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Werner Roeger, Kieran Mc Morrow,
Atanas Hristov and Valerie Vandermeulen

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Abstract

Questions have recently been raised on the usefulness of output gaps (which define the cyclical position of a country) for policymaking purposes. Whilst these questions are important in raising awareness concerning the uncertainty which inevitably surrounds an unobservable variable such as the output gap, we believe that the discussions are sometimes neglectful of the empirical evidence with respect to the performance of specific business cycle indicators. The current article therefore assesses the empirical performance of the most widely used business cycle indicators in output gap analysis, with a significant proportion of the recent criticism on the economic plausibility of output gaps drawing heavily on specific inflation indicators (such as headline or core inflation) or on indicators of external imbalances. The empirical evidence in this article shows that these inflation and external balance indicators do not perform well as indicators of the cycle and consequently should be used with caution by policy makers.

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Contact: European Commission, Directorate-General for Economic and Financial Affairs, Directorate B - Investment, growth and structural reforms, Unit Models and Databases, tel.: + 3222993362, office: CHAR 14/004, e-mail: werner.roeger@ec.europa.eu

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1. INTRODUCTION

Doubts have recently been raised about the usefulness of output gaps (which define the cyclical position of a country) for policymaking purposes (e.g. Brooks, 2019; Tooze, 2019). These doubts relate to two specific criticisms of the output gap estimates produced by the EU's commonly agreed methodology (CAM), as well as those of the IMF and OECD. The first criticism is based on the view that using specific business cycle indicators (i.e. headline or core inflation, as well as the current account balance), one would currently expect to see a significant negative output gap in the euro area and in individual Member States. The second criticism is that it is "absurd" for the CAM estimates to suggest that countries such as Italy and Germany are in broadly the same cyclical position, given their very different growth performances since 2008.

Even though there are many open, contentious, issues relating to different aspects of output gap estimation, the purpose of this article is not to provide a description of the EU's CAM for calculating output gaps¹; nor to discuss the Commission's "constrained discretion" in dealing with the unavoidable uncertainty surrounding structural budget balance estimates when interpreting the EU's fiscal rules².

The purpose of this article is to assess the empirical performance of the most widely used business cycle indicators employed in output gap analysis. We believe that a lot of the current debate on output gaps does not pay sufficient attention to the relative empirical performance of these business cycle indicators. In fact, as this article will show, a significant proportion of the recent criticism on the economic plausibility of the output gaps produced by the EU's CAM rests heavily on the use of specific indicators which the empirical evidence shows do not perform well as indicators of the business cycle. If those indicators are not empirically justified, any inferences in terms of the policy implications of the resultant output gap estimates should be interpreted with caution by policy makers.

The paper is structured as follows. Part 2 focusses on where the euro area is in the current economic cycle and how different indicators might be giving conflicting signals. Part 3 gives an overview of the main cyclical indicators available and in part 4 a common element is isolated from a subset of seven cyclical indicators using principal component analysis. Part 5 shows how this common element can be compared to the output gap estimates produced by the CAM, with the last part providing some overall conclusions from the analysis.

¹ In terms of the institutional framework, it is important to stress at the outset that in calculating output gaps, the Commission does not apply its own methodology. In order to ensure that all Member States are treated in the same way, the Commission applies the rules and methods that have been commonly agreed by output gap experts from all of the EU's 28 Member States. These experts meet 5 to 6 times a year in a dedicated Output Gap Working Group (OGWG), with any improvements to the common method which are approved by the OGWG having to be endorsed by the EU's Economic Policy Committee (EPC) and, if the change is large, by the ECOFIN Council. The OGWG is mandated to ensure scientifically robust output gap estimates and to carry out regular assessments of the real time performance of the commonly agreed methodology (CAM). A key strength of the CAM is its ability to recognise country-specific characteristics, with a range of country specific changes approved over recent years. In addition, the CAM results are cross-checked by the "Plausibility Tool" which is used to signal cases where the results of the agreed methodology could be interpreted as being economically counter-intuitive.

² In response to the difficulties associated with estimating the output gap and thus the structural balance, and following agreement with the EU's member states, the commonly agreed methodology (CAM) has recently been complemented with the use of a "constrained judgement" approach. This involves the use of the "plausibility tool" to identify countries where there are strong concerns that the CAM could produce output gaps subject to a large degree of uncertainty. The "constrained judgement" approach allows the Commission to depart from the output gap estimates of the CAM in its assessment of the cyclical position of any of the Member States when conducting its fiscal assessments. In addition, in its assessment of the fiscal effort, the Commission now gives prominence to the expenditure benchmark, which is less prone to revisions compared to the change in the structural balance since it is based on the medium-term rate of potential growth calculated on the basis of a ten-year average.

2. WHERE IS THE EURO AREA IN THE CURRENT ECONOMIC CYCLE?

Based on recent output gap estimates from the EU's commonly agreed methodology (CAM), as well as from other international institutions, the euro area's (EA) economy is currently operating at about its long-term sustainable growth rate (Malin et al., 2018). This means that the economic slack in the economy, which had built up following the global financial crisis and the sovereign debt crisis, has now largely been eliminated³. The euro area's unemployment rate is also near historic lows, and is predicted to fall well below 8% in 2019. In the past, such conditions have generally been associated with mounting inflationary pressures. Yet, the EA's core inflation⁴ is currently stuck at roughly 1%.

Lack of inflationary pressure raises questions about the current position of the EA in the cycle. For example, Brooks (2019) and others⁵ see the historically low (wage and price) inflation and the significant current account surplus as a sign that the EA has not yet reached its potential and that its output gap (which is the ratio of actual output over potential output and shows the cyclical position of a country) is still negative. However, applying the EU's CAM to the EA leads to slightly positive output gap estimates in the current juncture (European Commission, 2018). In addition, output gap measures based on sentiment and capacity utilisation indicators also indicate a positive gap (De Waziers, 2018).

Possible explanations for the conflicting signals provided by the different cyclical indicators include the fact that some of those indicators may only be capturing specific dimensions of the EA's business cycle (e.g., the product or labour market dimension). Moreover, they may not be unambiguous cyclical indicators since they contain strong trend components, relating to structural factors in the economy (a structural component is one that is permanent or very long-lived). In order to discriminate between the signalling power of specific indicators, this article firstly distils a common cyclical signal from the most widely used business cycle indicators (using principal component analysis) and then compares this cyclical signal to that provided by the output gap estimates of the EU's CAM to assess if the latter estimates are economically plausible.

3. SHORT OVERVIEW OF THE MAIN CYCLICAL INDICATORS USED IN OUTPUT GAP ANALYSIS

Before presenting the main results, it is important to discuss some features of the most frequently used indicators. The indicators we use are the following:

- **Price inflation:** This is a popular indicator, though theoretically it is not the preferred indicator; e.g., the curve literature would suggest to use the difference between current inflation and expected inflation and also recognises that inflation is not only driven by demand but also by cost push factors, which can contain trends.

³ An analysis in the Commission's Autumn 2018 forecast document, which examined different concepts of labour-market slack both at the euro area and Member State levels, concluded that "despite possible measurement uncertainty, most evidence shows a diminishing and relatively limited degree of slack at the aggregate level"

⁴ Core inflation is measured using the PCE (personal consumption expenditures) deflator excluding food and energy.

⁵ For example, the Jarocinski and Lenza paper from 2016 also stresses the importance of inflation as an indicator of the cycle, suggesting that output in the euro area was 6% lower than potential in 2014 and 2015, with this 6% output gap estimate being substantially below comparable institutional estimates.

- **Wage inflation:** The literature on the non-accelerating wage rate of unemployment (NAWRU) suggests that wage inflation contains cyclical information, but information on wage inflation *per se* is insufficient for assessing cyclical labour market conditions (e.g. it needs to be complemented by information about productivity growth).
- **Current account balance (CAB):** Whilst measures of external imbalances are linked to output gap developments; like inflation, they are not unequivocal cyclical indicators. The CAB can incorporate a strong trend component, because it can reflect changes in household savings, driven by shifts in demographic trends. Moreover, the link to the cycle is not straightforward: the current account balance can be positive because of low domestic demand (small or negative output gap) or because of buoyant external demand conditions (which tend to push up the output gap).
- **GDP Growth:** The growth of GDP is certainly correlated with the cycle but it will generally also be correlated with the trend. This correlation can be minimised by using lagged GDP growth, with the expectation that lagged GDP is only correlated with the cyclical component. Consequently, it is expected that the economic cycle follows the GDP growth cycle with a lag (by at least one year): if last years GDP growth rate is increasing, we expect the cycle to pick up⁶.
- **Short term unemployment rate (STUR):** This is a more clear-cut cyclical indicator, with changes nearly exclusively driven by cyclical variations. Hysteresis effects should show up in the long-term unemployment rate. However, the short term unemployment rate is not a comprehensive measure of cyclical labour market developments. Other labour market indicators such as the long-term unemployment rate, average hours worked and participation rates also contain cyclical elements.
- **Sentiment indicators and capacity utilisation indicators:** Survey indicators (including the sentiment indicator of economic slack which we exploit in section 4 of this paper)⁷ give an idea about the cyclical situation in certain sectors of the economy and have the advantage of not being revised (Fleischman and Roberts, 2011). Questions have been raised recently whether the correlation between economic sentiment indicators and hard data, such as GDP or industrial production, might have changed over time, as firms adjusted their expectations to the new long-term growth outlook (Gayer and Marc, 2018). Even with this changed link between sentiment and GDP growth, the use of surveys as cyclical indicators is still recommended (Gayer and Marc, 2018).

To sum up, some cyclical indicators might not be fully unambiguous indicators of the cycle for a number of reasons:

- they may contain trend components (e.g., inflation is dominated by a slow-moving trend associated with monetary policy and a noisy component related mainly to energy);
- they may move in the same direction with both a negative demand shock or a positive supply shock (e.g., the current account); and
- they may not be comprehensive enough indicators of labour market developments (e.g., the short term unemployment rate).

⁶ GDP growth is generally correlated with trend growth and the cycle. The correlation with trend growth can be reduced by using lagged GDP. For example, if trend growth is represented by a random walk with drift, lagged GDP growth is uncorrelated with trend growth, but remains correlated with the cycle.

⁷ It is important to stress that we don't use all of the available sentiment indicators because of the importance of restricting the analysis to indicators of the output gap cycle (in levels) and not the GDP growth cycle. A restrictive selection process is essential to avoid mixing level and growth signals, and consequently we restrict the analysis to just one sentiment indicator, namely the indicator of economic slack.

4. ISOLATING THE COMMON CYCLICAL SIGNAL USING A PRINCIPAL COMPONENTS ANALYSIS

Principal component analysis (PCA) is a powerful dimension reduction method, which allows one to assess how well individual indicators are correlated with the common cyclical component. It does not impose specific restrictions on the data and it sorts the data series into common components.

The main findings from the PCA are given in table 4.1 and in graphs 4.1 and 4.2, with a focus on four European countries namely Germany, Italy, Spain and Portugal. More information on the PCA is included in Box 4.1. A PCA on a set of seven indicators⁸ (see table 4.1) leads to the selection of two principal components⁹. These two components can explain more than 60% of the variation in each indicator. Looking at the weights for each indicator, one can see that the CAB and price inflation indicators are strongly related to the second component but that many of the correlation coefficients between the indicators and the second component are incorrectly signed, raising concerns that the CAB and price inflation indicators are ambiguous cyclical indicators. The graphs show that this second component does not have a strong cyclical pattern and that the indicators have inconsistent signs if one wishes to interpret the second component as being cyclical. This becomes clearly visible if one assumes that the short-term unemployment rate and the sentiment of economic slack indicators should have a negative sign (since these are the two most unambiguous cyclical indicators). In this case, capacity utilisation and GDP growth also have the correct sign, but all four variables only explain a very small fraction of the variation of the second component. However, the inflation indicators and the CAB indicator have the wrong sign if we interpret the second component as cyclical. An increase in the current account is positively associated with the second component, whilst both wage and price inflation are negatively correlated with this component. In our view, this confirms the ambiguity of the inflation and CAB indicators since they are manifestly driven by more than just demand shocks. Concerning inflation the second component can be interpreted consistently if we regard the negative impact of inflation as a cost-push shock. For example, an increase in oil prices raises inflation and has a negative impact on growth. The positive coefficient of the current account in the second component reflects the impact of world demand developments. Consequently, in this analysis we discard the shocks driving the second component as they are not unequivocally cyclical (further information on the cyclical behaviour of the second component is given in Box 4.2).

The first component can explain more than 50% of the variation in most of the indicators. Several slack indicators, namely capacity utilisation, slack in the economy and growth in GDP, are strongly related to the first component. These are the cyclical variables which are most closely linked to developments in the EA's product markets. Several labour market indicators are also picked up, namely the short-term unemployment rate and wage inflation, although a bit less strongly than the slack indicators. Table 4.1 also shows that the CAB and price inflation indicators are not strongly related to the first component. Consequently, whilst we accept that certain measures of domestic inflationary pressures and of external imbalances are linked to output gaps, the PCA suggests that the price inflation and CAB indicators are much less potent cyclical indicators than the other indicators. It is also interesting to observe that for Italy, Spain and Portugal the cyclical indicators are pointing towards a closing of the, or a positive, output gap in 2018, while Germany's cyclical position is slightly more advanced.

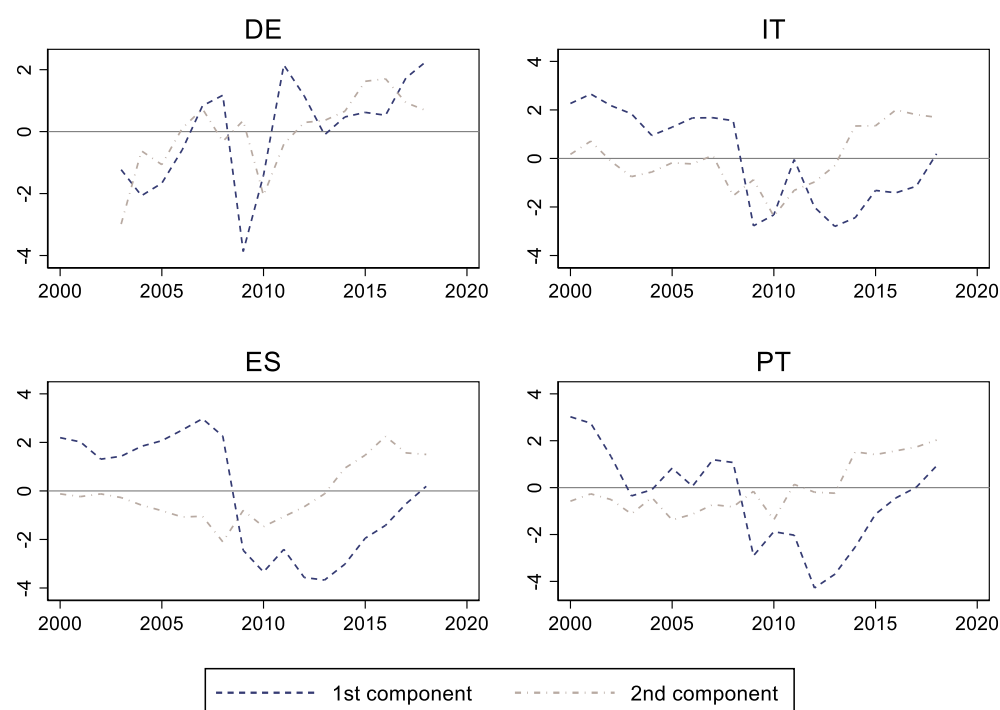
⁸ Several other indicators were tested (such as core inflation, real unit labour costs, house price inflation, household credit growth) and only the most cyclical ones were kept in the analysis.

⁹ The two principal components are new variables constructed as linear combinations of the chosen 7 indicators. These combinations are done in such a way that the new variables (i.e., principal components) are uncorrelated with each other and most of the information within the initial variables is squeezed or compressed into the first two components.

Table 4.1. Overview of PCA Results

	First component		Second component		
	Correlation coefficient	% of variance explained	Correlation coefficient	Additional % of variance explained	Total % of variance explained
Price inflation ¹⁰	0.3	0.3	-0.5	0.3	0.6
Wage inflation ¹¹	0.4	0.4	-0.3	0.1	0.6
Current account balance	-0.2	0.1	0.6	0.5	0.6
Growth in GDP (lagged)	0.4	0.6	0.2	0.0	0.6
Short term unemployment rate ¹²	-0.4	0.6	-0.3	0.1	0.7
Economic slack (sentiment indicator)	-0.4	0.7	-0.2	0.0	0.7
Capacity utilisation	0.4	0.6	0.3	0.1	0.7

Graph 4.1. First and second component of the PCA for Germany, Italy, Spain and Portugal (2000-2018)

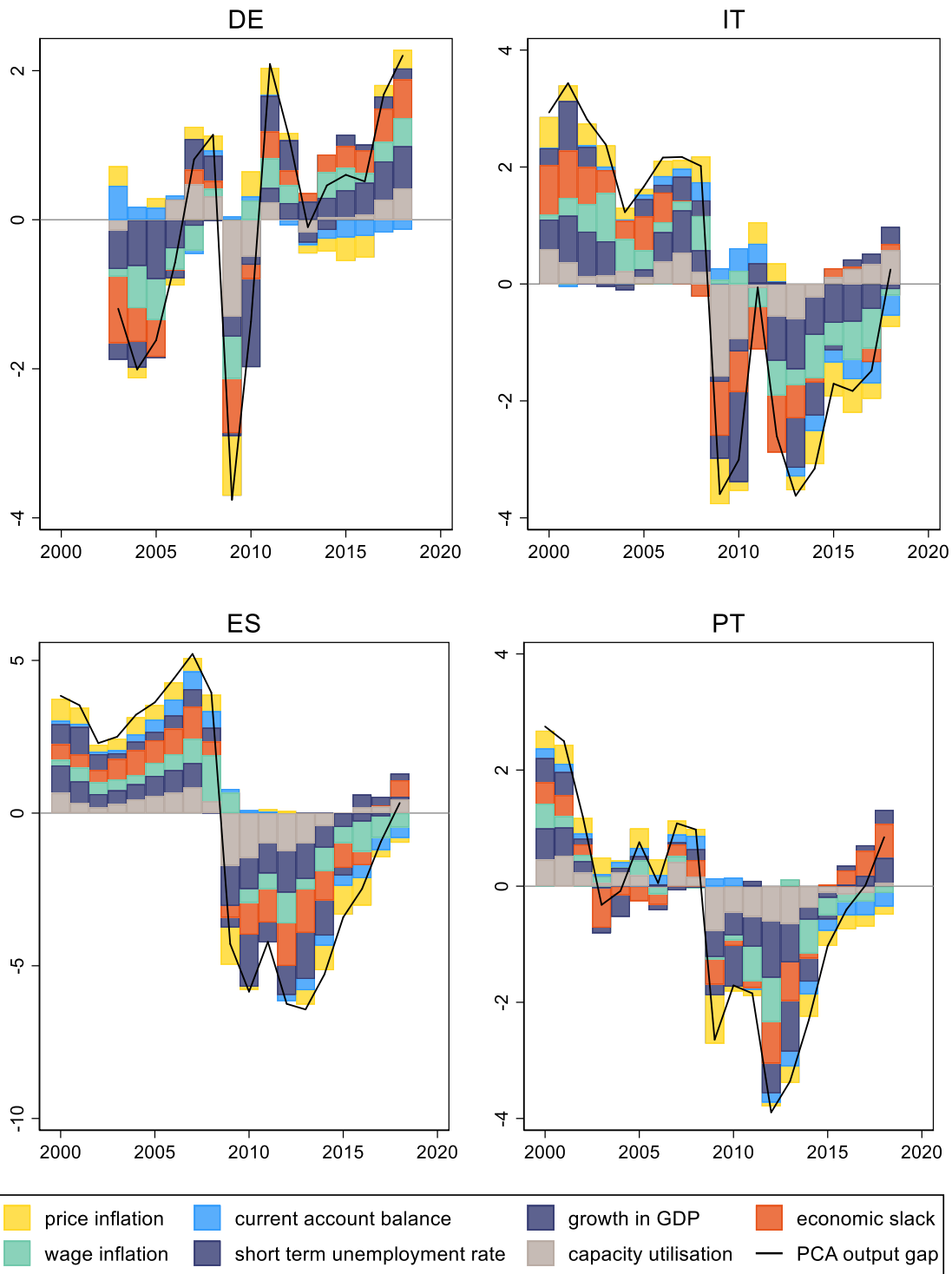


¹⁰ Price inflation is based on the deflator of private consumption expenditure.

¹¹ Wage inflation is calculated using nominal compensation per employee.

¹² Data on long term unemployment rate in Eurostat is only available for Germany as of 2003, limiting the sample and analysis.

Graph 4.2. Indicator contributions to the PCA output gap for Germany, Italy, Spain and Portugal (2000-2018)



Note: the PCA output gap is calculated using only the first component and rescaled to the standard deviation of the CAM output gap

Box 4.1. PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis (PCA) was used to select the common elements amongst several cyclical variables.

Data

The variables sentiment of economic slack and capacity utilisation are based on questions from the Business and Consumer Survey of the European Commission. Price inflation (private consumption expenditure deflator), wage inflation (nominal compensation per employee), current account balance and lagged growth in real GDP come from the AMECO database, Autumn 2018. The short term unemployment rate is calculated based on the harmonised unemployment rate available in AMECO and the long term unemployment rate from Eurostat.

The dataset includes all 28 European Union countries, excluding Ireland and Croatia due to lack of data. The sample period depends on the availability of the data and can differ from one country to another starting the earliest in 1996 and the latest in 2008 (Cyprus) and ending in 2018.

Method

The aim of PCA is to reduce observed data and to bring out strong patterns in a dataset. In the PCA, each common (principal) component (PC) is a combination of all explanatory variables (X) and a certain weight given to these variables (w). The number of common components (i) is selected based on the eigenvalue (all components are selected with an eigenvalue above 1).

$$PC_i = w_{1i}X_1 + w_{2i}X_2 + \dots$$

PCA is sensitive to the scale of the variables. Before performing the analysis, the variables are therefore standardised over the sample for which all variables exist per country. In order to get an estimate of an output gap comparable to the official CAM output gap, the selected components are rescaled, using the standard deviation of the CAM output gap, per country, over the sample for which all variables exist. A mean PCA output gap of zero is assumed.

Results

Two components are selected based on their eigenvalue. However, investigating the cyclical pattern of the second component (which also has a much smaller eigenvalue) suggests to only use the first component to calculate a PCA output gap (see Box 4.2). The weights (correlation coefficients) of each of the variables are given in Table 4.1.

	Eigenvalues
PC_1	3.3
PC_2	1.2
PC_3	0.7
PC_4	0.6
PC_5	0.5
PC_6	0.4
PC_7	0.3

The rescaled PC_1 thus gives the PCA output gap, which can be compared to the CAM output gap (see graph 5.1 for the results for Germany, Italy, Spain and Portugal).

Box 4.2. CYCLICAL PROPERTIES OF THE SECOND COMPONENT OF THE PCA

Within the text it is assumed that the second component of the PCA is not a clear cyclical variable. To decide whether a variable is cyclical, the following criteria were used:

1. Visual inspection: the series should follow a cyclical pattern, and preferably indicate troughs and peaks around the same time of the business cycle troughs and peaks.
2. Consistent signs for the coefficients: all coefficients should have consistent signs, as predicted by the theory of business cycle behaviour.
3. Cyclical process: a cyclical time series is expected to be stationary and to follow a second order autoregressive process.

As reported in the text, the second component does not perform well on the first and second criteria. Looking at graph 4.1, the second component does not have a strong cyclical pattern. The first component does show this pattern, with peaks and troughs at times when expected by general business cycle knowledge. Table 4.1 has shown that the indicators of the second component have inconsistent signs, if one wants to interpret it as being cyclical (see the main text for further elaboration).

Regarding the third criterion (i.e. can the time series based on the two principal components be specified using an AR(2) process), there are clear differences between the first and second components. Looking at the panel dataset (Random-effects ML regression) one can see that the first component follows a clear cyclical AR(2) process (first coefficient is positive and smaller than 1, second coefficient is negative, their sum is less than 1). Looking at the second component, the regression shows a positive and significant first coefficient, but also a positive and insignificant second coefficient (p-values are given between brackets). This pattern is much more consistent with a stationary trend process, rather than a cyclical process.

$$PC_1 = 0.77(0.00) L.PC1 - 0.29(0.00)L2.PC1$$

$$PC_2 = 0.73(0.00) L.PC2 + 0.05(0.31) L2.PC2$$

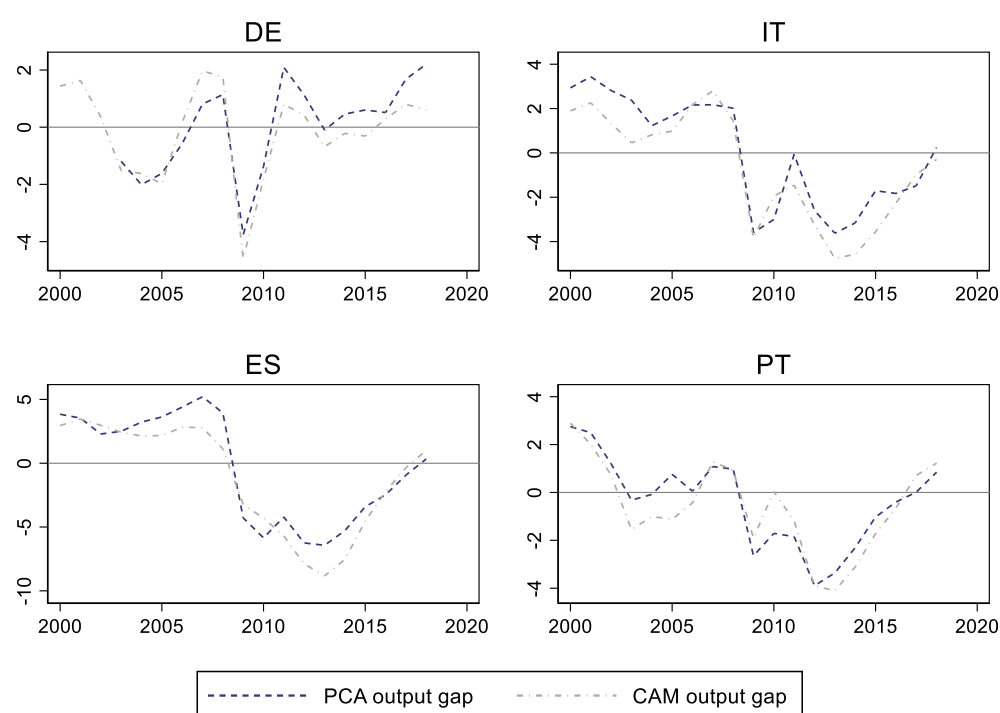
The next two tables confirm this result on a country by country basis.

First component				
	DE	ES	IT	PT
First lag	0.40	1.17	0.72	0.90
p-value	(0.16)	(0.00)	(0.01)	(0.00)
Second lag	-0.42	-0.37	-0.06	-0.13
p-value	(0.15)	(0.10)	(0.82)	(0.57)
N	14	21	17	21
R-squared	0.23	0.77	0.51	0.66
Second component				
	DE	ES	IT	PT
First lag	0.38	0.93	0.72	0.55
p-value	(0.19)	(0.00)	(0.01)	(0.02)
Second lag	0.18	-0.07	0.13	0.43
p-value	(0.44)	(0.78)	(0.65)	(0.08)
N	14	21	17	21
R-squared	0.27	0.71	0.59	0.63

5. COMPARING THE COMMON CYCLICAL COMPONENT TO THE OUTPUT GAP FROM THE EU'S COMMONLY AGREED METHOD

Given the issues raised with the second component, we build a PCA-derived output gap based on the first component only. The next graph, 5.1, shows that the resultant PCA output gap and the CAM output gap for the selected four euro area countries are highly correlated, with the two output gaps following a similar pattern over history.

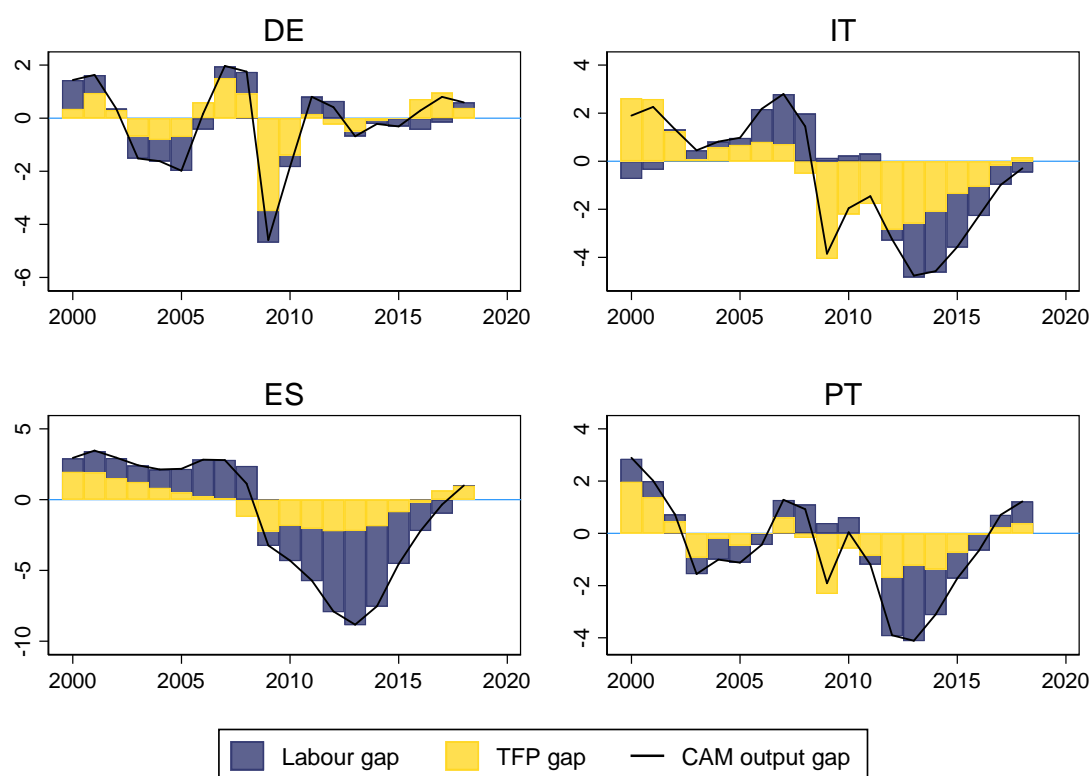
Graph 5.1. PCA output gap and CAM output gap for Germany, Italy, Spain and Portugal (2000-2018)



Note: the PCA output gap is calculated using only the first component and rescaled to the standard deviation of the CAM output gap

In the EU's CAM, potential output is calculated using the actual capital stock of a country multiplied by potential labour and potential total factor productivity (TFP) (Havik et al., 2014). Remark that potential labour and potential TFP are calculated using a multivariate Kalman filter, and as such incorporate more information than just their own historical trends (capacity utilisation and wage indicators are used as exogenous variables). Since the output gap is the ratio of actual over potential output, the total output gap can be rewritten as the sum of the labour gap and the productivity gap (TFP gap). Based on the CAM, the output gap is slightly positive for the four countries investigated, with the TFP gap slightly positive for all four countries, and the labour market broadly in balance for Spain and Germany, slightly negative still for Italy and slightly positive in Portugal.

Graph 5.2. CAM output gap, TFP and labour gap for Germany, Italy, Spain and Portugal (2000-2018)



The CAM uses several cyclical indicators. For example, the cyclical component of unemployment (unemployment gap) is extracted using information about real or nominal unit labour cost developments (non-accelerating wage rate of unemployment concept). The TFP gap, which measures the degree of capacity utilisation by firms (tightness in product markets), is informed by a whole set of sentiment indicators (capacity utilisation for manufacturing and business sentiment indicators for services and construction).

As mentioned earlier, Graph 5.1 shows that the PCA output gap follows closely the evolution of the CAM output gap. Both the PCA and CAM output gaps are highly correlated, showing a similar evolution after the 2008 economic bust as well as the different speeds of recovery between Germany and the other countries. Graph 5.2 shows that changes in capacity utilisation and slack in the economy were the important drivers of the recovery over recent years. For example for Italy, the slack and capacity utilisation indicators became positive in 2015 followed by growth in GDP, while the other indicators remained negative, even at the end of the sample (2018). One can see similar evolutions in Spain and Portugal. This is consistent with the results of the decomposition of the CAM aggregated output gaps into their TFP gap and labour market gap components (see Graph 5.2), which show that the recovery is mostly driven by a positive TFP gap. The recovery in Germany after 2013 was different: although the slack indicator became positive, the contribution of capacity utilisation remained small and the labour market indicators picked up much faster.

6. CONCLUSIONS

Since there are different views about the cycle based on different indicators, the only way they can be ranked is by empirical performance. On the basis of the evidence presented in this paper, if one uses PCA to extract one common cyclical component from several cyclical indicators, this extracted common component follows closely the output gap estimates of the EU's CAM, with both methods indicating that the output gap of the selected countries (and that of the EA as a whole) is heading towards positive territory. The analysis also confirms the ambiguous cyclical signals from indicators such as price inflation and the current account balance. Since the PCA or CAM methods exploit the cyclical signal from both the labour and product market sides of the economy, they are expected to lead to a more balanced and plausible view of the EA's current cyclical position. The indicators used in the EU's CAM method are empirically well grounded and point to a greater role for product market rather than labour market influences in determining the current evolution of the EA's overall output gap¹³. Finally, it should be stressed, that the inflation rate is not only a questionable indicator of where we are in the current cycle, it also had poor signalling properties in the pre-crisis period and consequently, in our view, any assessment of where the euro area is in the current economic cycle, which draws heavily or solely on the price inflation indicator, would be problematic.

¹³ We consider TFP, rather than the NAWRU (with the steady decline in the euro area's NAWRU over recent years being consistent with, and validated by, the secular wage moderation pattern which has been evident in the euro area for some time now), to be the source of the greatest risk of future potential growth rate and output gap revisions.

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