	0	1
		GC	.104	.870	3.5	0	0.8	1.0	0	1

Note: Lag and early statistics are average measures express on a monthly basis.

Source: Authors' calculations

5. CONCLUSION

In this paper we applied Markov-Switching models to jointly estimate probabilistic coincident indicators of the classical and growth cycles of the major Euro area's Member Countries so that they satisfy, by construction, the ABCD approach to turning points occurrence. The coincident indicators were obtained using a multivariate modelling framework in which the regimes of the latent state-variable were interpreted as either recessions or slowdowns of the classical and growth cycle, respectively. It is this interpretation of the regimes of a common Markov-chain in terms of economic cycles that allowed to define probabilistic coincident indicators of the classical and growth cycles that produce signals consistent with the ABCD approach.

We considered a huge number of alternative coincident indicators that were obtained by combining several model specifications, number of regimes, endogenous variables and rules to associate regimes and economic cycles. The accuracy of each pair of coincident indicators in locating economic fluctuations was measured with respect to a benchmark, the dating chronologies proposed in the Quarterly Assessment of the Euro area Economy. For each Member Country, we finally proposed a pair of coincident indicators, one expressing the probabilities of a recession of the classical cycle and the probabilities of a slowdown of the growth cycle. The proposed coincident indicators proved to quite accurately locate turning points of these two cycles.

In addition, given that the Member Countries considered in this analysis account for almost 90% of the Euro area GDP, we also indirectly construct a pair of probabilistic coincident indicators of the Euro area's classical and growth cycle as a weighted average of the corresponding coincident indicators obtained at country level.

Another possibility to model economic fluctuations in the Euro area as a whole, which we have not explored yet, is to derive probabilistic coincident indicators of the Euro area's classical and growth cycles via a multivariate Markov-Switching model in which the endogenous variables are economic indicators of the major Member Countries. This is left for future research.

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A. APPENDIX

1.1. France

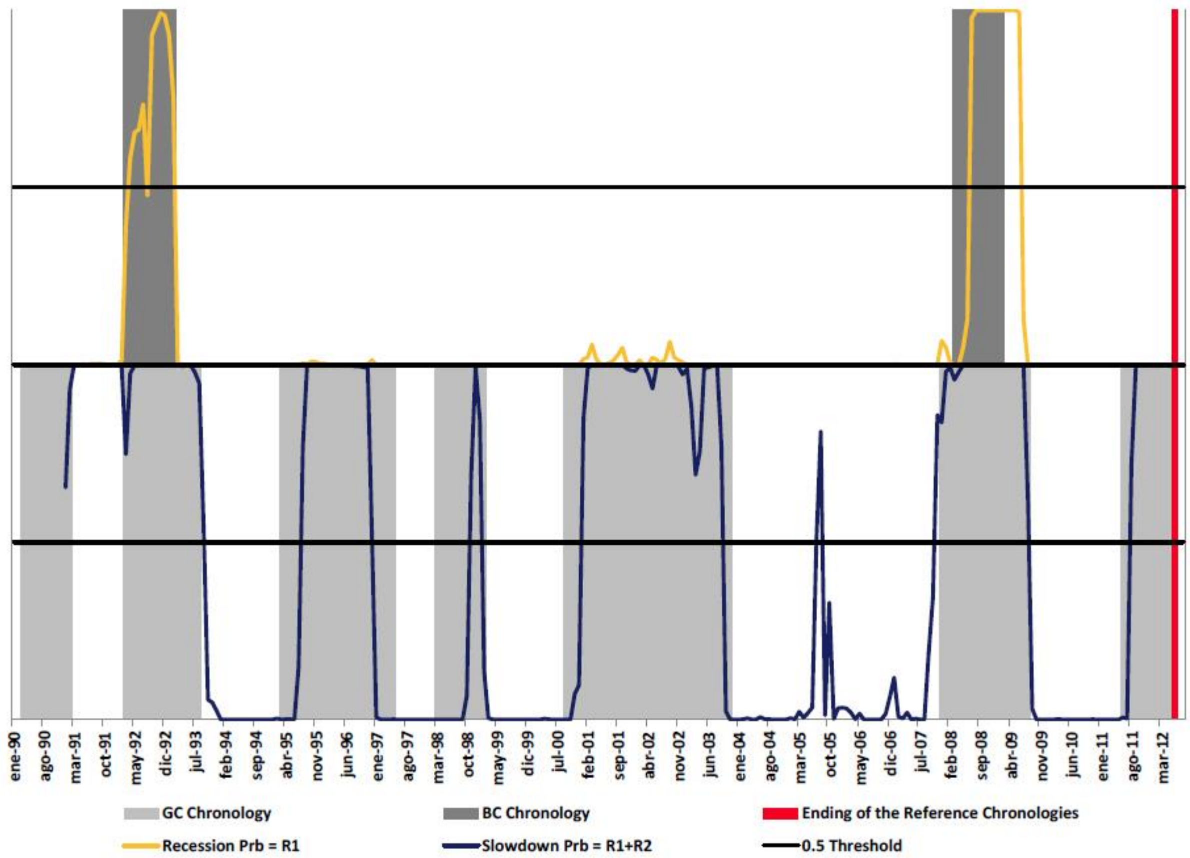
Table 34: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A	Model B	Model C
Model	MSIH(3)-VAR(0)	MSIH(4)-VAR(0)	MSIH(4)-VAR(0)
Sample	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08
Endogenous Variables	1. IPI (6) 2. BUIL (3) 3. CONS (1) 4. RETA (12)	6. IPI (6) 7. UR (1) 8. BUIL(3) 9. CONS (1) 10. RETA (12)	1. IPI (6) 2. UR (12) 3. BUIL(3) 4. CONS (3) 5. RETA (12)
Recession Regime(s)	R1	R1	R1
Slowdown Regime(s)	R1+R2	R1+R2	R1+R2

Source: Authors' calculations

MODEL A - MSIH(3)-VAR(0) FITTED TO IPI(6), BUIL(3), CONS(1), RETA(12)

Figure 24: Recession and slowdown probabilities of the French classical and growth cycles, respectively, estimated by fitting a MSIH(3)-VAR(0) model to IPI(6), BUIL(3), CONS(1), RETA(12)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

Table 35: Parameter estimates of Model A

Variable	Intercept			Volatility		
	R1	R2	R3	R1	R2	R3
IPI(6)	-1.91	-0.24	0.50	1.70	0.47	0.58
BUIL(3)	-1.56	-0.58	0.68	0.65	0.67	0.66
CONS(1)	-0.18	-0.24	0.22	0.99	1.09	0.90
RETA(12)	-0.82	-0.59	0.53	1.24	0.64	0.85

Source: Authors' calculations

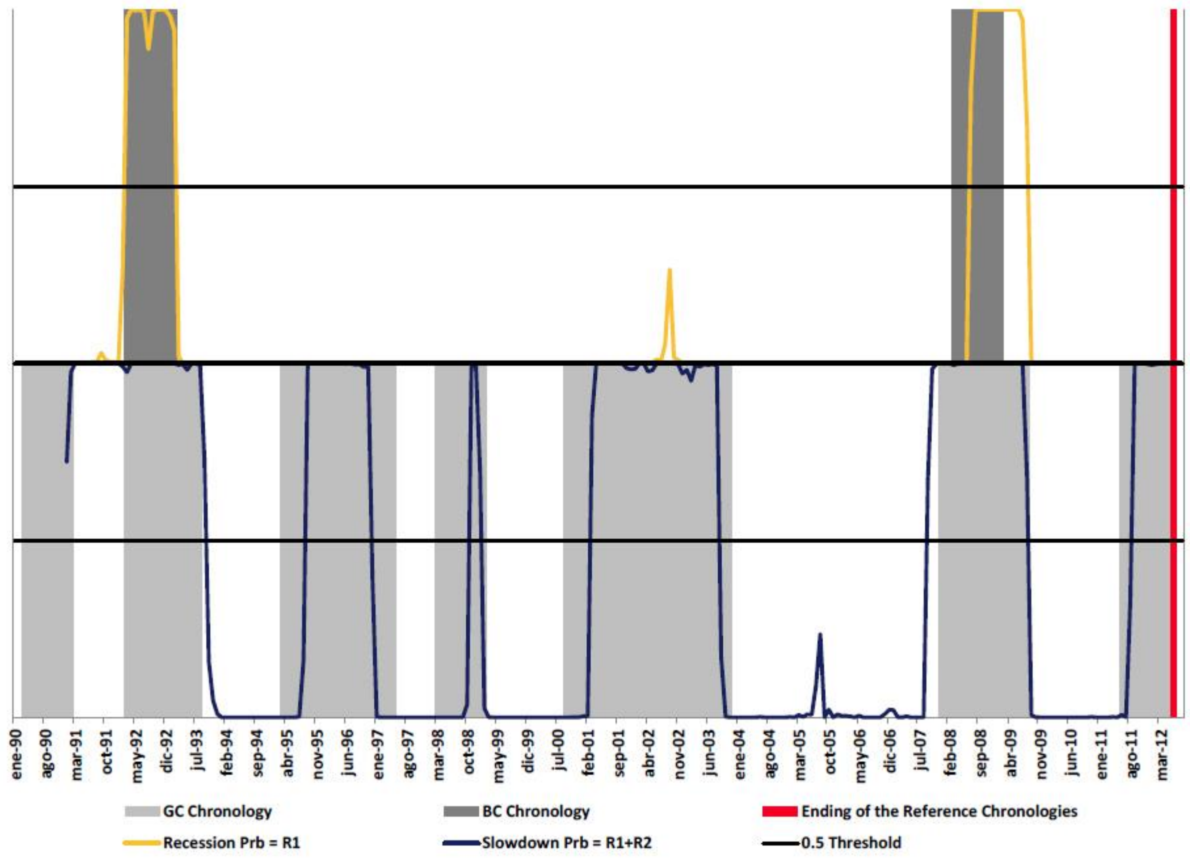
MODEL C - MSIH(4)-VAR(0) FITTED TO IPI(6), UR(12), BUIL(3), CONS(3), RETA(12)

Table 36: Parameter estimates of Model C

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(6)	-1.83	-0.28	0.49	0.50	1.72	0.45	0.65	0.45
UR(12)	-1.03	-0.06	-0.46	1.04	0.88	0.90	0.72	0.57
BUIL(3)	-1.48	-0.59	0.62	0.65	0.69	0.67	0.61	0.82
CONS(3)	-0.23	-0.51	0.37	0.42	0.99	1.10	0.79	0.70
RETA(12)	-0.76	-0.62	0.32	0.76	1.24	0.64	0.95	0.62

Source: Authors' calculations

Figure 25: Recession and slowdown probabilities of the French classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(6), UR(12), BUIL(3), CONS(3), RETA(12)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

Table 37: Turning points dating chronologies of the French classical and growth cycles according to the ABCD approach and turning point signals derived from the selected MS models

Turning Point	Reference Dating Chronology	Model A	Model B	Model C
Peak A	1990Q1	-	-	
Trough D	1991Q1	-	-	
Peak A	1992Q1	-	-	
Peak B	1992Q1	1992M3 (+1)	1992M3 (+1)	1992M2 (+0)
Trough C	1993Q1	1993M2 (+0)	1993M2 (+0)	1993M2 (+0)
Trough D	1993Q3	1993M9 (+1)	1993M8 (+0)	1993M9 (+1)
Peak A	1995Q1	1995M7 (+5)	1995M7 (+5)	1995M8 (+6)
Trough D	1997Q2	1996M12 (-5)	1996M11 (-6)	1996M11 (-6)
Peak A	1998Q1	1998M10 (+8)	1998M9 (+7)	1998M10 (+8)
Trough D	1999Q1	1999M1 (-1)	1999M1 (-1)	1999M1 (-1)
Peak A	2000Q3	2000M12 (+4)	2000M10 (+2)	2001M2 (+6)
Trough D	2003Q4	2003M9 (-2)	2003M8 (-3)	2003M8 (-3)
Peak A	2007Q4	2007M10 (-1)	2007M8 (-3)	2007M8 (-3)
Peak B	2008Q1	2008M6 (+4)	2008M6 (+4)	2008M6 (+4)
Trough C	2009Q1	2009M6 (+4)	2009M6 (+4)	2009M8 (+6)
Trough D	2009Q3	2009M8 (+0)	2009M7 (-1)	2009M8 (+0)
Peak A	2011Q2	2011M7 (+2)	2011M7 (+2)	2011M8 (+3)

Source: Authors' calculations

Table 38: Accuracy statistics of the proposed coincident indicators of the French classical and growth cycles

Model	Coincident Indicator from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1991:01	BC	.034	.961	2.5	0	2.0	0	0	0
		GC	.160	.833	3.8	0.2	0.2	1.63	1	1
Model B	1991:01	BC	.031	.965	2.5	0	2.0	0	0	0
		GC	.162	.826	3.2	0.6	0	2.2	1	1
Model C	1991:01	BC	.037	.961	2.0	0	3.0	0	0	0
		GC	.180	.810	4.6	0.6	0.2	2.0	1	1

Source: Authors' calculations

1.2. Germany

Table 39: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A	Model B	Model C
Model	MSIH(4)-VAR(0)	MSIH(3)-VAR(0)	MSIH(4)-VAR(0)
Endogenous Variables	1. IPI(3) 2. UR(3) 3. INDU(3) 4. CONS(12) 5. RETA(3)	1. IPI(3) 2. UR(1) 3. INDU(3) 4. BUIL(1)	6. IPI(3) 7. UR(3) 8. BUIL(3) 9. CONS(6) 10. RETA(12)
Sample	1991:01 – 2012:08	1991:01 – 2012:08	1991:01 – 2012:08
Recession Regime(s)	R1	R1	R1+R2
Slowdown Regime(s)	R1+R2	R1+R2	R1+R2+R3

Source: Authors' calculations

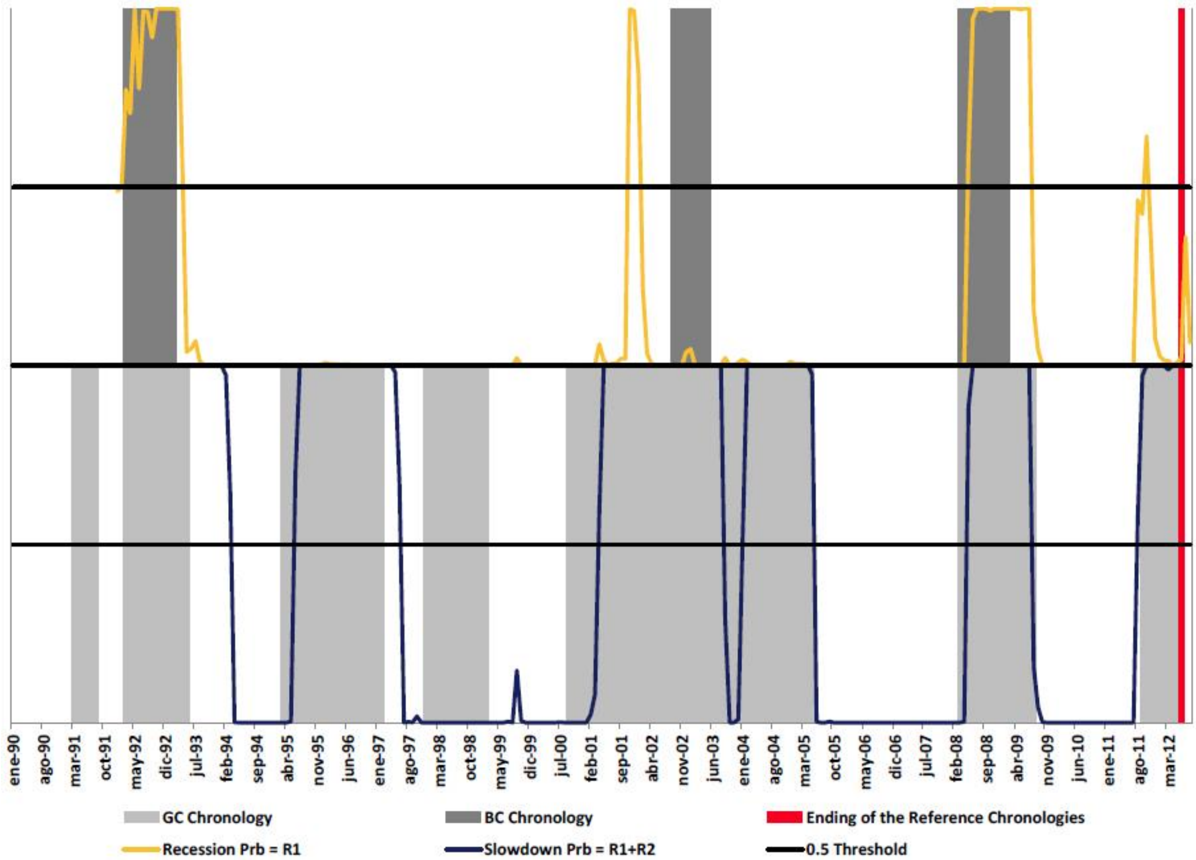
MODEL A - MSIH(4)-VAR(0) FITTED TO IPI(3), UR(3), INDU(3), CONS(12), RETA(3)

Table 40: Parameter estimates of Model A

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(3)	-1.29	-0.11	0.30	0.58	1.76	0.51	0.53	0.66
UR(3)	-0.59	-0.76	0.52	1.21	1.04	0.63	0.45	0.48
INDU(3)	-1.30	-0.19	0.28	1.10	0.96	0.67	0.79	0.62
CONS(12)	-1.16	-0.50	0.46	1.34	0.78	0.53	0.65	0.63
RETA(3)	-0.61	-0.10	0.09	0.52	1.15	0.92	0.81	0.95

Source: Authors' calculations

Figure 26: Recession and slowdown probabilities of the German classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(3), UR(3), INDU(3), CONS(12), RETA(3)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.
Source: Authors' calculations

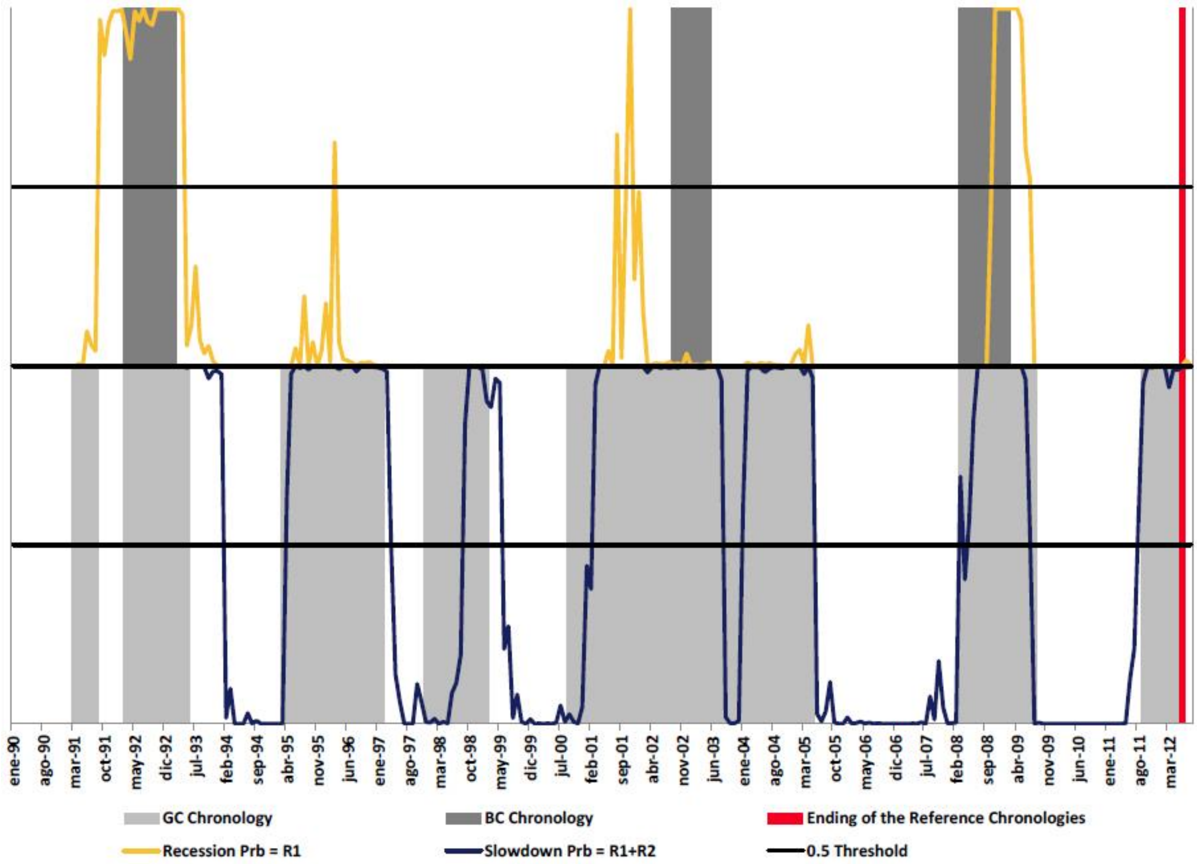
MODEL B - MSIH(3)-VAR(0) FITTED TO IPI(3), UR(1), INDU(3), BUIL(1)

Table 41: Parameter estimates of the Model B

Variable	Intercept			Volatility		
	R1	R2	R3	R1	R2	R3
IPI(3)	-1.38	-0.15	0.48	1.75	0.55	0.59
UR(1)	-1.04	-0.38	0.68	0.40	0.91	0.71
INDU(3)	-1.33	-0.36	0.78	0.85	0.67	0.67
BUIL(1)	-0.14	-0.10	0.15	1.33	0.98	0.87

Source: Authors' calculations

Figure 27: Recession and slowdown probabilities of the German classical and growth cycles, respectively, estimated by fitting a MSIH(3)-VAR(0) model to IPI(3), UR(1), INDU(3), BUIL(1)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

Table 42: Turning points dating chronologies of the German classical and growth cycles according to the ABCD approach and turning point signals derived from the selected MS models

Turning Point	Reference Dating Chronology	Model A	Model B	Model C
Peak A	1992Q1	-	-	-
Peak B	1992Q1	1992M2 (+0)	1991M8 (-6)	1992M2 (+0)
Trough C	1993Q1	1993M4 (+2)	1993M4 (+2)	1993M4 (+2)
Trough D	1993Q2	1994M3 (+10)	1994M1 (+8)	1994M4 (+11)
Peak A	1995Q1	1995M5 (+3)	1995M3 (+3)	1994M12 (-2)
Trough D	1997Q1	1997M6 (+4)	1997M3(+1)	1998M2 (+12)
Peak A	1997Q4	-	1998M8 (+9)	
Trough D	1999Q1	-	1999M5 (+3)	
Peak A	2000Q3	2001M3 (+7)	2001M2 (+6)	2001M3 (+7)
Peak B	-	2001M10	-	2001M10
Trough C	-	2002M1	-	2002M3
Peak B	2002Q3	-	-	2002M10 (+2)
Trough C	2003Q2	-	-	2003M4 (-1)
Trough D	-	2003M8	2003M8	2003M8
Peak A	-	2003M12	2003M12	2004M1
Trough D	2005Q2	2005M5 (+0)	2005M5 (+0)	2005M5 (+0)
Peak A	2008Q1	2008M4 (+2)	2008M2 (+0)	2008M4 (+2)
Peak B	2008Q1	2008M4 (+2)	2008M10 (+8)	2008M10 (+8)
Trough C	2009Q1	2009M7 (+5)	2009M7 (+5)	2009M6 (+4)

Turning Point	Reference Dating Chronology	Model A	Model B	Model C
Trough D	2009Q3	2009M7 (-1)	2009M7 (-1)	2009M7 (-1)
Peak A	2011Q3	2011M7 (-1)	2011M7 (-1)	2011M9 (+1)

Source: Authors' calculations

Table 43: Accuracy statistics of the proposed coincident indicators of the German classical and growth cycles

Model	Coincident Indicator from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1992:01	BC	.088	.911	1.0	0	3.5	0	1	1
		GC	.190	.801	3.0	0.3	3.5	0.3	0	1
Model B	1991:04	BC	.117	.871	4.0	3.0	3.5	0	1	1
		GC	.150	.839	3.6	0.2	2.4	0.2	0	0
Model C	1992:01	BC	.090	.911	3.4	0	2.0	0.4	1	0
		GC	.200	.789	2.5	0.5	5.8	0.3	0	1

Source: Authors' calculations

1.3. Italy

Table 44: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A	Model B	Model C
Model	MSIH(4)-VAR(0)	MSIH(5)-VAR(0)	MSIH(4)-VAR(0)
Endogenous Variables	1. IPI(3) 2. UR(1) 3. BUIL(1) 4. INDU(12) 5. RETA(3)	6. IPI(6) 7. UR(6) 8. BUIL(1) 9. INDU(6) 10. RETA(6)	1. IPI(6) 2. UR(6) 3. BUIL(1) 4. INDU(6) 5. RETA(6)
Sample	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08
Recession Regime(s)	R1	R1	R1
Slowdown Regime(s)	R1+R2	R1+R2	R1+R2

Source: Authors' calculations

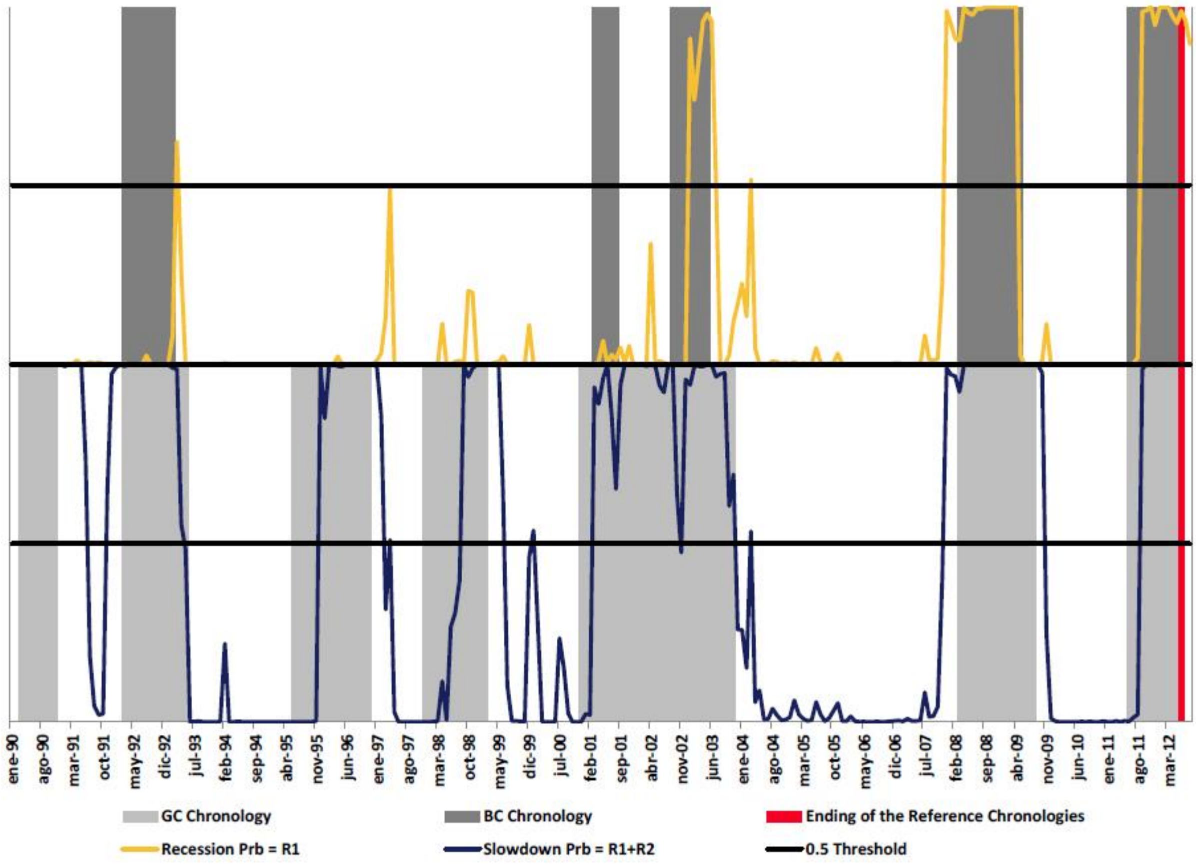
MODEL A - MSIH(4)-VAR(0) FITTED TO IPI(3), UR(1), BUIL(1), INDU(12), RETA(3)

Table 45: Parameter estimates of Model A

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI (3)	-1.14	-0.16	0.41	0.44	1.61	0.67	0.64	0.57
UR (1)	-0.69	0.07	0.22	-0.13	1.23	0.80	0.88	1.18
BUIL (1)	-0.03	-0.10	-0.03	0.33	0.52	0.99	0.60	1.72
INDU (12)	-0.59	-0.77	0.39	1.25	0.70	0.72	0.48	0.95
RETA (3)	-0.35	-0.11	0.09	0.36	0.38	1.37	0.36	1.49

Source: Authors' calculations

Figure 28: Recession and slowdown probabilities of the Italian classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(3), UR(1), BUIL(1), INDU(12), RETA(3)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

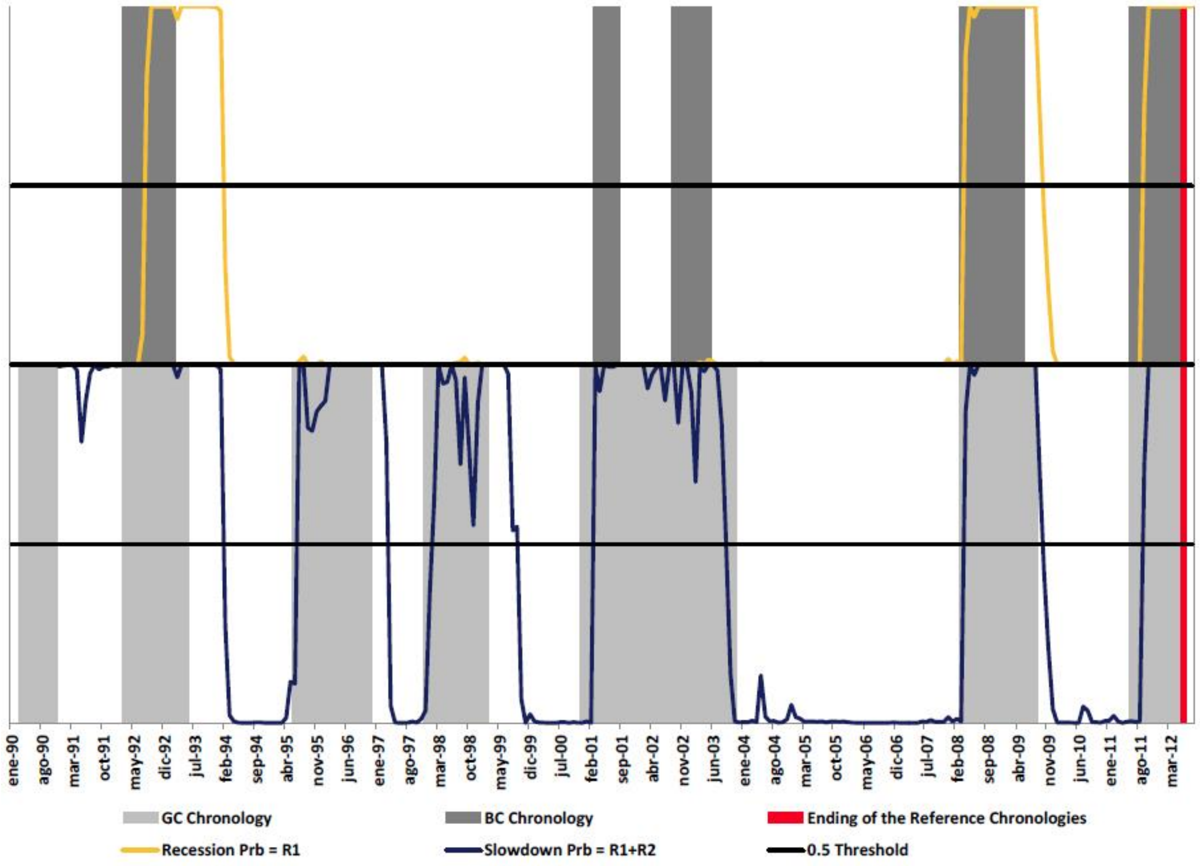
MODEL C - MSIH(4)-VAR(0) FITTED TO IPI(6), UR(6), BUIL(1), INDU(6), RETA(6)

Table 46: Parameter estimates of Model C

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(6)	-1.17	-0.10	0.23	1.09	1.48	0.45	0.41	0.39
UR(6)	-1.41	0.24	0.62	-0.24	0.93	0.46	0.64	0.84
BUIL(1)	-0.18	-0.01	0.00	0.21	1.34	0.95	0.53	1.22
INDU(6)	-0.44	-0.42	0.20	1.01	0.89	1.10	0.44	0.70
RETA(6)	-0.45	-0.02	0.06	0.45	0.86	1.21	0.35	1.23

Source: Authors' calculations

Figure 29: Recession and slowdown probabilities of the Italian classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(6), UR(6), BUIL(1), INDU(6), RETA(6)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

Table 47: Turning points dating chronologies of the Italian classical and growth cycles according to the ABCD approach and turning point signals derived from the selected MS models

Turning Point	Reference Dating Chronology	Model A	Model B	Model C
Peak A	1990Q1	-	-	-
Trough D	1990Q4	1991M6 (+7)	1991M6 (+7)	-
Peak A	1992Q1	1991M10 (-4)	1991M11 (-3)	-
Peak B	1992Q1	-	1992M7 (+5)	1992M7 (+5)
Trough C	1993Q1	-	1993M8 (+6)	1994M1 (+11)
Trough D	1993Q2	1993M4 (-1)	1993M8 (+3)	1994M1 (+8)
Peak A	1995Q2	1995M11 (+6)	1995M11 (+6)	1995M6 (+1)
Trough D	1996Q4	1997M4 (+5)	1997M1 (+2)	1997M3 (+4)
Peak A	1997Q4	1998M8 (+9)	1998M8 (+9)	1998M1(+2)
Trough D	1999Q1	1999M6 (+4)	1999M5 (+3)	1999M9 (+7)
Peak A	2000Q4	2001M2 (+3)	2001M9 (+10)	2001M2(+3)
Peak B	2001Q1	-	-	-
Trough C	2001Q3	-	-	-
Peak B	2002Q3	2002M12 (+4)	2002M12 (+4)	-
Trough C	2003Q2	2003M6 (+1)	2003M5 (+0)	-
Trough D	2003Q4	2003M11 (+0)	2003M8 (-3)	2003M9 (-2)
Peak A	2008Q1	2007M11 (-2)	2007M11 (-2)	2008M1 (-1)
Peak B	2008Q1	2007M11 (-2)	2007M11 (-2)	2008M1 (-1)
Trough C	2009Q2	2009M4 (-1)	2009M4 (-1)	2009M9 (+4)

Turning Point	Reference Dating Chronology	Model A	Model B	Model C
Trough D	2009Q3	2009M10 (+2)	2009M6 (-2)	2009M9 (+1)
Peak A	2011Q2	2011M8 (+3)	2011M6 (+1)	2011M8 (+3)
Peak B	2011Q2	2011M8 (+3)	2011M7 (+2)	2011M8 (+3)

Source: Authors' calculations

Table 48: Accuracy statistics of the proposed coincident indicators of the Italian classical and growth cycles

Model	Coincident Indicator from	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1991:01	BC	.120	.876	2.4	0.7	0.5	0.5	0	2
		GC	.163	.814	2.0	1.0	3.0	0.2	0	0
Model B	1991:01	BC	.102	.891	2.8	0.5	2.0	0.3	0	1
		GC	.203	.787	4.3	0.8	2.5	0.8	0	0
Model C	1990:07	BC	.146	.852	2.7	0.4	7.5	0	0	2
		GC	.167	.822	1.2	0.2	4.0	0.4	0	0

Source: Authors' calculations

1.4. The Netherlands

Table 49: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A	Model B
Model	MSIH(4)-VAR(0)	MSIH(4)-VAR(0)
Endogenous Variables	6. IPI (12) 7. BUIL (6) 8. INDU(3) 9. CONS (1) 10. RETA (1)	1. IPI (12) 2. BUIL (6) 3. INDU(3) 4. CONS (3) 5. RETA (1)
Sample	1990:01 – 2012:08	1990:01 – 2012:08
Recession Regime(s)	R1	R1
Slowdown Regime(s)	R1+R2	R1+R2

Source: Authors' calculations

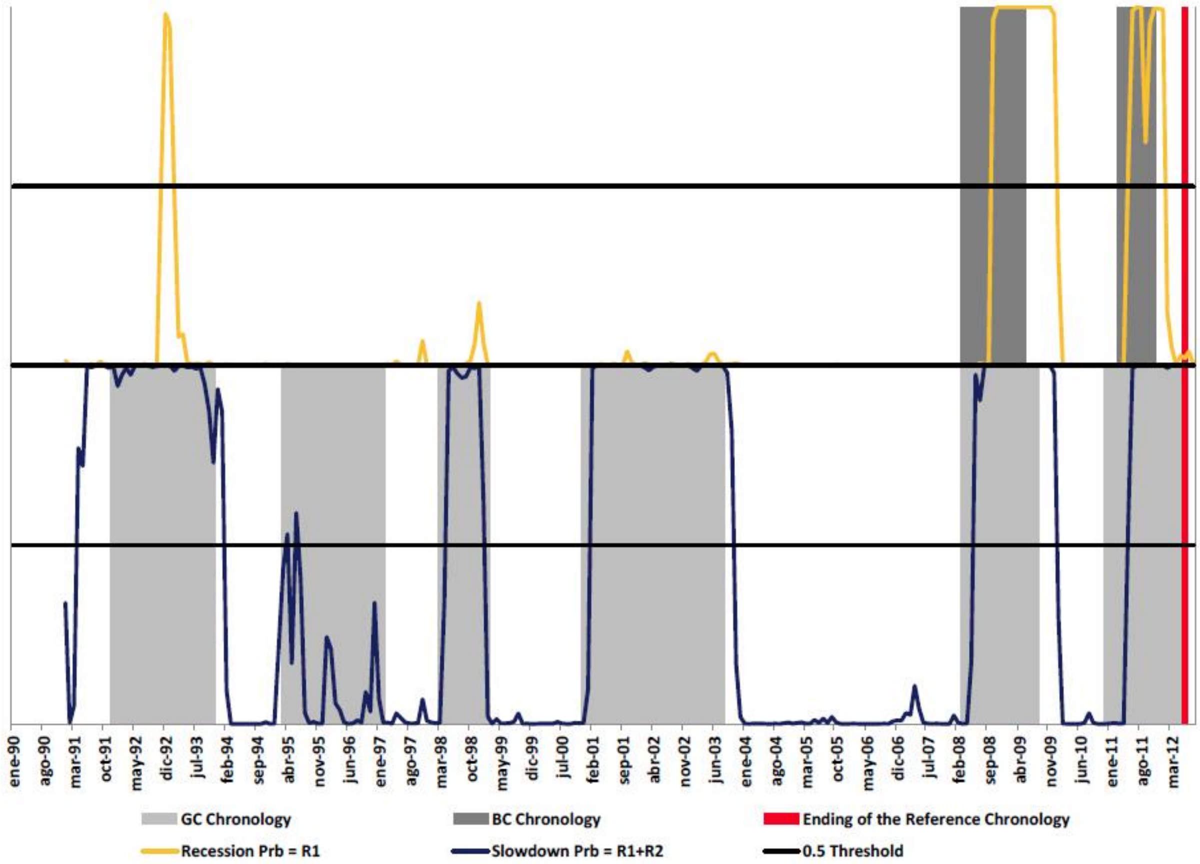
MODEL B - MSIH(4)-VAR(0) FITTED TO IPI(12), BUIL(6), INDU(3), CONS(3), RETA(1)

Table 50: Parameter estimates of Model B

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(12)	-1.54	-0.28	0.47	0.33	1.22	0.63	0.76	0.89
BUIL(6)	-1.23	-0.59	0.49	0.65	1.66	0.68	0.52	0.51
INDU(3)	-0.97	-0.29	-0.10	1.00	2.10	0.60	0.38	0.46
CONS(3)	-0.74	-0.24	0.06	0.69	1.42	0.92	0.84	0.63
RETA(1)	-0.19	-0.17	0.08	0.21	1.39	0.86	0.74	1.22

Source: Authors' calculations

Figure 30: Recession and slowdown probabilities of the Dutch classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(12), BUIL(6), INDU(3), CONS(3), RETA(1)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

Table 51: Turning points dating chronologies of the Dutch classical and growth cycles according to the ABCD approach and turning point signals derived from the selected MS models

Turning Point	Reference Dating Chronology	Model A	Model B
Peak A	1991Q4	1991M3 (-8)	1991M3 (-8)
Peak B	-	-	1992M10
Trough C	-	-	1993M1
Trough D	1993Q4	1993M12 (+1)	1994M1 (+2)
Peak A	1995Q1	-	-
Trough D	1997Q1	-	-
Peak A	1998Q1	1998M4 (+2)	1998M4 (+2)
Trough D	1999Q1	1998M10 (-3)	1999M1 (-1)
Peak A	2000Q4	2001M1 (+2)	2001M1 (+2)
Trough D	2003Q3	2003M12 (+4)	2003M10 (+2)
Peak A	2008Q1	2008M5 (+3)	2008M5 (+3)
Peak B	2008Q1	2008M9 (+7)	2008M9 (+7)
Trough C	2009Q2	2009M12 (+7)	2009M12 (+7)
Trough D	2009Q3	2009M12 (+4)	2009M12 (+4)
Peak A	2010Q4	2011M2 (+3)	2011M4 (+5)
Peak B	2011Q1	2011M2 (+0)	2011M4 (+2)
Trough C	2011Q4	2011M10 (+1)	2012M1 (+3)
Trough D	-	-	-

Source: Authors' calculations

Table 52: Accuracy statistics of the proposed coincident indicators of the Dutch classical and growth cycles

Coincident Indicator	Coincdent	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1991:01	BC	.061	.942	3.5	0	4.0	0	0	0
		GC	.195	.791	2.0	1.6	2.3	0.8	0	1
Model B	1991:01	BC	.081	.919	4.5	0	5.0	0	1	0
		GC	.177	.802	2.0	1.6	2.0	0	0	1

Source: Authors' calculations

1.5. Portugal

Table 53: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A	Model B	Model C	Model D	Model E
Model	MSIH(3)-VAR(0)	MSI(5)-VAR(0)	MSI(5)-VAR(0)	MSIH(5)-VAR(0)	MSIH(5)-VAR(0)
Endogenous Variables	1. IPI(3) 2. UR(12) 3. BUIL(12) 4. CONS(6) 5. RETA(6)	6. IPI(6) 7. BUIL(3) 8. INDU(3) 9. CONS(12) 10. RETA(1)	1. IPI(1) 2. UR(6) 3. INDU(3) 4. CONS(12) 5. RETA(1)	1. IPI(3) 2. UR(1) 3. BUIL(12) 4. CONS(1) 5. RETA(3)	1. IPI(6) 2. BUIL(12) 3. INDU(6) 4. CONS(12)
Sample	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08
Recession Regime(s)	R1	R1+R2	R1+R2	R1+R2	R1+R2
Slowdown Regime(s)	R1+R2	R1+R2+R3	R1+R2+R3	R1+R2+R3	R1+R2+R3

Source: Authors' calculations

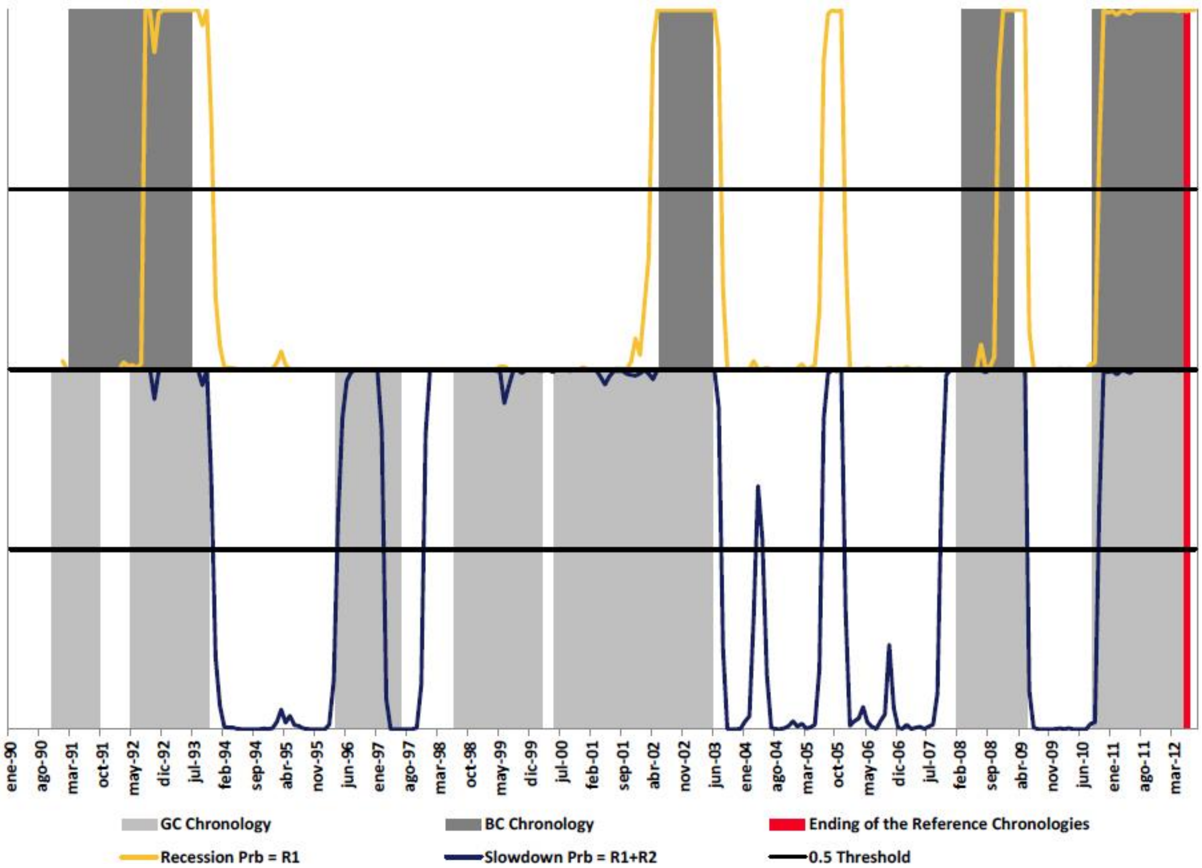
MODEL A - MSIH(3)-VAR(0) FITTED TO IPI(3), UR(12), BUIL(12), CONS(6), RETA(6)

Table 54: Parameter estimates of Model A

Variable	Intercept			Volatility		
	R1	R2	R3	R1	R2	R4
IPI(3)	-0.32	0.02	0.14	1.20	0.79	0.98
UR(12)	-0.87	0.85	-0.30	0.84	0.46	0.80
BUIL(12)	-0.97	0.33	0.50	0.93	0.78	0.65
CONS(6)	-0.72	-0.23	0.71	0.84	0.63	0.96
RETA(6)	-0.90	0.01	0.60	0.82	0.69	0.92

Source: Authors' calculations

Figure 31: Recession and slowdown probabilities of the Portuguese classical and growth cycles, respectively, estimated by fitting a MSIH(3)-VAR(0) model to IPI(3), UR(12), BUIL(12), CONS(6), RETA(6)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

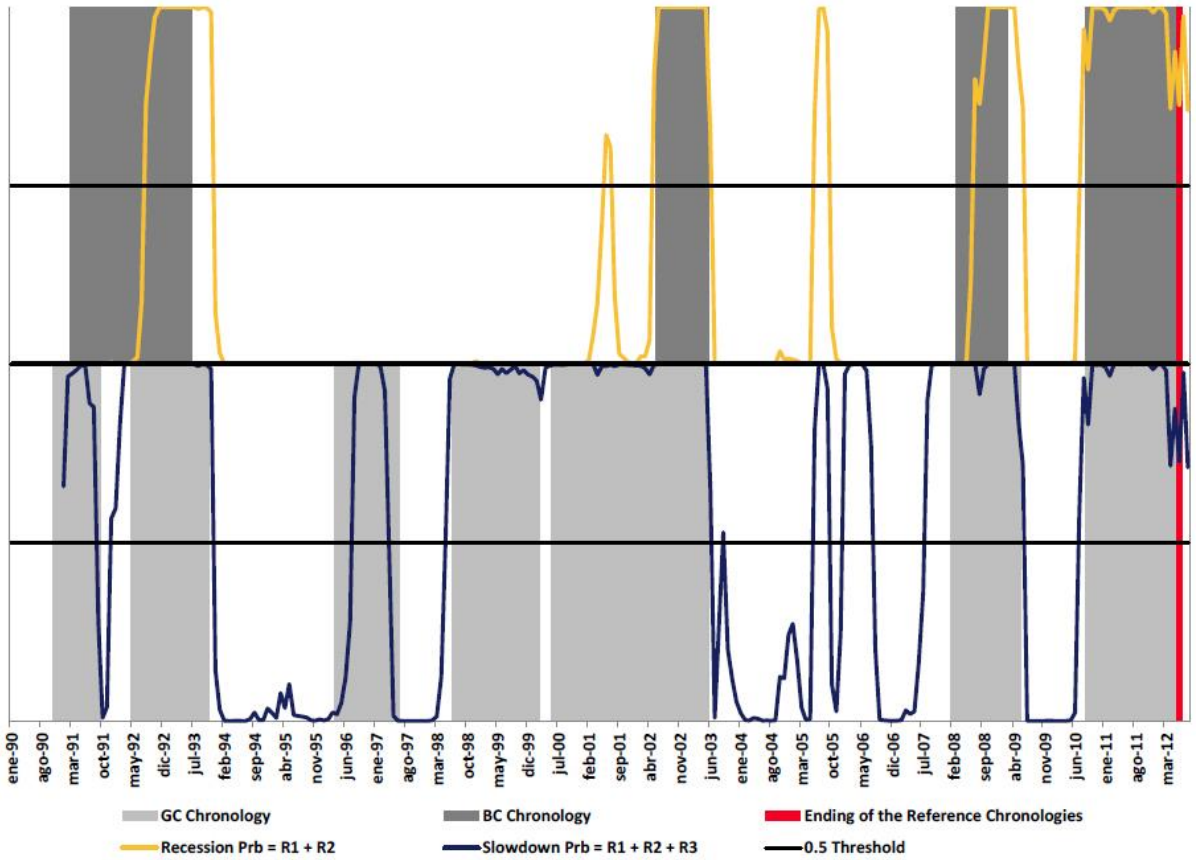
MODEL C - MSI(5)-VAR(0) FITTED TO IPI(1), UR(6), INDU(3), CONS(12), RETA(1)

Table 55: Parameter estimates of Model C

Variable	Intercept					Volatility
	R1	R2	R3	R4	R5	
IPI(1)	-0.85	-0.03	0.01	0.03	-0.01	1.01
UR(6)	-0.39	-0.97	0.79	0.09	-0.95	0.69
INDU(3)	-3.60	-0.38	-0.06	0.24	1.53	0.74
CONS(12)	-0.97	-1.07	-0.18	1.07	0.13	0.59
RETA(1)	-1.01	-0.21	0.01	0.05	0.57	0.98

Source: Authors' calculations

Figure 32: Recession and slowdown probabilities of the Portuguese classical and growth cycles, respectively, estimated by fitting a MSI(5)-VAR(0) model to IPI(1), UR(6), INDU(3), CONS(12), RETA(1).



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

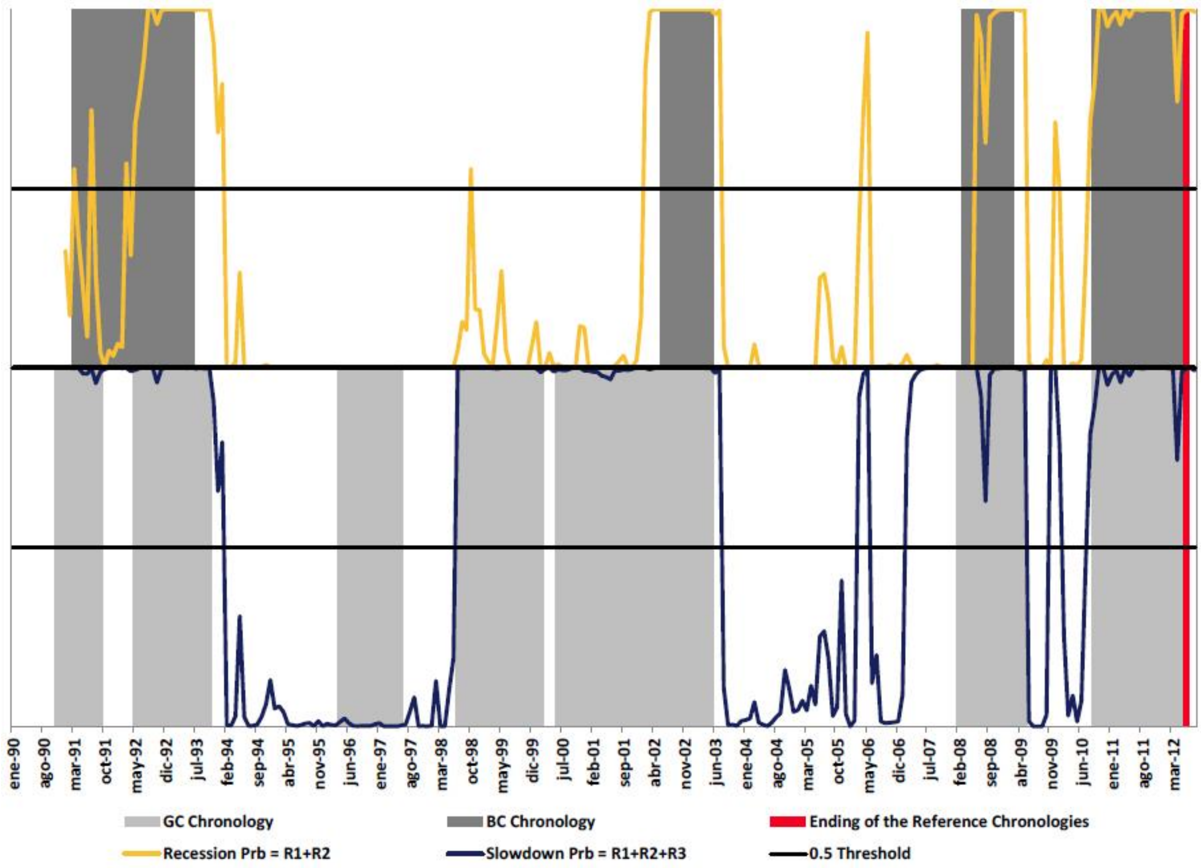
MODEL D - MSIH(5)-VAR(0) FITTED TO IPI(3), UR(1), BUIL(12), CONS(1), RETA(3)

Table 56: Parameter estimates of Model D

Variable	Intercept					Volatility				
	R1	R2	R3	R4	R5	R1	R2	R3	R4	R5
IPI(3)	-0.61	-0.09	-0.07	0.10	0.66	1.25	1.11	0.83	0.92	0.81
UR(1)	-1.47	-0.29	0.45	-0.01	0.81	1.07	0.72	0.76	0.77	1.57
BUIL(12)	-1.79	-0.58	0.20	0.78	0.02	0.99	0.51	0.65	0.62	0.60
CONS(1)	-0.73	-0.03	-0.10	0.16	0.75	1.03	1.14	0.73	0.97	0.75
RETA(3)	-0.89	-0.37	0.02	0.24	1.40	1.07	0.85	0.71	1.00	1.13

Source: Authors' calculations

Figure 33: Recession and slowdown probabilities of the Portuguese classical and growth cycles, respectively, estimated by fitting a MSIH(5)-VAR(0) model to IPI(3), UR(1), BUIL(12), CONS(1), RETA(3)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

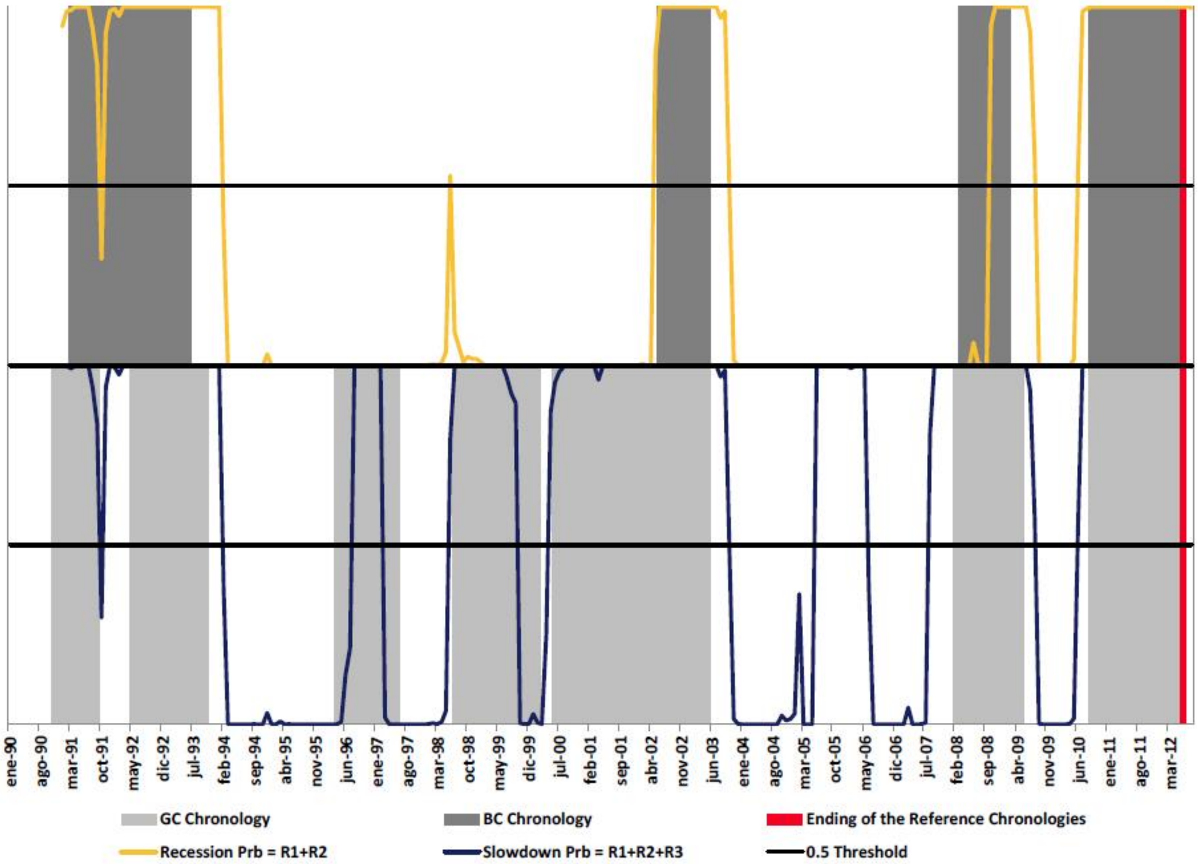
MODEL E - MSIH(5)-VAR(0) FITTED TO IPI(6), BUIL(12), INDU(6), CONS(12)

Table 57: Parameter estimates of Model E

Variable	Intercept					Volatility				
	R1	R2	R3	R4	R5	R1	R2	R3	R4	R5
IPI(6)	-0.80	-0.30	0.10	0.15	0.41	1.05	0.93	0.80	0.99	0.76
BUIL(12)	-1.45	-0.46	0.38	0.69	0.49	0.96	0.45	0.76	0.54	0.71
INDU(6)	-1.40	0.17	-0.15	0.17	1.32	1.01	0.54	0.61	0.69	0.85
CONS(12)	-1.23	-0.45	-0.42	0.76	1.32	0.49	0.86	0.39	0.41	0.77

Source: Authors' calculations

Figure 34: Recession and slowdown probabilities of the Portuguese classical and growth cycles, respectively, estimated by fitting a MSIH(5)-VAR(0) model to IPI(12), BUIL(6), INDU(12), CONS(6)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

Table 58: Turning points dating chronologies of the Portuguese classical and growth cycles according to the ABCD approach and turning point signals derived from the selected MS models

Turning Point	Reference Dating Chronology	Model A	Model B	Model C	Model D	Model E
Peak A	1990M10	-	-	1991M11 (+1)	-	-
Peak B	1991M2	1992M7 (+17)	1992M3 (+13)	1992M7 (+17)	1992M2 (+12)	-
Trough C	1993M6	1993M11 (+5)	1993M11 (+5)	1993M11 (+5)	1994M1 (+7)	1994M1 (+7)
Trough D	1993M10	1993M11 (+1)	1993M11 (+1)	1993M11 (+1)	1994M1 (+3)	1994M1 (+3)
Peak A	1996M3	1996M3 (+0)	1996M6 (+3)	1996M7 (+4)	-	1996M7 (+4)
Trough D	1997M6	1997M2 (-4)	1996M12 (-6)	1997M3 (-3)	-	1997M2 (-4)
Peak A	1998M6	1997M11 (-7)	1998M6 (+0)	1998M4 (-2)	1998M6 (+0)	1998M5 (-1)
Trough D	2000M2	-	-	-	-	1999M9 (-5)
Peak A	2000M5	-	-	-	-	2000M4 (-1)
Peak B	2002M5	2002M3 (-2)	2002M5 (+0)	2002M4 (-1)	2002M1 (-4)	2002M4 (-1)
Trough C	2003M5	2003M7 (+2)	2003M5 (+0)	2003M6 (+1)	2003M7 (+2)	2003M9 (+4)
Trough D	2003M5	2003M7 (+2)	2003M5 (+0)	2003M6 (+1)	2003M7 (+2)	2003M9 (+4)
Peak A	-	2005M6	2004M9	2005M5	-	2005M5
Peak B	-	2005M6	2005M6	2005M5	-	-
Trough C	-	2005M11	2005M9	2005M9	-	-
Trough D	-	2005M11	2005M9	2005M9	-	2006M5
Peak A	-	-	2005M12	2005M12	2006M2	-
Trough D	-	-	2006M7	2006M7	2006M5	-
Peak A	2008M1	2007M9 (-4)	2007M6 (-7)	2007M6 (-7)	2007M1 (-12)	2007M7 (-6)

Turning Point	Reference Dating Chronology	Model A	Model B	Model C	Model D	Model E
Peak B	2008M2	2008M10 (+8)	2008M5 (+3)	2008M6 (+4)	2008M5 (+3)	2008M9 (+7)
Trough C	2009M2	2009M5 (+3)	2009M5 (+3)	2009M6 (+4)	2009M5 (+3)	2009M8 (+6)
Trough D	2009M5	2009M5 (+0)	2009M5 (+0)	2009M6 (+1)	2009M5 (+0)	2009M8 (+3)
Peak A	-	-	-	-	2009M10	-
Trough D	-	-	-	-	2010M1	-
Peak A	2010M8	2010M9 (+1)	2010M6 (-2)	2010M6 (-2)	2010M7 (-1)	2010M5 (-3)
Peak B	2010M8	2010M9 (+1)	2010M9 (+1)	2010M7 (-1)	2010M7 (-1)	2010M5 (-3)
Trough C	-	-	2012M3	-	-	-

Source: Authors' calculations

Table 59: Accuracy statistics of the proposed coincident indicators of the Portuguese classical and growth cycles

Coincident Indicator	Coincdent	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1991:01	BC	.162	.833	6.5	0.5	3.4	0	1	0
		GC	.130	.860	0.3	2.3	0.8	1.0	1	0
Model B	1991:01	BC	.117	.872	4.3	0	2.7	0	1	0
		GC	.170	.814	0.6	1.8	0.3	1.5	2	0
Model C	1991:01	BC	.137	.849	5.3	0.5	3.4	0	1	0
		GC	.130	.841	1.0	2.2	0.8	0.8	2	0
Model D	1991:01	BC	.118	.864	3.8	1.3	4.0	0	0	0
		GC	.184	.810	0	4.4	1.7	0	2	1
Model E	1991:01	BC	.113	.876	2.4	1.4	5.7	0	0	0
		GC	.191	.798	0.8	2.2	2.0	1.8	1	0

Source: Authors' calculations

1.6. Spain

Table 60: Model specification, endogenous variables, sample period and assumptions on the association between latent Markov-chain and recession/slowdown phases

	Model A	Model B	Model C	Model D
Model	MSIH(4)-VAR(0)	MSIH(4)-VAR(0)	MSI(5)-VAR(0)	MSIH(4)-VAR(0)
Endogenous Variables	1. IPI (6) 2. BUIL (3) 3. CONS (12) 4. RETA (6)	1. IPI (6) 2. UR (3) 3. BUIL(3) 4. CONS (12)	1. IPI (6) 2. UR (1) 3. BUIL(12) 4. INDU (3) 5. CONS (6)	6. IPI (12) 7. UR (12) 8. BUIL (3) 9. INDU (6) 10. CONS (12)
Sample	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08	1990:01 – 2012:08
Recession Regime(s)	R1	R1	R1+R2	R1
Slowdown Regime(s)	R1+R2	R1+R2	R1+R2+R3	R1+R2

Source: Authors' calculations

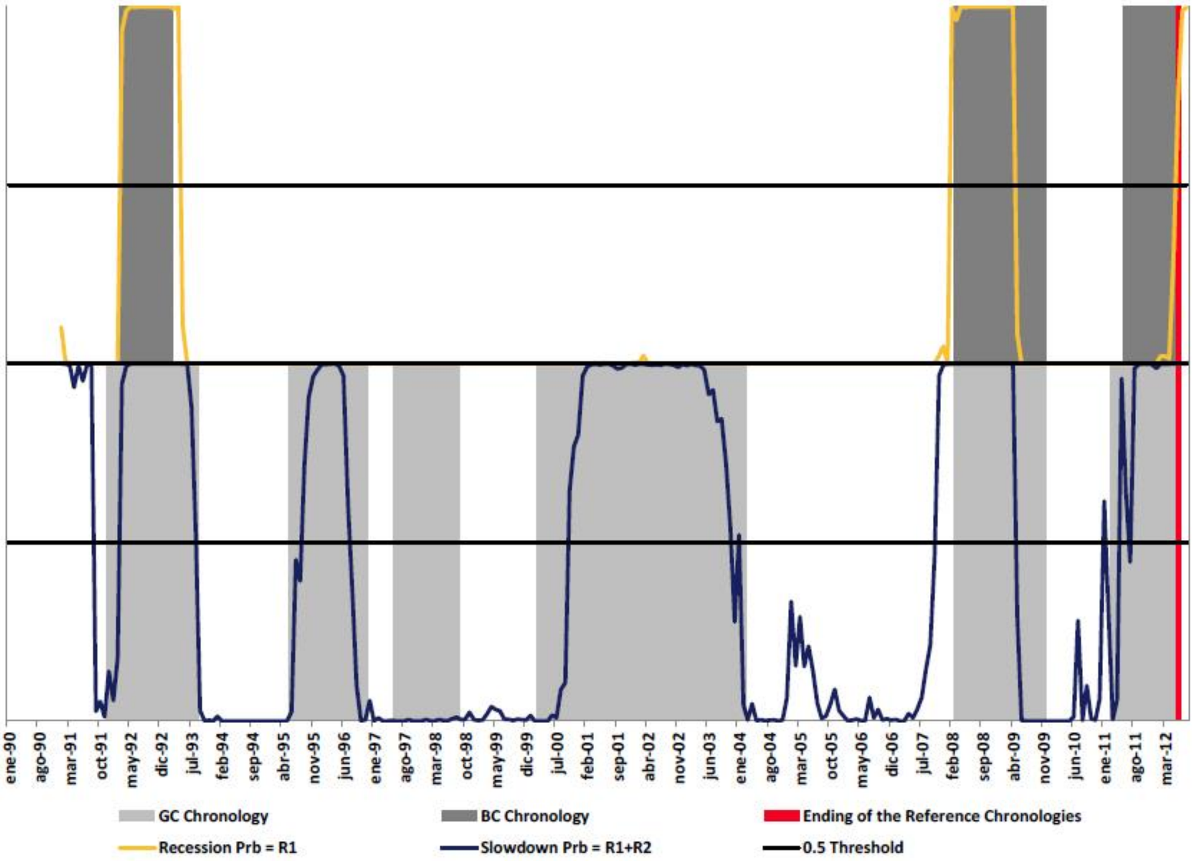
MODEL A - MSIH(4)-VAR(0) FITTED TO IPI(6), BUIL(3), CONS(12), RETA(6)

Table 61: Parameter estimates of Model A

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(6)	-1.71	-0.19	0.49	0.56	1.39	0.49	0.46	0.96
BUIL(3)	-0.42	-0.15	0.12	0.62	0.70	0.91	1.09	0.77
CONS(12)	-1.76	-0.24	0.29	1.97	0.65	0.55	0.35	0.61
RETA(6)	-1.16	0.07	0.10	1.13	1.15	0.56	0.86	0.81

Source: Authors' calculations

Figure 35: **Recession and slowdown probabilities of the Spanish classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(6), BUIL(3), CONS(12), RETA(6)**



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

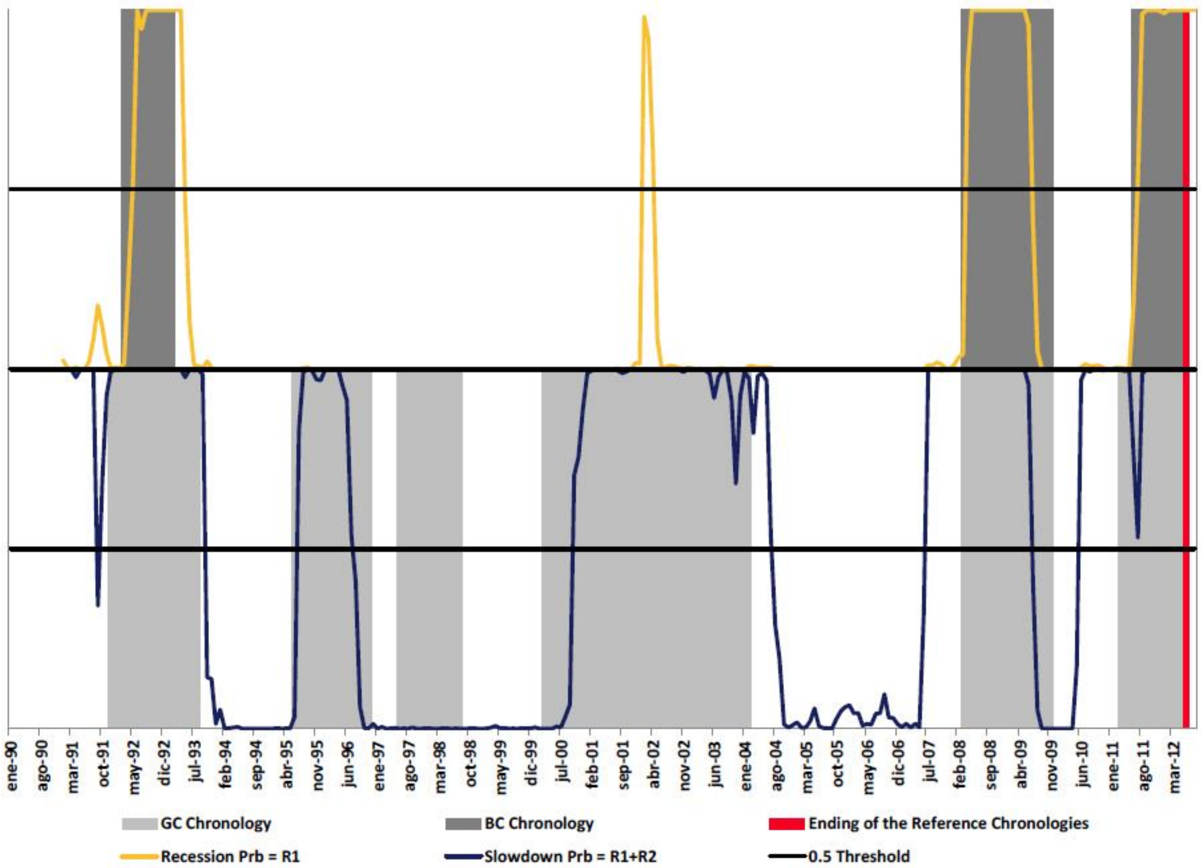
MODEL B - MSIH(4)-VAR(0) FITTED TO IPI(6), UR(3), BUIL(3), CONS(12)

Table 62: **Parameter estimates of Model B**

Variable	Intercept				Volatility			
	R1	R2	R3	R4	R1	R2	R3	R4
IPI(6)	-1.52	0.01	0.47	0.84	1.25	0.42	0.42	0.71
UR(3)	-1.64	0.02	0.77	0.02	0.95	0.51	0.39	0.70
BUIL(3)	-0.16	-0.26	0.23	0.45	0.74	0.87	1.12	1.08
CONS(12)	-1.19	-0.18	0.23	1.53	1.15	0.52	0.26	0.75

Source: Authors' calculations

Figure 36: Recession and slowdown probabilities of the Spanish classical and growth cycles, respectively, estimated by fitting a MSIH(4)-VAR(0) model to IPI(6), UR(3), BUIL(3), CONS(12)



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively.

Source: Authors' calculations

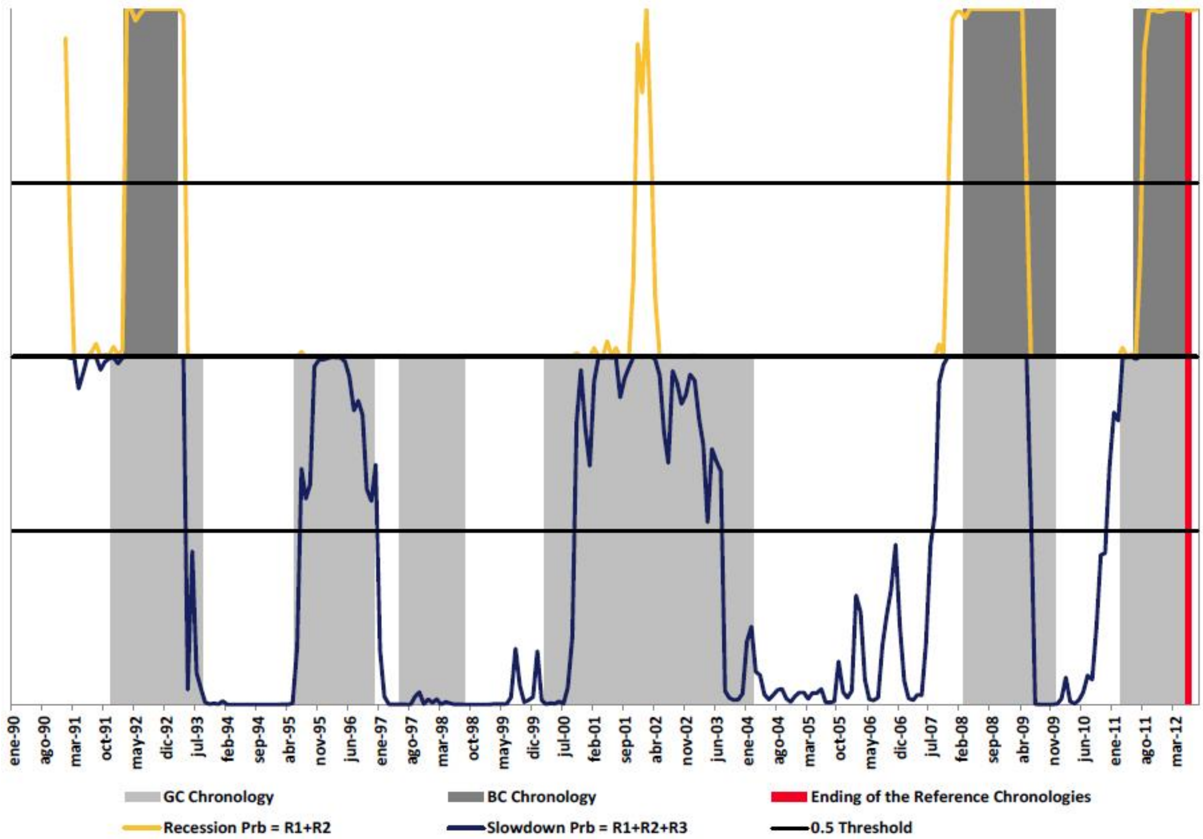
MODEL C - MSI(5)-VAR(0) FITTED TO IPI(6), UR(1), BUIL(12), INDU(3), CONS(6)

Table 63: Parameter estimates of Model C

Variable	Intercept					Volatility
	R1	R2	R3	R4	R5	
IPI(6)	-2.87	-0.84	-0.03	0.48	0.78	0.57
UR(1)	-2.53	-0.99	0.12	0.41	0.44	0.67
BUIL(12)	-1.35	-0.65	-0.38	0.27	1.41	0.76
INDU(3)	-1.90	-0.35	-0.24	0.40	0.75	0.81
CONS(6)	-1.82	-0.66	0.00	0.16	1.33	0.76

Source: Authors' calculations

Figure 37: Recession and slowdown probabilities of the Spanish classical and growth cycles, respectively, estimated by fitting a MSI(5)-VAR(0) model to IPI(6), UR(1), BUIL(12), INDU(3), CONS(6).



Note: Recession and slowdown periods (dark grey and light grey areas), as implied by the reference dating chronologies of the classical and growth cycle, respectively

Source: Authors' calculations

Table 64: Turning points dating chronologies of the Spanish classical and growth cycles according to the ABCD approach and turning point signals derived from the selected MS models

Turning Point	Reference Dating Chronology	Model A	Model B	Model C	Model D
Peak A	1991Q4	1992M2 (+3)	1991M9(-2)	-	-
Peak B	1992Q1	1992M2 (+0)	1992M4 (+2)	1992M2 (+0)	1992M5 (+3)
Trough C	1993Q1	1993M4 (+2)	1993M4 (+2)	1993M4 (+2)	1993M9 (+7)
Trough D	1993Q3	1993M8 (+0)	1993M9 (+1)	1993M4 (-4)	1993M9 (+1)
Peak A	1995Q2	1995M8 (+3)	1995M6 (+1)	1995M6 (+1)	1995M9 (+4)
Trough D	1996Q4	1996M7 (-4)	1996M7 (-4)	1996M12 (+1)	1996M6 (-5)
Peak A	1997Q2	-	-	-	-
Trough D	1998Q3	-	-	-	-
Peak A	2000Q1	2000M9 (+7)	2000M9 (+7)	2000M9 (+7)	2001M3 (+13)
Peak B	-	-	2002M1	2001M11	-
Trough C	-	-	2002M4	2002M3	-
Trough D	2004Q1	2004M1 (-1)	2004M7 (+5)	2003M7 (-7)	2003M10 (-4)
Peak A	2008Q1	2007M10 (-4)	2007M6 (-8)	2007M7 (-7)	2007M8 (-6)
Peak B	2008Q1	2008M1 (-1)	2008M3 (+1)	2007M11 (-4)	2008M1 (-1)
Trough C	2009Q4	2009M4 (-7)	2009M6 (-5)	2009M5 (-6)	2009M11 (+0)
Trough D	2009Q4	2009M4 (-7)	2009M6 (-5)	2009M6 (-5)	2009M11 (+0)
Peak A	2011Q1	2011M4 (+2)	2010M5 (-14)	2010M11 (-3)	2010M6 (-8)
Peak B	2011Q2	2012M5 (+12)	2011M6 (+1)	2011M7 (+2)	2011M6 (+1)

Source: Authors' calculations

Table 65: **Accuracy statistics of the proposed coincident indicators of the Spanish classical and growth cycles**

Coincident Indicator	Coincdent	Cycle	QPS	CI	Lag Peaks	Early Peaks	Lag Troughs	Early Troughs	False Signals	Missed Signals
Model A	1991:01	BC	.082	.915	6.0	0.2	0.7	2.3	0	0
		GC	.206	.779	3.0	0.8	0	3.0	1	1
Model B	1991:01	BC	.048	.946	1.3	0	1.5	2.5	1	0
		GC	.242	.748	1.8	6.0	1.5	2.3	1	1
Model C	1991:01	BC	.065	.930	0.7	1.3	1.0	3.0	2	0
		GC	.227	.764	2.0	2.5	0.3	4.0	1	1
Model D	1991:01	BC	.041	.953	1.3	0.3	3.5	0	0	0
		GC	.254	.740	4.3	3.5	0.3	2.3	1	1
Model E	1991:01	BC	.082	.915	6.0	0.2	0.7	2.3	0	0
		GC	.206	.779	3.0	0.8	0	3.0	1	1

Source: Authors' calculations

KS-TC-16-018-EN-N

Probabilistic coincident indicators of the classical and growth cycles

MONICA BILLIO, LEONARDO CARATI,
LAURENT FERRARA, GIAN LUIGI MAZZI AND
ROSA RUGGERI-CANNATA

This paper describes the construction of a pair of probabilistic coincident indicators for the growth and the business cycles turning points for the largest euro area economies.

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ISBN: 978-92-79-62180-2