



Economic Analysis Papers

A MONTHLY INDICATOR FOR GDP GROWTH IN CYPRUS

Christos Papamichael

Economics Research Centre

Nicoletta Pashourtidou

Economics Research Centre

No. 06-12

October 2012

Publication Editor: Sofia N. Andreou

ERC Sponsors (in alphabetical order)

Association of Cyprus Banks

Central Bank of Cyprus

Department of Economics, University of Cyprus

Ministry of Finance

Ministry of Labour and Social Insurance

Planning Bureau

University of Cyprus

Disclaimer: the views expressed in the Economic Policy Papers and Economic Analysis Papers are of the authors and do not necessarily represent the ERC.

A MONTHLY INDICATOR FOR GDP GROWTH IN CYPRUS

Christos Papamichael and Nicoletta Pashourtidou

Executive Summary

The aim of this paper is the construction of a monthly indicator for estimating Cyprus GDP growth, free of short run fluctuations. The purpose of the indicator is to provide timely signals about the direction of real economic activity in the current and in the following one to two quarters. The indicator presented here utilises the information from a large dataset of about 190 domestic and foreign/international monthly series by summarising it in a small number of common factors obtained via principal component analysis. The monthly factors reflecting the most recent information contained in monthly series are then used to obtain a projection of the medium/long run growth which is the proposed monthly indicator. By exploiting the timely signals from monthly series the indicator produces estimates of the medium/long run component of GDP growth at a monthly frequency. The indicator constructed using smoothed factors outperforms similar indicators based on non-smoothed factors (obtained directly from principal component analysis), or the Economic Sentiment Indicator (which uses information from business and consumer surveys only) in terms of correct turning point prediction and forecast error at the end of the sample. Furthermore, the monthly indicator yields the highest gains in the pseudo-out-of-sample exercise for nowcasting quarter-on-quarter GDP growth and for forecasting year-on-year growth one and two quarters ahead.

The indicator can be used for monitoring movements in real economic activity in the current and subsequent quarters and for providing early signs of expansions and contractions in the economy. It can be a useful tool for policy-makers and firms as regular observation of the evolution of the indicator could enable them to form a clearer picture of the outlook of the Cypriot economy and plan accordingly.

TABLE OF CONTENTS

ΠΕΡΙΛΗΨΗ	VI
1. INTRODUCTION.....	8
2. DATA.....	9
2.1 Monthly data	9
2.2 Medium/long run growth.....	10
2.3 Monthly factors.....	11
3. CONSTRUCTION OF THE MONTHLY INDICATOR	13
4. PERFORMANCE OF THE INDICATOR.....	16
4.1 End-of-sample performance.....	16
4.2 A Forecasting exercise for GDP growth	18
5. CONCLUSIONS	20
REFERENCES.....	22
APPENDIX	23
RECENT ECONOMIC POLICY/ANALYSIS PAPERS	28

ΜΗΝΙΑΙΟΣ ΔΕΙΚΤΗΣ ΤΟΥ ΡΥΘΜΟΥ ΜΕΤΑΒΟΛΗΣ ΤΟΥ ΑΕΠ ΣΤΗΝ ΚΥΠΡΟ

Χρίστος Παπαμιχαήλ και Νικολέττα Πασιουρτίδου

ΠΕΡΙΛΗΨΗ

Στόχος του Δοκιμίου είναι η κατασκευή ενός μηνιαίου δείκτη για την εκτίμηση του ρυθμού μεταβολής του ΑΕΠ στην Κύπρο, εξαιρουμένων οποιωνδήποτε βραχυπρόθεσμων διακυμάνσεων, καθώς και για την παροχή έγκαιρων ενδείξεων για την κατεύθυνση της πραγματικής οικονομικής δραστηριότητας το τρέχον και τα επόμενα ένα με δύο τρίμηνα. Ο δείκτης που παρουσιάζεται αξιοποιεί πληροφορίες από ένα μεγάλο αριθμό εγχώριων και ξένων/διεθνών μηνιαίων σειρών, συνοψίζοντάς τις σε ένα μικρό αριθμό κοινών παραγόντων (common factors). Οι μηνιαίοι παράγοντες που αντικατοπτρίζουν τις πιο πρόσφατες πληροφορίες που περιέχονται στις μηνιαίες μεταβλητές, χρησιμοποιούνται στον υπολογισμό μιας σειράς προβλέψεων για το μεσοπρόθεσμο/μακροπρόθεσμο ρυθμό ανάπτυξης. Οι προβλέψεις αυτές αποτελούν και τον προτεινόμενο μηνιαίο δείκτη. Αξιοποιώντας έτσι τις έγκαιρες ενδείξεις από τις μηνιαίες σειρές ο δείκτης παρέχει μια εκτίμηση της μεσοπρόθεσμης/μακροπρόθεσμης συνιστώσας του ρυθμού μεταβολής του ΑΕΠ σε μηνιαία βάση. Ο δείκτης που κατασκευάζεται με παράγοντες από τους οποίους έχουν αφαιρεθεί οι βραχυχρόνιες διακυμάνσεις, συνδέεται με μεγαλύτερο ποσοστό επιτυχίας πρόβλεψης των σημείων καμπής και με μικρότερο σφάλμα πρόβλεψης απ' ό,τι άλλοι μηνιαίοι δείκτες βασισμένοι είτε σε κοινούς παράγοντες που ενσωματώνουν βραχυχρόνιες μεταβολές, είτε στο Δείκτη Οικονομικής Συγκυρίας. Επιπλέον, από όλους τους δείκτες που χρησιμοποιήθηκαν στην ανάλυση, ο συγκεκριμένος μηνιαίος δείκτης δίνει τις ακριβέστερες προβλέψεις για τον τριμηνιαίο ρυθμό μεταβολής του ΑΕΠ το τρέχον τρίμηνο, καθώς για τον ετήσιο ρυθμό μεταβολής το επόμενο και μεθεπόμενο τρίμηνο.

Ο μηνιαίος δείκτης που κατασκευάζεται σε αυτό το Δοκίμιο μπορεί να χρησιμοποιηθεί για σκοπούς παρακολούθησης των μεταβολών στην πραγματική οικονομική δραστηριότητα το τρέχον και τα επόμενα τρίμηνα, καθώς και για την παροχή έγκαιρων ενδείξεων ανάκαμψης και συρρίκνωσης της οικονομίας. Θα μπορούσε να αποτελέσει ένα χρήσιμο εργαλείο για τους φορείς άσκησης οικονομικής πολιτικής και τις επιχειρήσεις, αφού η συστηματική παρατήρηση της πορείας του δείκτη συμβάλλει στη διαμόρφωση μιας πιο ξεκάθαρης εικόνας για τις βραχυπρόθεσμες προοπτικές της κυπριακής οικονομίας και συνεπώς σε καλύτερο προγραμματισμό.

1. INTRODUCTION

Indicators for monitoring the state of the economy are essential for the timely design and implementation of economic policies, as well as for planning purposes by private agents. Although the Gross Domestic Product (GDP) in constant prices is a comprehensive measure of real activity, it is published with a considerable delay and it is affected by short-run fluctuations. There is however, a large number of monthly variables that are released long before the publication of GDP which can provide valuable information about current and future evolution in activity.

Various methods have been proposed in the literature for combining monthly variables into composite indexes. The methods range from simple non-model based, such as weighted averages of index components, to more complicated model based techniques employing dynamic factor or Markov switching models (see e.g. Carriero and Marcellino, 2007). Non-model based methods and those using factor models result in a continuous variable which can be used to describe the developments in the economy, while Markov switching models yield discrete composite indexes representing expansions and contractions of the economic cycle. Another approach employs also monthly series to construct a monthly indicator of GDP which is then used in combination with short-term forecasting techniques to produce an early estimate of quarterly GDP growth, i.e. the estimate relates directly to standard measures of activity (see Mitchell et al., 2005).

The non-model based composite index of coincident indicators published by the Conference Board in the United States comprises of only four variables (number of employees on non-agricultural payroll, index of industrial production, manufacturing and trade sales, aggregate personal income excluding transfer payments) and it is amongst the most widely used indicators for the current state of the economy. The EuroCOIN published by the Centre for Economic Policy Research is a leading/coincident indicator of economic activity in the Euro Area, which is constructed using a dynamic factor model.¹ In particular, EuroCOIN is a real-time monthly estimate of Euro Area GDP growth free of short run fluctuations (see Altissimo et al., 2010).

In this paper we attempt to use a methodology similar to that employed in the construction of EuroCOIN to produce a monthly estimate of the medium/long run component of GDP growth for Cyprus. The monthly estimate exploits the information in a large set of timely available monthly variables (domestic and foreign/international) via the application of factor model analysis. The resulting indicator can be used to provide indications in real time about the current state of economy, as well as signals about the direction of real activity in the next couple of quarters. The paper is organised as follows. Section 2 describes the monthly dataset and the construction of

¹ See <http://www.cepr.org/data/eurocoin/>

the two main ingredients of the indicator namely the medium/long run component of GDP growth and the monthly factors. Section 3 presents the steps followed in the construction of the indicator. Section 4 evaluates the end-of-sample performance of the indicator against a target variable and assesses its ability for forecasting GDP growth. Section 5 concludes.

2. DATA

2.1 Monthly data

The dataset consists of about 190 monthly time series available since January 2002 onwards, covering various aspects of the domestic and international economy such as activity, labour market, prices, exchange rates, financial markets and economic sentiment. The monthly data are released long before the publication of official GDP figures e.g. in May of the current year, we can obtain numerous monthly series referring to April, March or February, while the latest available data for GDP refers to the last quarter of the previous year. The quarterly data for GDP (constant prices) begin in the first quarter of 1995.

Monthly variables obtained from the Statistical Service of Cyprus (e.g. volume indices of wholesale, retail trade and manufacturing, index of industrial production, building permits, sales of cement, registrations of motor vehicles, arrivals of tourists, tourism revenues, registered unemployed, etc.) provide up-to-date information on short-term developments in key sectors of the Cypriot economy. Data on industrial production and unemployment in the European Union and United Kingdom are drawn from Eurostat. Some of the abovementioned variables are published with a delay of one or two months with respect to the reference month, yet they have leading properties with respect to aggregate economic activity.

Economic sentiment data are obtained from the Business and Consumer Surveys (BCS) of the European Commission (DG-ECFIN) and are available at the end of each reference month. BCS data record, among other things, the perceptions and the expectations of firms about their production, demand, prices and employment, as well as consumers' expectations about the financial situation of their households and the economy. Finally, a large number of domestic and international financial variables (stock market indices, interest rates, spreads), price indices, international commodity prices and exchange rates which are readily available at the end of each reference month from the Cyprus Stock Exchange, the Central Bank of Cyprus and Datastream are also included in the dataset.

All variables used in the analysis are seasonally adjusted, transformed in order to remove outliers and induce stationarity where necessary (i.e. they are expressed in first differences of

logarithms or first differences of levels).² A detailed list of the variables along with the transformations used can be found in the Appendix.

Some of these variables are published with one or two months delay with respect to the reference month thus the sample is unbalanced at the end. To deal with the problem of unbalanced sample we use the realignment method described in Altissimo et al. (2010). For example, variable X is available up to time t and other series in the dataset are observed until time T , $t < T$, i.e. variable X is published with a delay of $T - t$ months. We therefore construct a new variable X^* by setting $X_T^* = X_t$. In other words, the unbalanced variable is realigned by associating its last available observation to the final date of the dataset, the next-to-last available observation to the penultimate sample date and so on. The realignment of several variables results in removing some observations at the beginning of the dataset depending on the publication lag of the variables.

In the analysis that follows we use monthly series spanning from June 2002 until March 2012, while the quarterly data for GDP cover the period 1995q1 – 2011q4.

2.2 Medium/long run growth

The monthly indicator constructed here provides a real-time (nowcast) estimate of GDP growth free of short run fluctuations. In other words the indicator aims to provide a monthly estimate of the medium/long run component of output growth. Hence our target variable, namely the medium/long run growth is the part of GDP *quarter-on quarter* (q-o-q) growth obtained after fluctuations lasting no more than 24 months are removed via a statistical filter.

The data for GDP are published in March, June, September and December, thus we need to compute monthly observations from quarterly growth data using linear interpolation. In this way the information in monthly variables can be exploited in the construction GDP growth estimates in real time. Then the interpolated series for GDP q-o-q growth are filtered to obtain the medium/long run component. In particular, the band pass filter is applied which extracts the medium/long run process at each date as an infinite, symmetric and two-sided linear combination (i.e. moving average) of q-o-q growth rates, while oscillations lasting less than 24 months are excluded.³

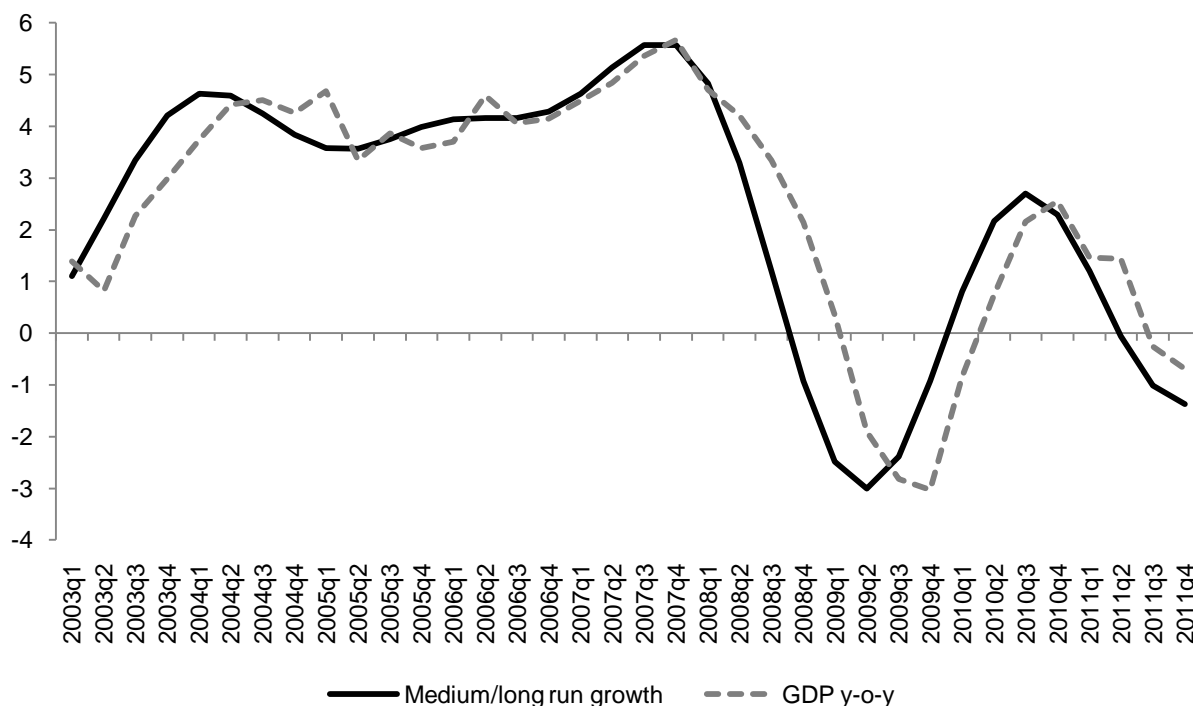
Figure 1 plots the medium/long run growth together with the year-on-year (y-o-y) GDP growth which can also be viewed as an indicator of medium/long run growth. Since y-o-y GDP growth at quarter t is the sum of the q-o-q growth rates at the current and the three previous quarters i.e. t ,

² Series are collected, if available, as seasonally adjusted otherwise seasonality is removed using the X11 filter.

³ The medium/long run component of GDP growth is given by $m_t = \sum_{k=-\infty}^{\infty} a_k y_{t-k}$, where $a_k = \frac{\sin(\pi/3)}{k\pi}$ for $k \neq 0$ and $a_0 = \frac{1}{3}$. In the empirical analysis we apply the finite version of the filter.

$t - 1$, $t - 2$ and $t - 3$, y-o-y growth is a linear combination of q-o-q growth rates as is the medium/long run component obtained via the band pass filter. However, y-o-y growth is not centred at current period t and takes into account only past values. Consequently, y-o-y growth follows the medium/long run growth with a delay of one and a half quarter.

Figure 1: Medium/long run growth and year on year GDP growth



Note: The medium/long run growth obtained via the band pass filter is annualised by multiplying by four to be comparable in magnitude with y-o-y growth.

2.3 Monthly factors

The information contained in a large dataset of about 190 monthly variables which are published much earlier than GDP in a given quarter is summarised using common factors. Common factors are linear combinations of series in the dataset that explain a large percentage of the variance in the data, while at the same time these combinations are free of any idiosyncratic variation. In particular, to obtain the common factors we employ a dynamic factor model along the lines of Stock and Watson (2002a, 2002b). Factor estimation is carried out by principal component analysis that entails averaging over series (i.e. cross section). The number of common factors is determined by alternative information criteria.

Here we follow Altissimo et al. (2010) and allow for at most 25 possible factors to describe our monthly dataset. Table 1 shows the different information criteria ICP1, ICP2 ICP3 (see Bai and Ng, 2002) and standardised eigenvalues that correspond to different number of estimated

factors. The number of factors estimated by each criterion is the one that corresponds to the smallest value of that criterion. ICP1 and ICP2 suggest two factors, while ICP3 estimates 12 factors. The standardised eigenvalues show the marginal contribution of the r -th factor (i.e. principal component) in explaining the total variation. This contribution decreases substantially after the third factor. The first two factors together explain about 36% of the cross section variation in the data, while the first 12 account for about half of the total variance in all the series.

Table 1: Factor analysis results

Number of factors	Information criteria			Standard. eigenvalues
	ICP1	ICP2	ICP3	
0	-0.009	-0.009	-0.009	-
1	-0.090	-0.083	-0.109	24.39
2	-0.104	-0.091	-0.142	11.47
3	-0.099	-0.079	-0.156	7.98
4	-0.094	-0.067	-0.169	7.42
5	-0.086	-0.052	-0.180	6.74
6	-0.077	-0.036	-0.190	6.23
7	-0.065	-0.017	-0.197	5.66
8	-0.052	0.002	-0.203	5.32
9	-0.039	0.022	-0.209	4.96
10	-0.022	0.046	-0.211	4.40
11	-0.006	0.069	-0.213	4.27
12	0.012	0.094	-0.214	3.90
13	0.032	0.120	-0.214	3.68
14	0.051	0.146	-0.213	3.50
15	0.070	0.173	-0.212	3.36
16	0.092	0.201	-0.210	3.08
17	0.113	0.229	-0.208	2.99
18	0.134	0.257	-0.205	2.85
19	0.155	0.284	-0.203	2.79
20	0.175	0.311	-0.202	2.72
21	0.195	0.338	-0.201	2.63
22	0.215	0.365	-0.200	2.55
23	0.235	0.391	-0.199	2.43
24	0.254	0.418	-0.198	2.37
25	0.274	0.445	-0.197	2.24

Notes: (i) The number of series in the balanced panel is 186 and the number of time periods is 118.

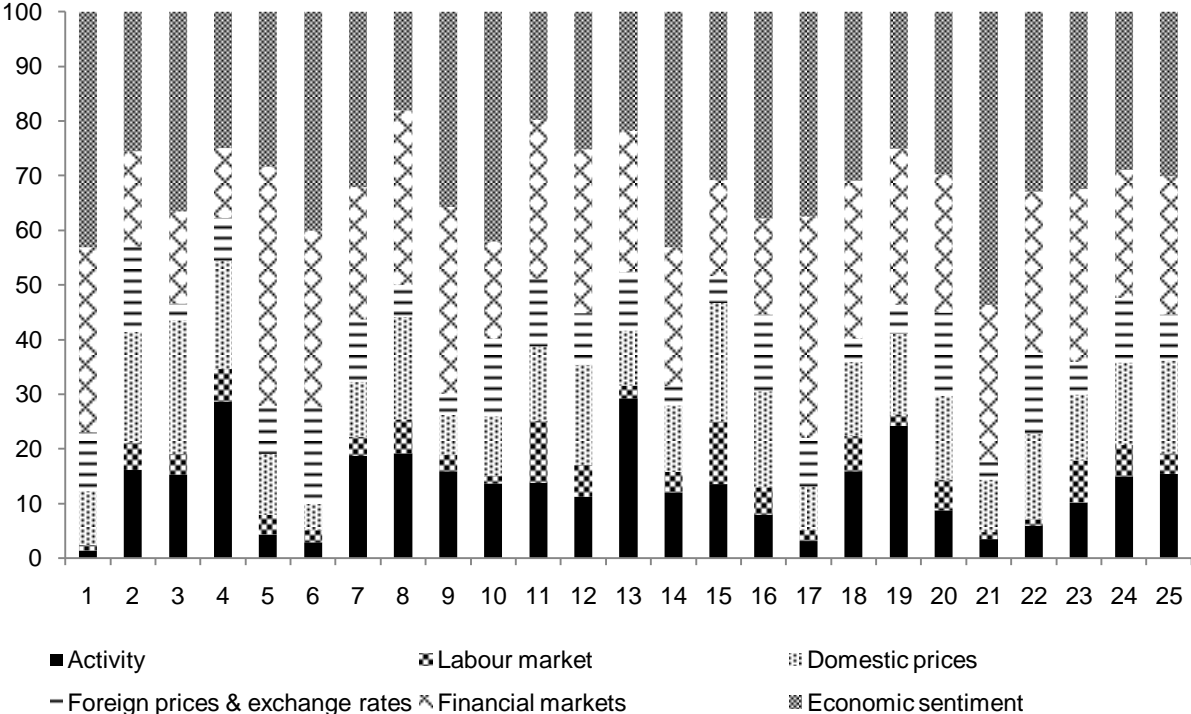
(ii) The percentage of total variance accounted for by the first 12 factors is 50%.

(iii) The sum of squared residuals is 6561.

Figure 2 shows how each one of the 25 factors relates to the different categories of variables in the dataset. Loosely speaking, Figure 2 can be interpreted as how the R^2 's from regressions of factors on each of the series (i.e. the percentage of the variation in each factor explained by each

variable) are distributed among the various categories of variables. For example the first factor correlates mostly with economic sentiment indicators (domestic and European) and financial market indicators, namely stock exchange indices, interest rates and spreads; the fourth factor is mainly associated with activity. Overall, most factors load quite heavily on economic sentiment and financial market indicators, while it is difficult to characterise factors in the sense of representing a single variable category.

Figure 2: Relation between factors and categories of variables



3. CONSTRUCTION OF THE MONTHLY INDICATOR

Next we use the monthly factors to compute forecasts for the medium/long run component of GDP growth which is expressed in monthly frequency via a linear interpolation (see section 2.2 above). Before constructing the model for forecasting medium/long run growth we need to address two issues namely the fluctuations present in monthly factors and the end-of-sample problem arising from the use of the band pass filter.

First, the fact that factors are obtained from monthly data make them prone to short run fluctuations, especially since a large number of variables in the dataset are volatile financial series. Thus, on one hand factors contain more timely information relative to GDP about the state of the economy but on the other, their short run oscillations could introduce substantial

volatility in the forecast of the medium/long run growth and therefore give misleading signals about current and future growth. This issue is tackled by smoothing the factors via the application of the band pass filter that removes short run volatility (i.e. fluctuations lasting less than 24 months).

Figure 3: Factors vs. smoothed factors

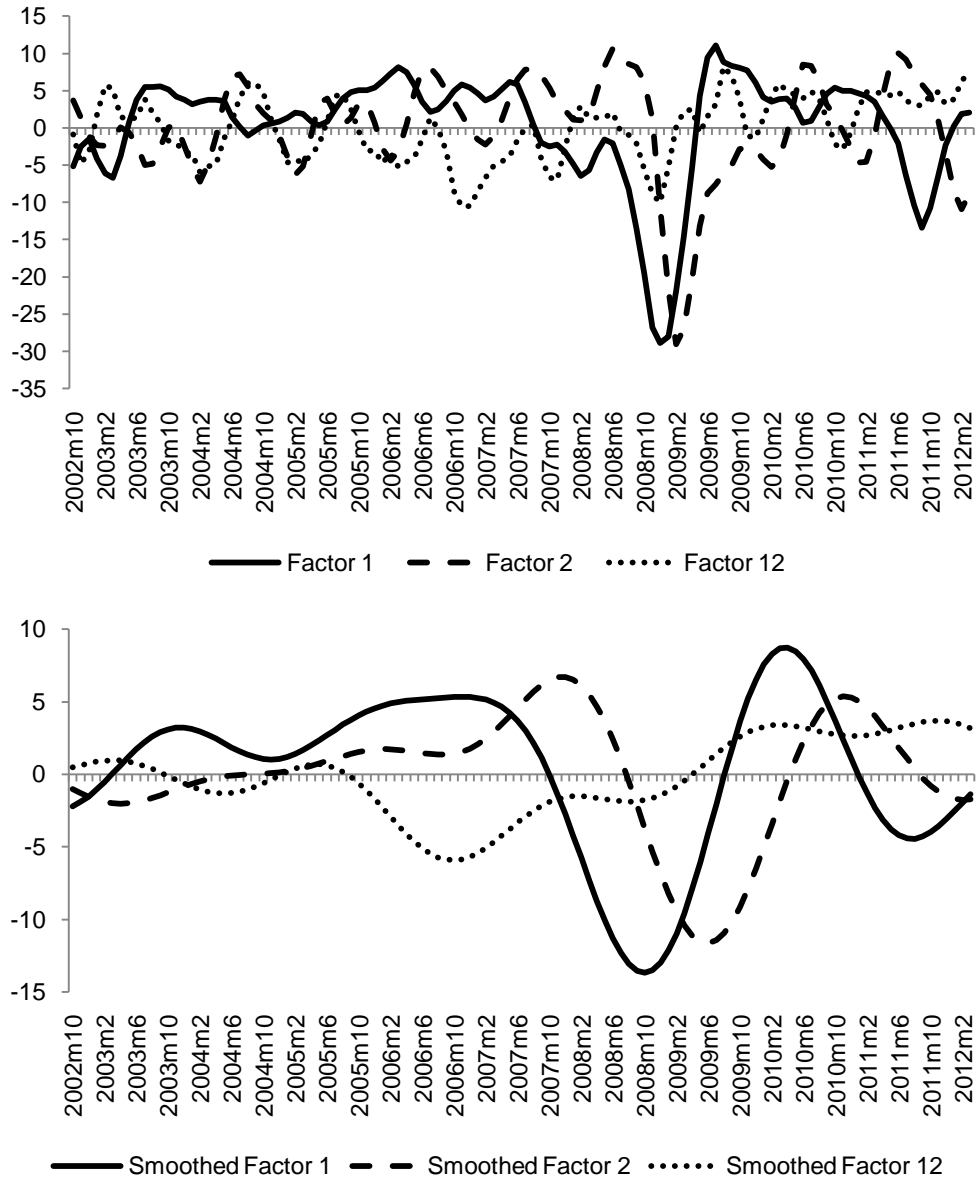


Figure 3 juxtaposes the first, second and twelfth factor (upper diagram) with their smoothed counterparts (lower diagram). Fluctuations seem less severe in the first factor but become more noticeable in the second and even more intense in the twelfth.

The second issue is a known drawback of the band pass filter, namely the deterioration exhibited by the filtered series at the end of the sample. Since the band pass filter is a two-sided moving average requires the use of predictions outside the sample. This could lead to poorly estimated values at the end of the sample and to substantial revisions as new data become available. To limit the end of sample problem, the regression of the medium/long run growth on the smoothed factors that is used for forecasting is estimated on a sample that excludes the last 12 observations (see Altissimo et al., 2010). In particular we estimate

$$m_t = \beta_0 + \sum_{k=1}^K \beta_k F_{kt}^* + e_t, \quad t = 1, 2, \dots, T - 12 \quad (1)$$

where m_t is the medium/long run growth and F_{kt}^* is the k -th smoothed factor.⁴ The number of smoothed factors in the regression is chosen by statistical criteria. Table 2 presents some statistical criteria for regression in (1) estimated using alternative numbers of smoothed factors. Additional factors after the twelfth add little in explaining the variation in medium/long run growth.

Table 2: Statistical criteria for choosing the number of factors in the indicator

Number of smoothed factors	Adjusted R ²	AIC	BIC
1	0.276	150.74	158.55
2	0.771	36.74	47.16
12	0.999	-1142.78	-1106.31
13	0.999	-1141.27	-1102.20
14	0.999	-1144.41	-1102.73

After obtaining the estimated parameters $(\hat{\beta}_0, \hat{\beta}_1, \dots, \hat{\beta}_K)$ we can compute the monthly indicator as

$$\hat{m}_t = \hat{\beta}_0 + \sum_{k=1}^{K^*} \hat{\beta}_k F_{kt}^*, \quad t = 1, 2, \dots, T \quad (2)$$

where K^* is the number of factors in a model with the desirable performance based on statistical criteria. The values of \hat{m}_t for $t > T - 12$ are obtained via the use of the monthly factors so that at the end of the sample we have timely monthly observations (reflecting the most recent information contained in monthly series) but no new GDP data.⁵

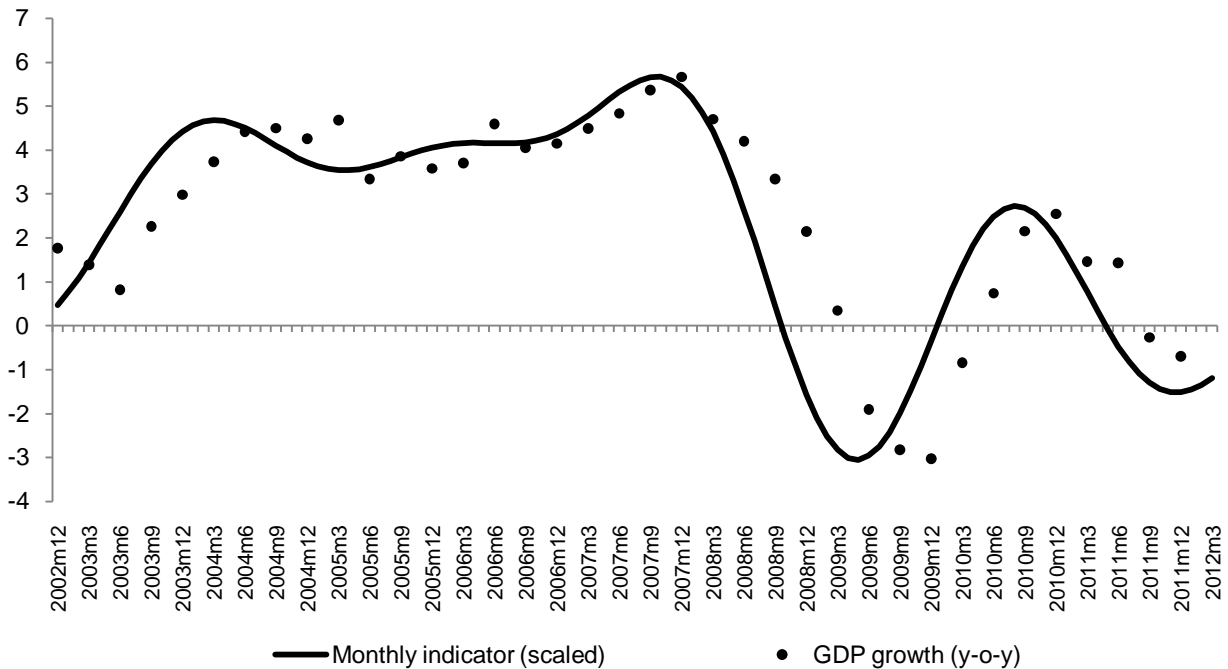
Based on the statistical criteria in Table 2, the monthly indicator is constructed using 12 monthly factors. The resulting indicator is plotted in Figure 4 together with y-o-y GDP growth. The

⁴ The medium/long run growth component is obtained from linear interpolation of q-o-q GDP growth, while the monthly variables are expressed as month-on-month percentage change in the principal component analysis for the construction of factors. In order to use the factors for forecasting the medium/long run growth, we apply the transformation $F_{kt} = F_{kt}^{PC} + 2 F_{kt-1}^{PC} + 3 F_{kt-2}^{PC} + 2 F_{kt-3}^{PC} + F_{kt-4}^{PC}$ where F_{kt}^{PC} is the k -th principal component and F_{kt} is the factor before the application of the band pass filter.

⁵ Some end-of-sample bias is possibly introduced via the use of smoothed factors which, as shown in section 4 can be less serious for end-of-sample performance and forecasting ability than the volatility associated with the non-smoothed factors obtained directly from principal component analysis. The construction of smoothed factors in the frequency domain as in Altissimo et al. (2010) is currently under investigation.

monthly indicator leads growth by about four months and captures well the medium/long run movements in output growth.

Figure 4: Monthly indicator and y-o-y GDP growth



Note: The monthly indicator is scaled by four so that its magnitude is comparable to that of y-o-y GDP growth.

4. PERFORMANCE OF THE INDICATOR

Following Altissimo et al. (2010) we assess the performance of the indicator by considering its end-of-sample performance relative to a target long run growth series. Moreover we provide an evaluation of the indicator's forecasting ability for GDP growth in a pseudo out-of-sample exercise.

4.1 End-of-sample performance

In this section we test the pseudo-real-time performance of the monthly indicator constructed in the previous section. The sample period is June 2002 up to December 2011; the period until December 2006 is used for estimation and the remaining 60 months are used as pseudo out-of-sample forecast. The target variable is the medium/long run component of GDP growth, $m_t(T)$,

for $t = 1, \dots, T - 12$, where T is the last available date.⁶ The monthly indicator, $\hat{m}_t(\tau)$, is constructed for each month using all the available monthly data until period τ .

We compare the performance of the monthly indicator $\hat{m}_t(\tau)$ with the target $m_t(T)$, $t = 1, \dots, T - 12$. In addition to the monthly indicator $\hat{m}_t(\tau)$, we include in the comparison the following timely available monthly indicators:

- $\tilde{m}_t(\tau)$ which is computed with the same procedure as $\hat{m}_t(\tau)$ but using directly the factors obtained from principal component analysis, without applying the smoothing filter;
- $\tilde{s}_t(\tau)$ which is estimated using equation (1) but the factors are replaced by the Economic Sentiment Indicator (ESI) constructed by the Economics Research Centre using business and consumer survey data, hence it is not revised. The ESI which summarises firms' and consumers' perceptions and expectations about economic conditions is available at the end of each reference month.

Let $i_t(\tau)$ be any of the monthly indicators $\hat{m}_t(\tau)$, $\tilde{m}_t(\tau)$ or $\tilde{s}_t(\tau)$ constructed using data up to time τ . The performance of the monthly indicators is evaluated using three different criteria:

1. percentage of correct predictions of the sign of the change in the target $m_t(T) - m_{t-1}(T)$, attained by $i_t(t) - i_{t-1}(t)$, i.e. the ability of the indicator to forecast turning points;
2. the forecasting (nowcasting) ability of each monthly indicator with respect to the target measured by the mean squared deviation of each monthly indicator from the target i.e.

$$\frac{1}{48} \sum_{t=T-60}^{T-12} [i_t(t) - m_t(T)]^2;$$

3. the size of the revision error in the indicator when another month of information is available given by $\frac{1}{59} \sum_{t=T-60}^{T-1} [i_t(t+1) - i_t(t)]^2$.

Table 3 presents the results of the evaluation criteria for the three monthly indicators. The indicator $\hat{m}_t(\tau)$ that uses smoothed factors dominates the other two indicators with respect to the first two criteria. The indicator $\tilde{s}_t(\tau)$ yields the lowest mean squared error of revision as it is based on survey data which by construction are not revised, i.e. each month a new observation is added to the ESI series leaving the previous observations unchanged, thus $\tilde{s}_t(\tau)$ is revised only when new GDP data become available. On the contrary, the other two indicators which are

⁶ To obtain a reliable approximation of the medium/long run component and therefore of the target, the last 12 points are removed but no observations are removed at the beginning of the sample. The reason is that quarterly data for GDP are available since 1995 and are all included in the estimation of the medium/long run component, while the sample period used here is June 2002 up to December 2011.

based on monthly factors are revised each month with the arrival of new monthly data, as well as with the release of new GDP data.

The monthly indicator based on the smoothed factors predicts about 78% of the turning points in the target variable, whereas if the factors obtained from principal component analysis are used the percentage of correct predictions drops to 50%; the result for the indicator based on the ESI lies somewhere in the middle.

Table 3: End-of-sample performance

Indicator	% of correct predictions of sign of $m_t(T) - m_{t-1}(T)$	Mean squared error of forecast	Mean squared error of revision
$\hat{m}_t(\tau)$: smoothed factors	78.3	0.32	0.0150
$\tilde{m}_t(\tau)$: non-smoothed factors	50.0	0.85	0.1100
$\tilde{s}_t(\tau)$: ESI	61.7	0.48	0.0003

The second column of Table 3 shows the mean squared error of the forecast. As mentioned above, the target is the medium/long run component of GDP growth rate $m_t(T)$ for $t = 1, \dots, T - 12$. For each month of the evaluation period three indicators $\hat{m}_t(\tau)$, $\tilde{m}_t(\tau)$ and $\tilde{s}_t(\tau)$ are constructed using data up to time τ and the last forecast values $\hat{m}_\tau(\tau)$, $\tilde{m}_\tau(\tau)$ and $\tilde{s}_\tau(\tau)$ are used as the forecasts for the corresponding value ($m_\tau(T)$) of the target variable. The results show that the indicator based on the smoothed factors is associated with the lowest forecast error. The indicator using the ESI instead performs much better than that employing non-smoothed factors suggesting that the non-smooth factors induce substantial short run fluctuations that do not help in predicting with sufficient accuracy the medium/long run component of GDP.

These results show that according to the three criteria used, the indicator based on the smoothed factors is superior than that constructed with the non-smooth factors. Furthermore, the indicator using the ESI, which is the easiest to compute and the least data demanding is associated with the smallest revision error.

4.2 A Forecasting exercise for GDP growth

In this section we investigate the forecasting ability of the three monthly indicators discussed above for actual q-o-q and y-o-y GDP growth. In particular we assess how well the three indicators can forecast GDP growth in the current quarter (i.e. nowcast) for which the official GDP data are published with a delay of about five (flash estimate) to ten weeks (GDP growth release).

The monthly indicators are transformed into quarterly frequency by using the average value of the three months in the quarter. Moreover, for the indicator of interest $\hat{m}_t(\tau)$ based on smoothed factors, we use alternatively as quarterly observations the values of the first, second and third month in each quarter individually.

Table 4: Mean squared forecast error relative to the random walk

	GDP growth (t)	
	q-o-q	y-o-y
Predictors		
Lags of GDP growth (AIC)	0.95	1.68
Lags of GDP growth (BIC)	0.95	1.64
<i>Current values (t)</i>		
$\hat{m}_t(\tau)$: smoothed factors (average)	0.46	0.49
$\hat{m}_t(\tau)$: smoothed factors (1 st month)	0.50	0.39
$\hat{m}_t(\tau)$: smoothed factors (2 nd month)	0.46	0.49
$\hat{m}_t(\tau)$: smoothed factors (3 rd month)	0.45	0.58
$\tilde{m}_t(\tau)$: non-smoothed factors (average)	0.51	0.58
$\tilde{s}_t(\tau)$: ESI (average)	0.67	0.78
<i>First lag ($t-1$)</i>		
$\hat{m}_t(\tau)$: smoothed factors (average)	0.66	0.20
$\hat{m}_t(\tau)$: smoothed factors (1 st month)	0.76	0.20
$\hat{m}_t(\tau)$: smoothed factors (2 nd month)	0.66	0.20
$\hat{m}_t(\tau)$: smoothed factors (3 rd month)	0.57	0.28
$\tilde{m}_t(\tau)$: non-smoothed factors (average)	0.78	0.46
$\tilde{s}_t(\tau)$: ESI (average)	0.88	0.71
<i>Second lag ($t-2$)</i>		
$\hat{m}_t(\tau)$: smoothed factors (average)	0.95	0.38
$\hat{m}_t(\tau)$: smoothed factors (1 st month)	1.01	0.51
$\hat{m}_t(\tau)$: smoothed factors (2 nd month)	0.95	0.39
$\hat{m}_t(\tau)$: smoothed factors (3 rd month)	0.87	0.27
$\tilde{m}_t(\tau)$: non-smoothed factors (average)	0.99	0.60
$\tilde{s}_t(\tau)$: ESI (average)	1.04	0.81

The pseudo-out-of- sample forecasting exercise is performed using as dependent variables q-o-q and y-o-y GDP growth rates and as predictors the separately the current values, their first and second lag of the monthly indicators transformed into quarterly frequency. Autoregressive models in q-o-q and y-o-y GDP growth with the lag length chosen using the Akaike (AIC) and Bayesian (BIC) information criteria are also used in the forecasting exercise. The random walk model (with a drift) for GDP growth is used as the benchmark. Table 4 reports the root mean squared forecast error of the pseudo-out-of-sample forecasting exercise for each model, relative to that of the random walk.

The current values and first lags of the various monthly indicators yield substantial forecasting gains over simple AR models for forecasting both q-o-q and y-o-y GDP growth. Gains range from about 10% to 50% for q-o-q growth and from 30% to 80% for y-o-y growth. Moreover, it appears that current values of the indicators are more appropriate for forecasting (nowcasting) q-o-q growth, while their first lags are associated with much smaller relative forecast error for y-o-y growth. Thus, the information content of the monthly indicator in the current quarter is more relevant for the current quarter q-o-q growth, but it is more useful for forecasting y-o-y growth in the next quarter than for nowcasting y-o-y growth. Models with the second lags of monthly indicators based on factors as predictors give forecasting gains over simple autoregressive models in the case of y-o-y GDP growth. It therefore appears that monthly indicators provide leading information for y-o-y growth up to two quarters ahead.

The indicator based on the ESI is inferior to those constructed using factors (smoothed or non-smoothed) in terms of forecasting ability; however it yields some forecasting gains (about 30%) when its current value and first lag is used in forecasting q-o-q and y-o-y GDP growth, respectively. The monthly indicator constructed using smoothed factors outperforms the corresponding indicator based on non-smoothed factors. Looking at different quarterly versions of the monthly indicator based on smoothed factors, the third month of each quarter, which incorporates the most recent information in each quarter, yields slightly better results than the average (across all three months in a quarter) for forecasting q-o-q growth; in the case of y-o-y growth this holds only for two-quarter ahead forecasts.

5. CONCLUSIONS

The aim of this paper is the construction of a monthly indicator for estimating Cyprus GDP growth, free of short run fluctuations. The purpose of the indicator is to provide timely signals about the direction of real economic activity in the current and the following one to two quarters. The monthly indicator for Cyprus is constructed along the lines of the EuroCOIN indicator published by the Centre for Economic Policy Research for the Euro Area.

The indicator presented here utilises the information from a large dataset of about 190 domestic and foreign/international monthly series by summarising it in a small number of common factors obtained via principal component analysis. The monthly factors reflecting the most recent information contained in monthly series are then used to obtain a projection of the medium/long run growth which is the proposed monthly indicator. By exploiting the timely signals from monthly series, the indicator produces estimates of the medium/long run component of GDP growth at a monthly frequency. For example, in the first week of February we can construct the indicator with monthly data up to January, hence obtaining estimates for GDP growth (excluding any short run variation) for the last quarter of the previous year, as well as for the first quarter of the current year, before the release of official GDP data.

The monthly indicator constructed using smoothed factors outperforms similar indicators based on non-smoothed factors (obtained directly from principal component analysis), or the ESI (which uses information only from business and consumer surveys) in terms of correct turning point prediction and forecast error at the end of the sample. Furthermore, the monthly indicator yields the highest gains in the pseudo-out-of-sample exercise for nowcasting q-o-q GDP growth and for forecasting y-o-y growth one and two quarters ahead.⁷

The indicator can be used for monitoring movements in real economic activity in the current and subsequent quarters and for providing early signs of expansions and contractions in the economy. It can be a useful tool for policy-makers and firms as regular observation of the evolution of the indicator could enable them to form a clearer picture of the outlook of the Cypriot economy and plan accordingly.

⁷ The process of constructing the indicator is under constant update and improvement in terms of monthly data and techniques for obtaining smoothed factors. The indicator is estimated every month by the Economics Research Centre and it is available upon request. Moreover, the indicator is published in the quarterly bulletin of the Centre "Economic Outlook".

REFERENCES

Altissimo, F., R. Cristadoro, M. Forni, M. Lippi and G. Veronese (2010), "New Eurocoin: Tracking economic growth in real time", *Review of Economics and Statistics* 92, 1024-1034.

Bai, J. and S. Ng (2002), "Determining the number of factors in approximate factor models", *Econometrica* 70, 191-221.

Carriero, A., and M. Marcellino (2007), "A comparison of methods for the construction of composite coincident and leading indexes for the UK", *International Journal of Forecasting* 23, 219-236.

Mitchell, J., R. J. Smith, M. R. Weale, S. Wright and E. L. Salazar (2005), "An indicator of monthly GDP and an early estimate of quarterly GDP growth", *Economic Journal* 115, F108-F129.

Stock, J. H. and M. W. Watson (2002a), "Forecasting using principal components from a large number of predictors", *Journal of the American Statistical Association* 97, 1167-1179.

Stock, J. H. and M. W. Watson (2002b), "Macroeconomic forecasting using diffusion indexes", *Journal of Business and Economic Statistics* 20, 147-162.

APPENDIX

Table A1: List of variables and transformations

	Transformation
QUARTERLY VARIABLE: TARGET	
Gross Domestic Product (€mn – constant prices 2005) - SA	Δln
MONTHLY VARIABLES	
Domestic activity	
Registration of motor vehicles (passenger cars)	Δln
Local cement sales (m. ton)	Δln
Building permits authorised (act no)	Δln
Retail trade-value index (2005=100)	Δln
Price index of manufacturing production (2005=100)	Δln
Volume index of manufacturing production (2005=100)	Δln
Volume index of general production (2005=100)	Δln
Industrial production index (mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply)	Δln
Domestic labour market	
Registered unemployed - total (act)	Δln
Registered unemployed -manufacturing (act)	Δln
Registered unemployed -construction (act)	Δln
Registered unemployed -wholesale and retail trade (act)	Δln
Registered unemployed -restaurants and hotels (act)	Δln
Unemployment Rate	Level
Tourism	
Tourism revenue (act €mn)	Δln
Tourist arrivals TOTAL (usual residency)	Δln
Tourist arrivals from UK (usual residency)	Δln
Tourist arrivals from GER (usual residency)	Δln
Tourist arrivals from RUS (usual residency)	Δln
Tourist arrivals from GR (usual residency)	Δln
Cyprus Stock Exchange indices	
CSE All Share Composite	Δln
FTSE/SE-20	Δln
SE Banks Index	Δln
SE Hotels Index	Δln
SE Investment Companies	Δln
Domestic interest rates	
Consumer credit and other loans (up to 1 year maturity)	Δ
Deposits from households redeemable at notice (over 3 months)	Δ
Domestic price indices	
Consumer Price Index (CPI) (2005=100)	Δln
CPI-Food and non-alcoholic beverages (2005=100)	Δln

CPI-Alcoholic beverages and tobacco (2005=100)	Δln
CPI-Clothing and footwear (2005=100)	Δln
CPI-Housing, water, electricity and gas (2005=100)	Δln
CPI-Furnishings, household equipment and supplies (2005=100)	Δln
CPI-Health (2005=100)	Δln
CPI-Transport (2005=100)	Δln
CPI-Communication (2005=100)	Δln
CPI-Recreation and culture (2005=100)	Δln
CPI-Education (2005=100)	Δln
CPI-Restaurants and hotels (2005=100)	Δln
CPI-Miscellaneous goods and services (2005=100)	Δln
Harmonised Index of Consumer Price –HICP (2005=100)	Δln
HICP – Communications (2005=100)	Δln
HICP – Electricity (2005=100)	Δln
HICP – Energy (2005=100)	Δln
HICP – Food (2005=100)	Δln
HICP – Health (2005=100)	Δln
HICP - Industrial Goods (2005=100)	Δln
HICP - Motor Cars (2005=100)	Δln
HICP -Pharmaceutical Products (2005=100)	Δln
HICP – Transport (2005=100)	Δln
HICP - Water Supply (2005=100)	Δln
Price index of construction materials (2005=100)	Δln
Domestic economic sentiment indicators	
Economic Sentiment Indicator	Δ
Industrial Confidence Indicator	Δ
Services Confidence Indicator	Δ
Retail Trade Confidence Indicator	Δ
Construction Confidence Indicator	Δ
Consumer Confidence Indicator	Δ
<i>Specific questions from Business and Consumer Surveys</i>	
Business situation development over the past 3 months (services)	Δ
Evolution of the demand over the past 3 months (services)	Δ
Expectation of the demand over the next 3 months (services)	Δ
Evolution of the employment over the past 3 months (services)	Δ
Expectations of the employment over the next 3 months (services)	Δ
Business activity (sales) development over the past 3 months (retail trade)	Δ
Volume of stock currently hold (retail trade)	Δ
Orders expectations over the next 3 months (retail trade)	Δ
Business activity expectations over the next 3 months (retail trade)	Δ
Employment expectations over the next 3 months (retail trade)	Δ
Production trend observed in recent months (industry)	Δ
Assessment of order-book levels (industry)	Δ

Assessment of export order-book levels (industry)	Δ
Assessment of stocks of finished products (industry)	Δ
Production expectations for the months ahead (industry)	Δ
Selling price expectations for the months ahead (industry)	Δ
Employment expectations for the months ahead (industry)	Δ
Building activity development over the past 3 months (construction)	Δ
Evolution of your current overall order books (construction)	Δ
Employment expectations over the next 3 months (construction)	Δ
Prices expectations over the next 3 months (construction)	Δ
Financial situation over last 12 months (consumers)	Δ
Financial situation over next 12 months (consumers)	Δ
General economic situation over last 12 months (consumers)	Δ
General economic situation over next 12 months (consumers)	Δ
Price trends over last 12 months (consumers)	Δ
Price trends over next 12 months (consumers)	Δ
Unemployment expectations over next 12 months (consumers)	Δ
Major purchases at present (consumers)	Δ
Major purchases over next 12 months (consumers)	Δ
Savings at present (consumers)	Δ
Savings over next 12 months (consumers)	Δ
Statement on financial situation of household (consumers)	Δ
Foreign activity indicators and unemployment	
<i>Industrial production index</i>	
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply, construction EU27	ΔIn
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply EU27	ΔIn
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply, construction EA	ΔIn
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply EA	ΔIn
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply, construction UK	ΔIn
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply UK	ΔIn
Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply GR	ΔIn
Unemployment rate European Union (27 countries)	Level
Unemployment rate United Kingdom	Level
Exchange rates	
Canadian dollar	ΔIn
Japanese yen	ΔIn
Pound sterling	ΔIn
Russian rouble	ΔIn
Swiss franc	ΔIn
US dollar	ΔIn
Foreign price indices and international commodity prices	
Harmonised Index of Consumer Prices EU27	ΔIn
Harmonised Index of Consumer Prices GR	ΔIn
EA (fixed composition), ECB Commodity Price index Euro denominated, import weighted, Food	ΔIn

EA (fixed composition), ECB Commodity Price index Euro denominated, import weighted, Non-food	ΔIn
EA (fixed composition), ECB Commodity Price index Euro denominated, import weighted, Total non-energy commodity	ΔIn
EA (fixed composition), ECB Commodity Price index Euro denominated, use-weighted, Food	ΔIn
EA (fixed composition), ECB Commodity Price index Euro denominated, use-weighted, Non-food	ΔIn
EA (fixed composition), ECB Commodity Price index Euro denominated, use-weighted, Total non-energy commodity	ΔIn
Brent Crude Oil (€)-Commodity Prices	ΔIn
Crude Oil Futures (€) -Futures Contracts	ΔIn
Gold Bullion Price-New York (€/Ounce) -Commodity Price	ΔIn
Silver Cash Price (€/Ounce) -Commodity Prices	ΔIn
Foreign stock price indices	
ATHEX Composite- Price Index	ΔIn
DAX 30 Performance - Price Index	ΔIn
FTSE 100 - Price Index	ΔIn
NYSE Composite - Price Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx 50 Price Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Price Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Basic Materials E Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Consumer Goods Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Consumer Services Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Financials Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Technology E Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Healthcare Index (S1ESH1E)	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Industrials Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Oil & Gas Energy Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Telecommunications Index	ΔIn
Euro area (changing composition), Euro, Dow Jones Euro Stoxx Utilities E Index	ΔIn
Europe, Euro, Dow Jones Stoxx 50 Price Index	ΔIn
United States, US dollar, Standard & Poors 500 Composite Index (S_PCOMP)	ΔIn
Dow Jones EURO STOXX 50	ΔIn
Dow Jones EURO STOXX Broad	ΔIn
Dow Jones Industrial Average	ΔIn
Dow Jones STOXX 50 (Europe)	ΔIn
Dow Jones STOXX Broad (Europe)	ΔIn
Japan, Japanese yen, Nikkei 225 Stock Average Index	ΔIn
Nikkei 225	ΔIn
Foreign interest rates and spreads	
UK 10 -year Government Bond Yield (UK10)	Δ
Greece 10 -year Government Note Yield (GR10)	Δ
Germany 10 -year Government Benchmark Bond Yield (DE10)	Δ
Europe 3-month EURIBOR	Δ
Europe 6-month EURIBOR	Δ
Europe 12-month EURIBOR	Δ
Europe Central Bank Deposit Rate	Δ

Europe Central Bank Lending Rate	Δ
France 10-year Government Bond Yield (FR10)	Δ
France 3-month Treasury Bill Yield (FR3)	Δ
UK 3-month Treasury Bill Yield (UK3)	Δ
Germany 3-month Treasury Bill Yield (DE3)	Δ
Greece 3-month Treasury Bill Yield (GR3)	Δ
Spain 10 -year Government Bond Yield (ES10)	Δ
Italy 10 -year Government Note Yield (IT10)	Δ
Spain 3-month Treasury Bill Yield (ES3)	Δ
Italy3-month Treasury Bill Yield (IT3)	Δ
FR10-FR3	Level
DE10-DE3	Level
GR10-GR3	Level
ES10-ES3	Level
IT10-IT3	Level
UK10-UK3	Level
European economic sentiment indicators	
Economic Sentiment Indicator EU.	Δ
Industrial Confidence Indicator EU	Δ
Services Confidence Indicator EU.	Δ
Consumer Confidence Indicator EU.	Δ
Retail Confidence Indicator EU.	Δ
Construction Confidence Indicator EU.	Δ
Economic Sentiment Indicator EA	Δ
Industrial Confidence Indicator EA	Δ
Services Confidence Indicator EA	Δ
Consumer Confidence Indicator EA	Δ
Retail Confidence Indicator EA	Δ
Construction Confidence Indicator EA	Δ
Economic Sentiment Indicator UK	Δ
Industrial Confidence Indicator UK	Δ
Services Confidence Indicator UK	Δ
Consumer Confidence Indicator UK	Δ
Retail Confidence Indicator UK	Δ
Construction Confidence Indicator UK	Δ
Economic Sentiment Indicator GR	Δ
Industrial Confidence Indicator GR	Δ
Services Confidence Indicator GR	Δ
Consumer Confidence Indicator GR	Δ
Retail Confidence Indicator GR	Δ
Construction Confidence Indicator GR	Δ

RECENT ECONOMIC POLICY/ANALYSIS PAPERS

- 05-12 Ketteni E., Th. P. Mamuneas and P. Pashardes, " ICT and Energy Use: Patterns of Substitutability and Complementarity in Production ", September 2012.
- 04-12 Christodoulou Tr. and S. Clerides, "Emissions-Based Vehicle Tax Reform for Cyprus: A Simulation Analysis ", June 2012.
- 03-12 Koutsampelas C. "Measuring the Poverty Risk among Immigrants in Cyprus ", April 2012.
- 02-12 Andreou S. N., C. Koutsampelas and A. Polycarpou "The Unified Database of Household Budget Surveys 1984/85, 1990/91, 1996/97, 2003 and 2009 ", March 2012 - in Greek.
- 01-12 Ketteni E. ,Th. Mamuneas, Th. Zachariades and L. Coutinho "The Effect of EU Energy and Climate Policies on the Economy of Cyprus ", March 2012.
- 09-11 Ketteni E. and Th. Mamuneas, "Labor Productivity and ICT Capital", December 2011.
- 08-11 Andreou N. S., "The Borrowing behaviour of Households: Evidence from the Cyprus Family Expenditure Surveys", December 2011.
- 07-11 Savva S.C., "Foreign Direct Investments in Cyprus", November 2011, - in Greek.
- 06-11 Koutsampelas C. "Social Transfers and Income Distribution in Cyprus", November 2011.
- 05-11 Kalaintzidakis P., T. Mamuneas, V.Tzouvelekas, T. Stengos and P. Gregoriou, "Optimal Tax Rates for Pesticides Usage in Cyprus Agriculture Production", November 2011.
- 04-11 Pashardes P., A. Polycarpou, "Poverty and Labour Market Participation of Public Assistance Recipients in Cyprus", September 2011.
- 03-11 Pashourtidou N., A. Tsiaklis and Z. Kontolemis, "Consumers' opinions about macroeconomic variables", August 2011.
- 02-11 Zachariadis Th. and E. Shoukri, "Direct Effects from the Implementation of the EU Energy and Climate Package on Cypriot Economic Sectors and Households", July 2011.
- 01-11 Andreou A. and Th. Mamuneas, "Factors explaining productivity in Cyprus", May 2011 – in Greek.
- 10-10 Andreou E., A. Kourtellos and N. Pashourtidou, "Forecasting toolbox for Cyprus GDP growth", December 2010.