CENTRE FOR PLANNING AND ECONOMIC RESEARCH

No 104

A Coincident Economic Indicator of Economic Activity in Greece

Ekaterini Tsouma

September 2009

Ekaterini Tsouma

Research Fellow
Centre for Planning and Economic Research (KEPE), Athens, Greece
e-mail for correspondence: etsouma@kepe.gr

A Coincident Economic Indicator of Economic Activity in Greece

CENTRE FOR PLANNING AND ECONOMIC RESEARCH

The Centre for Planning and Economic Research (KEPE) was established as a research unit, under the title "Centre of Economic Research", in 1959. Its primary aims were the scientific study of the problems of the Greek economy, the encouragement of economic research and the cooperation with other scientific institutions.

In 1964, the Centre acquired its present name and organizational structure, with the following additional objectives: first, the preparation of short, medium and long-term development plans, including plans for local and regional development as well as public investment plans, in accordance with guidelines laid down by the Government; second, the analysis of current developments in the Greek economy along with appropriate short and medium-term forecasts, the formulation of proposals for stabilization and development policies; and third, the additional education of young economists, particularly in the fields of planning and economic development.

Today, KEPE focuses on applied research projects concerning the Greek economy and provides technical advice on economic and social policy issues to the minister of the Economy and Finance, the Centre' s supervisor.

In the context of these activities, KEPE produces five series of publications, notably:

Studies. They are research monographs.

Reports. They are synthetic works with sectoral, regional and national dimensions.

Statistical Series. They refer to the elaboration and processing of specified raw statistical data series.

Discussion Papers series. They relate to ongoing research projects.

Research Collaborations. They are research projects prepared in cooperation with other research institutes.

The number of the Centre's publications exceed 650.

The Centre is in a continuous contact with foreign scientific institutions of a similar nature by exchanging publications, views and information on current economic topics and methods of economic research, thus furthering the advancement of economics in the country.

Οικονομικός Δείκτης Συγκυρίας για την
Οικονομική Δραστηριότητα στην Ελλάδα

Αικατερίνη Τσούμα

ΠΕΡΙΛΗΨΗ

Η κατασκευή και ανάλυση σύνθετων οικονομικών δεικτών συγκυρίας για την έγκαιρη αναγνώριση της τρέχουσας οικονομικής συγκυρίας αποτελεί πλέον παράδοση στις ΗΠΑ και άλλες ανεπτυγμένες οικονομίες. Με στόχο την απόκτηση ενός αξιόπιστου και έγκαιρα διαθέσιμου συνολικού μεγέθους σε μηνιαία συχνότητα για την αξιολόγηση της τρέχουσας οικονομικής δραστηριότητας, στην παρούσα εργασία εισάγεται ένας σύνθετος οικονομικός δείκτης συγκυρίας για την Ελληνική οικονομία. Ο προτεινόμενος δείκτης κατασκευάζεται στην βάση των δύο προσδιοριστικών χαρακτηριστικών των οικονομικών διακυμάνσεων: Του ότι οι μεμονωμένες οικονομικές μεταβλητές δείχνουν να συμβαδίζουν και ότι παρατηρείται ασύμμετρη συμπεριφορά μεταξύ οικονομικών υφέσεων και επεκτάσεων. Ο σύνθετος οικονομικός δείκτης συγκυρίας για την Ελληνική οικονομία κατασκευάζεται μέσω της εφαρμογής της συνθετικής μεθοδολογίας του υποδείγματος δυναμικού παράγοντα και εναλλαγής καθεστώτος. Η συγκεκριμένη μεθοδολογία επιλέγεται διότι καθιστά δυνατή την απόκτηση μέσα από το υπόδειγμα όχι μόνο του σύνθετου δείκτη συγκυρίας ως μεμονωμένης μεταβλητής που αντανακλά την 'κατάσταση της οικονομίας', αλλά και των πιθανοτήτων ύφεσης και επέκτασης. Το επιλεγμένο υπόδειγμα εκτιμάται χρησιμοποιώντας μεμονωμένες οικονομικές μεταβλητές σε μηνιαία συχνότητα και η περίοδος κάλυψης είναι από τον Ιανουάριο 1970 έως τον Δεκέμβριο 2007. Τα εμπειρικά αποτελέσματα στηρίζουν την εφαρμογή του συνθετικού υποδείγματος επιβεβαιώνοντας την ασυμμετρία μεταξύ υφέσεων και επεκτάσεων και παρέχουν χρήσιμη πληροφόρηση για τις κυκλικές διακυμάνσεις στην Ελληνική οικονομική δραστηριότητα. Ο σύνθετος οικονομικός δείκτης συγκυρίας και οι πιθανότητες ύφεσης που εξάγονται από την εκτίμηση του συνθετικού υποδείγματος φαίνεται να απεικονίζουν ικανοποιητικά τους οικονομικούς κύκλους για την Ελλάδα κατά την υπό εξέταση χρονική περίοδο.

ABSTRACT

In the USA and other advanced economies, it has long been a tradition to develop and analyze composite coincident economic indicators to provide a broad representation of the underlying economic conditions. In order to develop a similar indicator of the direction of economic activity in Greece on a monthly basis, in this paper we introduce a composite coincident indicator of Greek economic activity. The proposed indicator is developed on the basis of the two determining features of economic fluctuations: co-movement among individual economic variables and asymmetric behavior in recessions and expansions. The indicator is constructed by applying a dynamic factor model with regime switching. The selected methodology allows us to obtain both the composite coincident indicator as a single unobserved variable, and the implied probabilities for the regimes of expansion and recession. We use monthly data covering the January 1970-December 2007 period. The evidence supports the application of the Markov switching framework. The empirical results indicate that the applied model with regime switching leads to a satisfactory representation of the sample data. The estimated coincident indicator appears to be adequate for an evaluation of Greek economic activity, since stylized facts of the Greek business cycle are well captured by the model.

1. Introduction

Business and economic policy decisions require a timely understanding of the current status of aggregate economic activity. However, in most cases no broad measure indicating the direction of economic activity is available on a monthly basis. To respond to this need, it has long become a tradition in the USA and other advanced economies to develop and analyze composite coincident economic indicators. Such research was initiated by Burns and Mitchell (1947) for the USA. It relies on the concept that the combination of the information incorporated in individual economic series into a composite indicator can provide a broad representation of the underlying economic conditions.

In Greece, where there is also no available measure of aggregate economic activity on a monthly basis, the existence of a timely available and reliable composite coincident economic indicator is essential for economic policy and business decision making. Hence, in this paper we propose a composite coincident indicator of economic activity in Greece on the basis of the two determining features of economic fluctuations: co-movement among individual economic variables and asymmetric behavior in recessions and expansions. We apply the dynamic factor model methodology with regime switching according to Diebold and Rudebusch (1996), Chauvet (1998) and Kim and Nelson (1999). Within this framework, we obtain both the composite coincident indicator as a single unobserved variable, "the state of the economy", and the implied probabilities of expansion and recession. To our knowledge, this is the first attempt to construct a composite coincident indicator of Greek economic activity using the selected methodology. We think such an extension of the existing empirical literature, which is indeed very limited, is important for two basic reasons: first, the combination of the individual variables and the derivation of the indicator rely on a formal econometric approach and, second, the methodology applied provides us with signals of changes in aggregate economic activity. The results support the application of the specific methodology and stylized facts of the Greek business cycle are well captured by the model.

The rest of the paper is organized as follows. Section 2 provides a review of the relevant literature. Section 3 outlines the underlying empirical methodology and presents the applied model specification. Section 4 discusses the data and Section 5 presents the empirical results. The last section concludes.

2. A Review of the Literature

Since the introduction of cyclical indicators for monitoring economic conditions in the USA by Burns and Mitchell in the 1920s and 1930s, coincident indicators[1] have been widely used to indicate the direction of economic activity worldwide. The pioneering work of Burns and Mitchell (1947) has led, on the one hand, to serious criticism such as the Koopmans's (1947) "measurement without theory" critique; on the other hand, it has spurred the production of a wide literature dealing with the development of sophisticated methods for the combination of individual series into composite indices and the construction of coincident indicators of economic activity.

[1] According to whether the fluctuations in the monitored series persistently led, coincided or lagged turning points in US BC, Burns and Mitchell classified economic variables as leading, coincident and lagging, respectively.

Composite indicators for the US economy were first published in November 1968.[2] The construction of the composite coincident index of economic activity was based on a weighting scheme developed and applied by Moore and Shiskin (1967)[3]. To date, the official coincident index for US economic activity released by the Conference Board is calculated as a weighted average of four well-established, broad-based, timely series, namely, industrial production, personal income less transfer payments, employees on non-agricultural payrolls and manufacturing and trade sales. The underlying weighting procedure has been extensively used until the late 1980s. It still forms the basis for numerous applications for the construction of coincident indices of economic activity,[4] such as the work of Layton and Moore (1989) for the US service sector, Phillips, Vargas, and Zarnowitz (1996) for the Mexican economy, Altissimo, Marchetti, and Oneto (2000) for the Italian economy and Lamy and Sabourin (2001) for Canada. Despite the popularity of the weighting approach and the satisfactory results it has provided, there was still the argument that the associated weights were chosen subjectively and the analysis did not rely on any formal econometric framework.

[2] They were published by the Bureau of the Census. of the US Department of Commerce in the Business Conditions Digest. In 1968, the original monthly report *Business Cycle Developments* was renamed *Business Conditions Digest*. The publication of the first was initiated in 1961 by the US Government in cooperation with the NBER (see Business Cycle Indicators Handbook, Conference Board, 2000). In 1972, the indicators were shifted to the Bureau of Economic Analysis and in December 1995 the release of the indicators was taken over by the Conference Board.

[3] According to that scheme, variables were scored based on specific criteria. These criteria were economic significance, statistical adequacy, cyclical timing and business cycle conformity. Composite indicators for the US economy were first published in November 1968 by the Bureau of the Census of the US Department of Commerce in the Business Conditions Digest. In December 1995 the release of the indicators was taken over by the Conference Board.

[4] For a comprehensive survey on non-model based and model based approaches for the construction of composite coincident indicators, see the reference to the choice and construction of the target variable that the leading indicators are supposed to lead in Marcellino (2005). The author concludes that the estimation of the current economic condition is rather robust to the choice of methodology. In a paper reviewing the main statistical techniques for constructing coincident indicators, Carriero and Marcellino (2007) come to similar conclusions on the comparability of the derived coincident indicators.

To face such criticism, Stock and Watson (1988a, 1989) developed an econometric approach to derive, among other indices, a new composite coincident indicator for US economic activity. As a result, the work of Stock and Watson (hereafter S&W) significantly enriched the analysis of cyclical composite indicators of economic activity. Within the framework of an explicit probability model, the dynamic factor model, the composite coincident indicator is derived as a single unobserved variable, "the state of the economy". The constructed index, which is quantitatively similar to the DOC index, is based on four series: industrial production, real personal income less transfer payments, real manufacturing and trade sales, and employee-hours in non-agricultural establishments. The S&W dynamic factor model became very popular and caused a surge in related work, mostly in/for the USA and several advanced economies.[5] The S&W approach has been also applied by researchers to construct coincident indices on the regional or state level, but also for specific sector economic activity. Various modifications and extensions to the basic S&W model have been also developed.[6]

An important extension to the basic S&W model is introduced in Mariano and Murasawa (2003), who develop a factor model of time series with mixed frequencies. In an attempt to improve the basic factor model, they include quarterly real GDP in order to take into account the important information contained therein. On the basis of this earlier work, Mariano and Murasawa (2004) derive a two-factor model for the

[5] Similar applications can be found in Kim and Nelson (1999) for the US, Gaudreault, Lamy and Liu (2003) for the Canadian economy, Fukuda and Onodera (2001) for Japan, Chen (2007), in research on the synchronization of the Eurozone Business Cycles, for the Eurozone aggregate, individual Eurozone countries (such as Germany, France, Austria, Belgium, Italy, the Netherlands, Spain, Finland, Portugal) and to the USA, UK and Canada, and Hall and Zonzilos (2003) for the Greek economy.

[6] Clayton-Matthews and Stock (1998) use the S&W methodology to estimate a coincident index for the Massachusetts economy, Megna and Xu (2003) for the New York State economy, Phillips (2004) for Texas economic activity, Crone and Clayton-Matthews (2004) for all 50 states and Cañas, Gilmer, and Phillips (2003) for Houston. Lahiri, Yao, and Young (2003) and Lahiri and Yao (2004) apply the S&W dynamic factor model to the transportation sector of the US economy using sectoral data. Using a modification to the basic S&W dynamic factor model, Nieto and Melo (2001) construct a coincident indicator for the Colombian economy.

observable mixed-frequency series. Crone and Clayton-Matthews (2004) also consider an extension with mixed frequency series in the construction of coincident indices for the 50 states. In an application of dynamic factor analysis to construct coincident indices for the USA and the Euro area, Proietti and Moauro (2006) take into account the non-linear temporal aggregation constraint when using mixed-frequency data. Kholodilin (2002) extends the basic S&W one-factor model to a two-factor model of the common coincident and leading economic indicators, where the two factors are estimated simultaneously.

Limitations faced regarding large data sets due to computational problems and the need to identify and select the coincident variables to be included in the model prior to estimation (basically by heuristic criteria) are the most cited drawbacks of the basic S&W methodology. To cope with these problems, Forni, Hallin, Lippi, and Reichlin (FHLR 2000a), FHLR (2000b, 2001) and S&W (2002a, 2002b) developed alternative procedures for the analysis of dynamic factor models. FHLR (2000a) introduced the generalized dynamic factor model which relates/reconciles dynamic factor analysis with dynamic principal component analysis. The model underlying the method for the construction of the EuroCOIN coincident indicator compiled for the Euro area belongs also to the class of FHLR models.[7] In a recent work on the Belgian economy using a large data set, Van Nieuwenhuyze (2006) also applies the specific version of the FHLR generalized dynamic factor model and derives (among others) a common component driven by the Belgian business cycle.

[7] The project for the construction of a coincident indicator for the Euro area, as described in Altissimo et al. (2001), has led to regular monthly release of the EuroCOIN coincident indicator since January 2002. The innovation introduced in the FHLR (2005) model also initiated refinements in the procedure applied for the production of the real time EuroCOIN indicator (Altissimo et al. (2006)), so that no future information be/is required.

The basic S&W dynamic factor model and all the related extensions and modifications which were developed thereafter incorporated one key attribute outlined in Burns and Mitchell's definition of business cycles: co-movement among individual economic variables. However, the same did not hold for the second prominent feature, i.e. the separate treatment of expansions and contractions. This key element was considered by Hamilton (1989) in a non-linear model for real GNP with discrete regime switching between periods of expansion and contraction. In an effort to combine the two main ideas used by scholars of the cycle, Diebold and Rudebusch (1996) argue that the dynamic factor and regime switching literatures should not be considered in isolation. They propose an empirical synthesis and describe a framework for the analysis of business cycle data incorporating both factor structure and regime switching,[8] even though they do not fully estimate the synthesized model. The task of estimating such a model was tackled by Kim and Yoo (1995) and Chauvet (1998) who used filtering and smoothing methods developed by Kim (1994) for the maximum likelihood estimation. Kim and Nelson (1998a, 1998b) also apply dynamic factor models with regime switching relying on different estimation procedures.

Similarly to the basic S&W factor model, the synthesized dynamic factor model with regime switching caused a surge in similar applications, as well as extensions and modifications.[9] Kholodilin (2003) considers a similar model (among others) for the Japanese business cycle and in extending earlier work he proposes and estimates (Kholodilin (2001)) a dynamic factor model with regime switching with mixed frequencies for the US economy and, furthermore, introduces and estimates a two-factor model which takes into account coincident as well as leading variables

[8] They also offer an extensive survey of related literature and provide some links between macroeconomic theory and factor structure and regime switching.
[9] Such applications refer also to the construction and estimation of composite leading indicators. See for example Bandholz and Funke (2003) for Germany and Bandholz (2005) for Hungary and Poland.

(Kholodilin (2002)). Similar models are applied to the German and to large European economies in Kholodilin (2005) and Kholodilin (2006), respectively. In an application to the UK economy, Mills and Wang (2003) propose and estimate a common factor regime switching. In his work mentioned above investigating the synchronization of the Eurozone Business Cycles, Chen (2007) further applies the common factor model with regime switching. Finally, in applications to the US transportation sector, Lahiri, Yao, and Young (2003) and Lahiri and Yao (2004) apply dynamic factor models with regime switching.

3. Data

We use five monthly coincident economic variables to estimate the above described model.[10] The selected series, as described in Table 1, are chosen to provide a broad coverage of the underlying conditions in the Greek economy. The selection of variables is further dictated by data availability considerations and is also based on statistical criteria.[11] The data sample covers the time period from January 1970 to December 2007 and includes the following series: (a) industrial production, (b) retail sales, (c) imports, (d) tourism (arrivals of foreigners) (e) and passenger cars (licenses issued). We believe the series under consideration to be satisfactorily diversified in

[10] Nominal variables are deflated and, wherever necessary, series are seasonally adjusted using the US Census Bureau X12 procedure. See also Table 1.

[11] Although data on employment and/or unemployment and personal income belong to the basic components used to construct coincident economic indicators for the US and other advanced economies, we do not include such data due to data availability restrictions. More generally, it is noted that the selection of the data series to be used for model estimation is highly constrained by the restricted availability of historical monthly data. An alternative would be the examination of a considerably shorter time period, possibly enlarging the set of available monthly series. However, it is believed that the validity and robustness of the indicator should be in a fist stage established by showing its consistence with historical stylized facts of the Greek business cycle.

their coverage of the Greek economic sectors so that the index to be constructed can be expected to capture the cyclical movements in aggregate economic activity.[12]

To evaluate the usefulness of the proposed variables as potential coincident series, we check for their contemporaneous correlation with GDP.[13] For all series but imports the correlations at lag zero are significantly high. Furthermore, the tourism series appears to exhibit a slightly lagging structure. Moreover, we do not find high correlations between industrial production and the other four series and, as a result we do not expect the estimated indicator to be dominated by movements in industrial production. We further conduct ADF unit root tests to check for stationarity and cointegration tests to check for cointegration. The test results are presented in Table 2. In all cases we cannot reject the null hypothesis of the existence of a unit root for the series in levels but the test results suggest rejection of the null when first differences are considered. Moreover, according to the conducted Johansen cointegration test we cannot reject the hypothesis of no cointegration. As a result, the model is estimated in first differences of the logarithms of the selected variables.

4. Empirical methodology and model specification

In this paper we apply the dynamic factor model with regime switching to develop a coincident index of economic activity for the Greek economy. To the best of our knowledge, this is the first attempt to construct such a coincident indicator for Greece on the basis of the specific methodology. The selection of this methodology is

[12] Our data sources are the General Secretariat of National Statistical Service of Greece and Eurostat.
[13] Note, that we use real GDP quarterly data which are converted into monthly data (via a low-to-high frequency conversion procedure applied in EViews) as a benchmark series for the GDP series. It should be further noted that, against the background of the significant 2007 upward revision of GDP the General Secretariat of National Statistical Service of Greece provides adjusted GDP data only back to 2000. In order to construct a continuous GDP time series, we adjust the data backwards on the basis of the q-o-q percentage changes of the non-revised earlier quarterly data provided by Eurostat back to 1970.

based on considerations relating to the ability of the model to encompass the two defining features of business cycles and to provide us with implied probabilities of recessions and expansions which can be used to date turning points.

In the following model which synthesizes the S&W (1989) dynamic factor model with Hamilton's (1989) regime-switching model, the coincident indicator is extracted as the common component out of a group of exogenous economic variables signaling the current state of the economy. At the same time, the cyclical movement of the indicator is translated into probabilities of being in a recession or expansion. Defining $\Delta y_{it} = \Delta Y_{it} - \Delta \overline{Y}_i$ and $\Delta c_t = \Delta C_t - \delta$, the applied model is expressed in deviations from means as follows:[14]

$$\Delta y_{it} = \gamma_i(L)\Delta c_t + e_{it}, \qquad i = 1,2,3,4,5 \qquad (1)$$

$$\phi(L)\Delta c_t = \mu_{s_t} + v_t, \qquad v_t \sim i.i.d.N(0,1), \qquad (2)$$

$$\psi_i(L)e_{it} = \varepsilon_{it}, \qquad \varepsilon_{it} \sim i.i.d.N(0,\sigma_i^2), \qquad (3)$$

$$\mu_{s_t} = \mu_0(1 - S_t) + \mu_1 S_t \qquad S_t = \{0,1\}, \qquad (4)$$

$$\Pr[S_t = 1 \mid S_{t-1} = 1] = p, \qquad \Pr[S_t = 0 \mid S_{t-1} = 0] = q, \qquad (5)$$

where in equation (1), Δy_{it} represent the differences of the logs of the economic variables, Δc_t is the growth rate of the common factor, hence of the composite coincident index, γ_i are the individual weights measuring the variables' sensitivity to the business cycle. Equation (2) expresses the dependence of Δc_t on whether the economy is in recession or expansion.[15] Hence it incorporates the asymmetry characteristic of business cycles since, according to equations (4) and (5), the common component is assumed to be generated by a two-state Markov switching

[14] Otherwise the means of the processes are overdetermined and the model is not identified.

[15] As in Kim and Yoo (1995), Chauvet (1995) and the application in Chapter 5 of Kim and Nelson (1999), we allow here for the intercept term of the common component to be regime dependent. In the model of Diebold and Rudebusch (1996) it is the mean of the common component which is allowed to be regime dependent.

process. The unobservable state variable S_t switches between the recessionary 0 and the expansionary 1 regimes, where the respective transition probabilities q and p are given by equation (5). The processes of the idiosyncratic components e_{it} are described by equation (3) and the innovations v_t and ε_{it} are assumed to be independent for all t and i.

For estimation purposes, the model is cast into state space form. Parameter estimates as well as the unobserved common factor and the inferred probabilities are obtained by maximum likelihood estimation. However, due to the non-linearity of the model, the usual Kalman filter is not applicable.[16] The applied estimation procedure therefore consists of a combination of Hamilton's algorithm and a non-linear version of the Kalman filter, as introduced by Kim (1994).[17]

We select AR(2) processes for the common factor and the idiosyncratic terms. Other higher parameterized specifications were also used, but they did not provide any additional statistically significant coefficients or a significantly different estimate of the common factor. Furthermore, a second lag of Δc_t is allowed to enter the tourism equation of the model.[18] For purposes of identification, all series are demeaned by subtracting the mean difference and the variance of v_t is set equal to unity. The selected model specification can be described by the following measurement and transition equations:[19]

---

[16] For an intuitive explanation for that see Kim and Nelson (1999).

[17] The basic filtering and also smoothing procedures involve some approximations. Kim and Nelson (1999) argue that in cases where exact maximum likelihood estimation is not feasible, the approximation-based algorithms can be employed, since the approximations appear to be quite accurate with only marginal efficiency cost. They also introduce the Gibbs sampling approach to enable approximation-free inference in non-linear models.

[18] See also Section 3.

[19] The GAUSS programs written to estimate the models draw on routines that are referred to and presented on the website of Kim and Nelson (1999).

$$
\begin{bmatrix} \Delta y_{1t} \\ \Delta y_{2t} \\ \Delta y_{3t} \\ \Delta y_{4t} \\ \Delta y_{5t} \end{bmatrix}
=
\begin{bmatrix}
\gamma_1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\gamma_2 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
\gamma_3 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
\gamma_{40} & \gamma_{41} & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
\gamma_5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0
\end{bmatrix}
\begin{bmatrix} \Delta c_t \\ \Delta c_{t-1} \\ e_{1t} \\ e_{1t-1} \\ e_{2t} \\ e_{2t-1} \\ e_{3t} \\ e_{3t-1} \\ e_{4t} \\ e_{4t-1} \\ e_{5t} \\ e_{5t-1} \end{bmatrix}, \tag{6}
$$

$$
\begin{bmatrix} \Delta c_t \\ \Delta c_{t-1} \\ e_{1t} \\ e_{1t-1} \\ e_{2t} \\ e_{2t-1} \\ e_{3t} \\ e_{3t-1} \\ e_{4t} \\ e_{4t-1} \\ e_{5t} \\ e_{5t-1} \end{bmatrix}
=
\begin{bmatrix} \mu_{s_t} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}
+
\begin{bmatrix}
\phi_1 & \phi_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \psi_{11} & \psi_{12} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \psi_{21} & \psi_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \psi_{31} & \psi_{32} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \psi_{41} & \psi_{42} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \psi_{51} & \psi_{52} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0
\end{bmatrix}
$$

$$
*
\begin{bmatrix} \Delta c_{t-1} \\ \Delta c_{t-2} \\ e_{1t-1} \\ e_{1t-2} \\ e_{2t-1} \\ e_{2t-2} \\ e_{3t-1} \\ e_{3t-2} \\ e_{4t-1} \\ e_{4t-2} \\ e_{5t-1} \\ e_{5t-2} \end{bmatrix}
+
\begin{bmatrix} v_t \\ 0 \\ \varepsilon_{1t} \\ 0 \\ \varepsilon_{2t} \\ 0 \\ \varepsilon_{3t} \\ 0 \\ \varepsilon_{4t} \\ 0 \\ \varepsilon_{5t} \\ 0 \end{bmatrix}, \tag{7}
$$

5. Empirical results

The estimated dynamic factor model with regime switching appears to successfully provide information about cyclical movements in Greek economic activity. Furthermore, the model seems to fit the data quite well, since almost all parameters have the expected signs and are statistically significant. Moreover, the empirical evidence provides support for the two-state specification, and hence, for the asymmetry between recessions and expansions.

More specifically, the two autoregressive coefficients of the common component are negative and statistically significant. As regards the idiosyncratic components, the factor loadings picturing the sensitivity of the variables to the business cycle are in all cases positive and in all but one cases statistically significant. More specifically, industrial production has the highest weighting on the common factor with a coefficient of 0.30 and, hence, seems to respond the most to business cycle changes in economic conditions. Imports, tourism and cars are less sensitive but still responsive with coefficients around 0.1. In contrast, retail sales appear to respond the less to business cycle fluctuations with a low and not statistically significant factor loading of 0.05. Hence, among the components included, retail sales is the least cyclical one. The negative coefficients of ψ_i for all series except industrial production imply that the idiosyncratic components exhibit negative serial correlation, while the respective first coefficient for the industrial production series indicates positive idiosyncratic autocorrelation.

The empirical evidence further supports the usefulness of the Markov switching feature of the model. The adequacy of the selected model is confirmed by the signs of the estimated Markov-switching parameters μ_0 and μ_1. In recessions, μ_0 equaling -9.3157 is significantly below zero, while during cyclical upswings μ_1 which equals 0.0935 is positive. In line with similar findings in the literature, the probability of staying in expansion ($p = 0.983$) is higher than that of staying in a recession ($q = 0.337$). This agrees with the suggestion that the average duration of expansions is larger than the duration of recessions. The implied expected durations of expansion calculated as $[1/(1-p)]$ and recession given by $[1/(1-q)]$ are approximately 59 and 2 months, respectively.

The combination of the dynamic factor model with the regime switching methodology makes it possible to extract the common factor as well as the probability that the economy is in a recession. The estimated monthly coincident index of economic activity in Greece is plotted in levels in Figure 1. Unfortunately, there is no officially released business cycle chronology for Greek economic activity to compare our results to. Still, as illustrated, the constructed composite coincident index of Greek economic activity seems to perform reasonably well in picturing the business cycle for the time period under consideration. Figure 2 pictures the implied filtered and smoothed recession probabilities. As can be seen and expected, Greek business cycles have not been regular and there are no two cycles which seem to be identical. The indicated differences mainly suggest that the 1970s and 1980s were characterized by considerable up- and downswings. The same does not hold for the period after the early 1990s, which appears to be significantly more stable. The constructed coincident indicator accurately reproduces the basic downward movements of the Greek business cycle: the mid-1970s recession, which coincides with the first oil price shock and was also related to domestic political developments; a short-lived early 1980s downswing following the second oil price shock, where in this case the implied probability of recession does not exceed 0.5; the 1987 recession and, finally, the early 1990s recession also related to the spike in the price of oil.[20]

In order to check whether the model is correctly specified, we perform some misspecification tests on the one-step-ahead forecast errors. To confirm the validity of the model, the latter should be serially uncorrelated, hence not predictable, and normally distributed. As the Q-Ljung-Box statistics indicate, there are no signs of remaining autocorrelation. However, there are some departures from the normality hypothesis. Moreover, we check the correlation between the growth of the constructed coincident index and the growth of the included variables and also GDP growth and find positive contemporaneous correlation coefficients in all cases. The highest correlation coefficients are found for industrial production and the lowest for retail sales.

6. Conclusions

In this paper we have constructed a coincident indicator of Greek economic activity for the January 1970 to December 2007 period. Using five coincident component series and estimating a dynamic factor model with regime switching, we have obtained a common factor representing the state of the economy and the related recession probabilities. The specific methodology was selected to place emphasis on the construction of the coincident indicator on the basis of a formal econometric approach and to incorporate the two key elements of business cycles.

The provided empirical evidence supports the application of the specific methodology. Co-movement among the individual components and the regime

[20] If one would adopt the popular informal rule that a recession is characterized by two consecutive quarters of decline in GDP, then the recession dates indicated by the model would be all confirmed.

switching property are confirmed to be reasonable characteristics of fluctuations in Greek economic activity. Moreover, stylized facts of the Greek business cycle, such as the higher volatility of the 1970s and 1980s compared to the more stable 1990s, as well as the deepest downswings characterizing Greek economic activity during the period under investigation, are captured by the model. Hence, the proposed coincident indicator can be used for a timely evaluation of current Greek economic conditions. An interesting exercise for further research would consist in the compilation of a composite coincident indicator of Greek economic activity for the time period after the 1990s. Such a project would make it possible to take into account the important role of credit expansion and, depending on data availability restrictions, to include variables representing the employment and service sectors of the Greek economy.

Table 1 Variables description

Name-Mnemonic	Description	Transformation
IP	Industrial production index, monthly	Seasonally adjusted
RS	Turnover index in retail trade, monthly	Deflated, seasonally adjusted
IMP	Value of imports (arrivals), monthly	Indexed, deflated, seasonally adjusted
TRSM	Total arrivals of foreigners at the Greek borders, monthly	Indexed, seasonally adjusted
CARS	Number of issued passenger cars (private use) licenses	Indexed, seasonally adjusted
GDP	Constant prices, quarterly	Indexed, seasonally adjusted, converted to monthly

Source: General Secretariat of National Statistical Service of Greece, Eurostat.

Table 2 ADF unit root tests and Johansen test for cointegration

	Variables				
	IP	RS	IMP	TRSM	CARS
			ADF unit root tests		
Levels	-2.754	-0.160	0.487	0.217	-0.922
	(0.066)	(0.941)	(0.986)	(0.974)	(0.781)
First differences	-16.461	-23.917	-16.631	-12.306	-15.322
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			Johansen cointegration test		
Trace test			67.335		
			(0.078)		
Max-eigenvalue test			25.309		
			(0.364)		

Notes: Augmented Dickey-Fuller test statistics are provided with the corresponding *p*-values in parentheses. The test critical values at the 5% and 10% levels are -2.868 and -2.570, respectively. The unrestricted cointegration rank test statistics are provided with the corresponding *p*-values in parentheses. The 0.05 critical values for the trace and max-eigenvalue tests are 69.819 and 33.877, respectively.

Table 3 Parameter estimates of the dynamic factor model with regime switching

Common factor						
	ϕ_1	ϕ_2	μ_0	μ_1	p	q
	-0.862	-0.3949	-9.3157	0.0935	0.983	0.337
	(0.086)	(0.0691)	(1.1188)	(0.1887)	(0.0038)	(0.2634)
Idiosyncratic component						
(ΔIP_t)	γ_1		ψ_{11}	ψ_{12}	σ_1^2	
	0.3025	-	0.1984	-0.4388	0.5202	
	(0.0435)		(0.1256)	(0.069)	(0.0541)	
(ΔRS_t)	γ_2		ψ_{21}	ψ_{22}	σ_2^2	
	0.0469	-	-0.6532	-0.2728	0.8279	
	(0.0342)		(0.0463)	(0.0455)	(0.0275)	
(ΔIMP_t)	γ_3		ψ_{31}	ψ_{32}	σ_3^2	
	0.1133	-	-0.4483	-0.1839	0.8876	
	(0.0343)		(0.0464)	(0.0463)	(0.0297)	
$(\Delta TRSM_t)$	γ_{40}	γ_{41}	ψ_{41}	ψ_{42}	σ_4^2	
	0.0822	0.1638	-0.5276	-0.174	0.8634	
	(0.0387)	(0.0369)	(0.0489)	(0.0483)	(0.0303)	
$(\Delta CARS_t)$	γ_5		ψ_{51}	ψ_{52}	σ_5^2	
	0.1181	-	-0.4288	-0.2455	0.8862	
	(0.0351)		(0.046)	(0.0461)	(0.0297)	
Log likelihood: -807.181						

Note: Standard errors are given in parentheses.

Figure 1 The coincident indicator of Greek economic activity

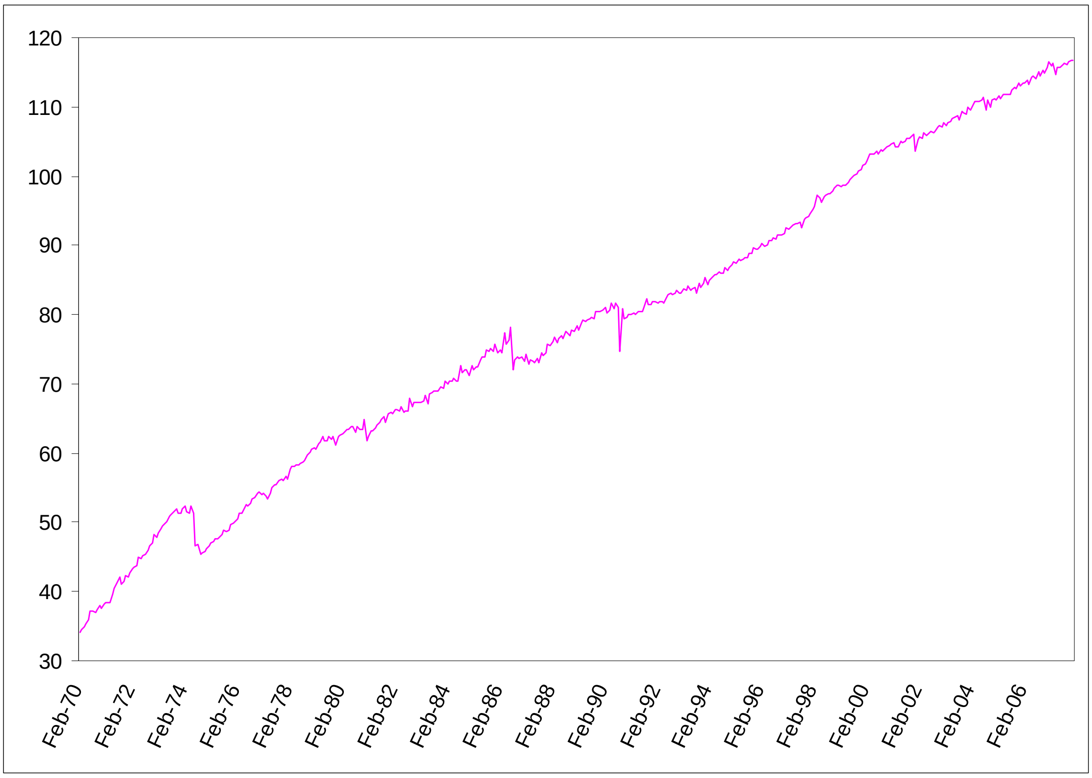
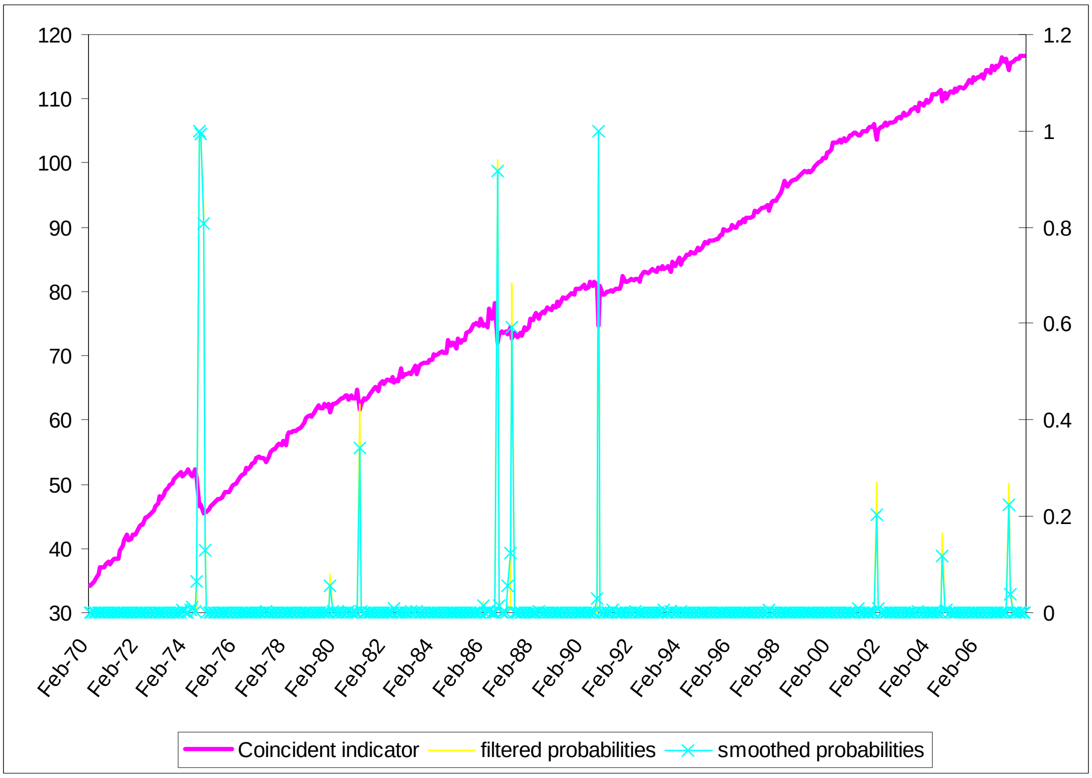


Figure 2 The coincident indicator, filtered and smoothed recession probabilities



References

Altissimo, F., Bassanetti, A., Cristadoro, R., Forni, M., Hallin, M., Lippi, M., Reichlin, L. and Veronese, G. (2001). EuroCOIN: A real time coincident indicator of the Euro area business cycle, CEPR Discussion Paper 3108.

Altissimo, F., Cristadoro, R., Forni, M., Lippi, M., and Veronese, G. (2006). New Eurocoin: Tracking economic growth in real time, Bank of Italy, Economic Research Department Economic Working Paper 631.

Altissimo, F., Marchetti, D. J. and Oneto, G.P. (2000). The Italian business cycle: Coincident and leading indicators and some stylized facts, Banca d' Italia Temi di discussione del Servizio Studi 377.

Bandholz, H. (2005). New composite leading indicators for Hungary and Poland, Ifo Working Paper 3.

Bandholz, H. and Funke, M. (2003). In search of leading indicators of economic activity in Germany, *Journal of Forecasting*, 22, 277-297.

Burns, A. F. and Mitchell, W. C. (1947). Measuring business cycles, NBER Studies in Business Cycles No.2, New York.

Cañas, J., Gilmer, R. W. and Phillips, K. (2003). A new index of coincident economic activity for Houston, Federal Reserve Bank of Dallas, Houston Branch Houston Business.

Carriero, A. and Marcellino, M. (2007), Monitoring the Economy of the Euro Area: A comparison of composite coincident indexes, IGIER Working Paper No. 319.

Chauvet, M. (1998). An econometric characterization of business cycle dynamics with factor structure and regime switching, *International Economic Review*, 39(4), 969-996.

Chen, X. (2007). Evaluating the synchronisation of the Eurozone business cycles using multivariate coincident macroeconomic indicators, Loughborough University, Department of Economics Discussion Paper 26.

Clayton-Matthews, A. and Stock, J. H. (1998). An application of the Stock/Watsonindex methodology to the Massachusetts economy, Journal of Economic and Social Measurement, 25(3-4), 183-233.

Crone, T. M. and Clayton-Matthews, A. (2004). Consistent economic indexes for the 50 States, Federal Reserve Bank of Philadelphia Research Department Working Paper 9.

Diebold, F. X. and Rudebusch, G. D. (1996). Measuring business cycles: A modern perspective, *Review of Economics and Statistics*, 78, 67-77.

Forni, M., Hallin, M., Lippi, M. and Reichlin L. (2000a). Reference cycles: The NBER methodology revisited, CEPR Discussion Paper 2400.

Forni, M., Hallin, M., Lippi, M. and Reichlin L. (2000b). The generalized dynamic factor model: Identification and estimation, *The Review of Economics and Statistics*, 82(4), 540-554.

Forni, M., Hallin, M., Lippi, M. and Reichlin L. (2001). Coincident and leading indicators for the Euro area, *The Economic Journal*, 111, C62-C85.

Forni, M., Hallin, M., Lippi, M. and Reichlin L. (2005). The generalized dynamic factor model: One-sided estimation and forecasting, *Journal of the American Statistical Association*, 100, 830-840.

Fukuda, S.-i. and Onodera, T. (2001), A new composite index of coincident economic indicators in Japan: How can we improve the forecast performance?, *International Journal of Forecasting*, 17(3), 483-498.

Gaudreault, C., Lamy, R. and Liu Y. (2003). New coincident, leading and recession indexes for the Canadian economy: An application of the Stock and Watson methodology, Department of Finance Working Paper 12.

Hall, S. G. and Zonzilos, N. G. (2003). An indicator measuring underlying economic activity in Greece, Bank of Greece Working Paper 4.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle, *Econometrica*, 57, 357-384.

Kholodilin, K. A. (2001). Markov switching common dynamic factor model with regime switching, Université catholique de Louvain IRES Discussion Paper 2001020.

Kholodilin, K. A. (2002). Predicting the cyclical phases of the post-war U.S. leading and coincident indicators, *Economics Bulletin*, 3(5), 1-15.

Kholodilin, K. A. (2002). Unobserved leading and coincident common factors in the post-war U.S. business cycle, Université catholique de Louvain IRES Discussion Paper 2002008.

Kholodilin, K. A. (2003). Identifying and forecasting the turns of the Japanese business cycle, Université catholique de Louvain IRES Discussion Paper 2003008.

Kholodilin, K. A. (2005). Forecasting the turns of German business cycle: Dynamic bi-factor model with Markov switching, DIW Berlin Discussion Papers 494.

Kholodilin, K. A. (2006). Using the dynamic bi-factor model with Markov switching to predict the cyclical turns in the large European economies, DIW Berlin Discussion Papers 554.

Kim C.-J. and Nelson, C. R. (1998). Business cycle turning points, a new coincident index, and tests of duration dependence based on a dynamic factor model with regime switching, *Review of Economics and Statistics*, 80, 188-201.

Kim C.-J. and Nelson, C. R. (1999). State space models with regime switching – Classical and Gibbs-Sampling approaches with applications, Cambridge (MA): MIT Press.

Kim, C.-J. (1994). Dynamic linear models with Markov switching, *Journal of Econometrics*, 60, 1-22.

Kim, M.-J. and YooJ.-S. (1995). New index of coincident indicators: A multivariate Markov switching factor model approach, *Journal of Monetary Economics*, 36, 607-630.

Koopmans, T. C. (1947). Measurement without theory, *Review of Economics and Statistics*, 29, 161-179.

Lahiri, K and Yao, W. (2004). A dynamic factor model of the coincident indicators for the US transportation sector, *Applied Economics Letters*, 11, 595-600.

Lahiri, K., Yao, W. and Young, P. (2003). Cycles in the Transportation sector and the aggregate economy, University at Albany, SUNY, Department of Economics Discussion Paper 03-14.

Lamy, R. and Sabourin, P. (2001). Monitoring regional economies in Canada with new high-frequency coincident indexes, Department of Finance Working Paper 05.

Layton, A. P. and Moore, G. H. (1989). Leading indicators for the service sector, *Journal of Business and Economic Statistics*, 7(3), 379-386.

Marcellino, M. (2005). Leading Indicators: What have we learned?, IGIER Working Paper No. 286.

Mariano, R. S. and Murasawa, Y. (2003). A new coincident index of business cycles based on monthly and quarterly series, *Journal of Applied Econometrics*, 18, 427-443.

Mariano, R. S. and Murasawa, Y. (2004). Constructing a coincident index of business cycles without assuming a one-factor model, SMU Economics and Statistics Working Paper 22.

Megna, R. and Xu Q. (2003). Forecasting the New York State economy: The coincident and leading indicators approach, *International Journal of Forecasting*, 19(4), 701-713.

Mills, T. C. and Wang, P. (2003). Multivariate Markov switching common factor models for the UK, *Bulletin of Economic Research*, 55(2), 177-193.

Moore, G. H. and Shiskin, J. (1967). Indicators of business expansions and contractions, NBER Occasional Paper No. 103.

Nieto, F. H. and Melo, L. F. (2001). About a coincident index for the state of the economy, Banco de la República, Borradores de economia 001938.

Phillips, K. R. (2004), A new monthly index of the Texas business cycle, Federal Reserve Bank of Dallas Research Department Working Paper 0401.

Phillips, K. R., Vargas, L. and Zarnowitz V. (1996). New tools for analyzing the Mexican economy: Indexes of coincident and leading indicators, Federal Reserve Bank of Dallas Economic Review, Second quarter.

Proietti, T. and Moauro, F. (2006). Dynamic factor analysis with non-linear temporal aggregation constraints, *Journal of the Royal Statistical Society*, Series C, 55(2), 281-300.

Stock, J. H. and Watson, M. W. (1988). A probability model of the coincident economic indicators, NBER Working Paper 2772.

Stock, J. H. and Watson, M. W. (1989). New indexes of coincident and leading economic indicators, in O. J. Blanchard and S Fischer (eds.), *NBER Macroeconomics Annual*, 351-394, Cambridge: MIT Press.

Stock, J. H. and Watson, M. W. (2002a). Macroeconomic forecasts using diffusion indexes, *Journal of Business and Economic Statistics*, 20(2), 147-162.

Stock, J. H. and Watson, M. W. (2002b). Forecasting using principal components from a large number of predictors, *Journal of the American Statistical Association*, 97(460), 1167-1179.

The Conference Board (2000). Business cycle indicators Handbook, New York.

Van Nieuwenhuyze, C. (2006). A generalized dynamic factor model for the Belgian economy – Useful business cycle indicators and GDP growth forecasts, National Bank of Belgium Working Paper 80.

IN THE SAME SERIES

No 103 E. Athanassiou, “Fiscal Policy and the Recession: The Case of Greece’’. Athens, 2009.

No 102 St. Karagiannis, Y. Panagopoulos and Ar. Spiliotis, “Modeling banks’ lending behavior in a capital regulated framework’’. Athens, 2009.

No 101 Th. Tsekeris, “Public Expenditure Competition in the Greek Transport Sector: Inter-modal and Spatial Considerations’’. Athens, 2009.

No 100 N. Georgikopoulos and C. Leon, “Stochastic Shocks of the European and the Greek Economic Fluctuations’’. Athens, 2009.

No 99 P. I. Prodromídis, “Deriving Labor Market Areas in Greece from commuting flows’’. Athens, 2009.

No 98 Y. Panagopoulos and Prodromos Vlamis, “Bank Lending, Real Estate Bubbles and Basel II”. Athens, 2008.

No 97 Y. Panagopoulos, “Basel II and the Money Supply Process: Some Empirical Evidence from the Greek Banking System (1995-2006)”. Athens, 2007.

No 96 N. Benos, St. Karagiannis, “Growth Empirics: Evidence from Greek Regions”. Athens, 2007.

No 95 N. Benos, St. Karagiannis, “Convergence and Economic Performance in Greece: New Evidence at Regional and Prefecture Level”. Athens, 2007.

No 94 Th. Tsekeris, “Consumer Demand Analysis of Complementarities and Substitutions in the Greek Passenger Transport Market”. Athens, 2007.

No 93 Y. Panagopoulos, I. Reziti, and Ar. Spiliotis, “Monetary and banking policy transmission through interest rates: An empirical application to the USA, Canada, U.K. and European Union”. Athens, 2007.

No 92 W. Kafouros and N. Vagionis, "Greek Foreign Trade with Five Balkan States During the Transition Period 1993-2000: Opportunities Exploited and Missed. Athens, 2007.

No 91 St. Karagiannis, " The Knowledge-Based Economy, Convergence and Economic Growth: Evidence from the European Union , Athens, 2007.

No 90 Y. Panagopoulos, "Some further evidence upon testing hysteresis in the Greek Phillips-type aggregate wage equation". Athens, 2007.

No 89 N. Benos, “Education Policy, Growth and Welfare". Athens, 2007.

No 88 P. Baltzakis, "Privatization and deregulation". Athens, 2006 (In Greek).

No 87 Y. Panagopoulos and I. Reziti, "The price transmission mechanism in the Greek food market: An empirical approach". Athens, 2006. Published in Agribusiness, vol. 24 (1), 2008, pp. 16-30.

No 86 P. I. Prodromídis, " Functional Economies or Administrative Units in Greece: What Difference Does It Make for Policy?" Athens, 2006. Published in: Review of Urban & Regional Development Studies, vol. 18.2, 2006, pp. 144-164.

No 85 P. I. Prodromídis, "Another View on an Old Inflation: Environment and Policies in the Roman Empire up to Diocletian's Price Edict". Athens, 2006.

No 84A E. Athanassiou, "Prospects of Household Borrowing in Greece and their Importance for Growth". Athens, 2006. Published in: South-Eastern Europe Journal of Economics, vol.5, 2007, pp. 63-75.

No 83 G. C. Kostelenos, "La Banque nationale de Grèce et ses statistiques monétaires (1841-1940)". Athènes, 2006. Published in: Mesurer la monnaie. Banques centrales et construction de l' autorité monétaire (XIXe-XXe siècle), Paris: Edition Albin Michel, 2005, 69-86.

No 82 P. Baltzakis, "The Need for Industrial Policy and its Modern Form". Athens, 2006 (In Greek).

No 81 St. Karagiannis, "A Study of the Diachronic Evolution of the EU's Structural Indicators Using Factorial Analysis". Athens, 2006.

No 80 I. Resiti, "An investigation into the relationship between producer, wholesale and retail prices of Greek agricultural products". Athens, 2005.

No 79 Y. Panagopoulos, A. Spiliotis, "An Empirical Approach to the Greek Money Supply". Athens, 2005.

No 78 Y. Panagopoulos, A. Spiliotis, "Testing alternative money theories: A G7 application". Athens, 2005. Published in Journal of Post Keynesian Economics, vol. 30 (4), 2008, pp.607-629

No 77 I. A. Venetis, E. Emmanuilidi, "The fatness in equity Returns. The case of Athens Stock Exchange". Athens, 2005.

No 76 I. A. Venetis, I. Paya, D. A. Peel, "Do Real Exchange Rates "Mean Revert" to Productivity? A Nonlinear Approach". Athens, 2005.

No 75 C. N. Kanellopoulos, "Tax Evasion in Corporate Firms: Estimates from the Listed Firms in Athens Stock Exchange in 1990s". Athens, 2002 (In Greek).

No 74 N. Glytsos, "Dynamic Effects of Migrant Remittances on Growth: An Econometric Model with an Application to Mediterranean Countries". Athens, 2002. Published under the title "The contribution of remittances to growth: a dynamic approach and empirical analysis" in: Journal of Economic Studies, December 2005.

No 73 N. Glytsos, "A Model Of Remittance Determination Applied to Middle East and North Africa Countries". Athens, 2002.

No 72 Th. Simos, "Forecasting Quarterly gdp Using a System of Stochastic Differential Equations". Athens, 2002.

No 71 C. N. Kanellopoulos, K. G. Mavromaras, "Male-Female Labour Market Participation and Wage Differentials in Greece". Athens, 2000. Published in: Labour, vol. 16, no. 4, 2002, 771-801.

No 70 St. Balfoussias, R. De Santis, "The Economic Impact of The Cap Reform on the Greek Economy: Quantifying the Effects of Inflexible Agricultural Structures". Athens, 1999.

No 69 M. Karamessini, O. Kaminioti, "Labour Market Segmentation in Greece: Historical Perspective and Recent Trends". Athens, 1999.

No 68 S. Djajic, S. Lahiri and P. Raimondos-Moller, "Logic of Aid in an Intertemporal Setting". Athens, 1997.

No 67 St. Makrydakis, "Sources of Macroecnomic Fluctuations in the Newly Industrialized Economies: A Common Trends Approach". Athens, 1997. Published in: Asian Economic Journal, vol. 11, no. 4, 1997, 361-383.

No 66 N. Christodoulakis, G. Petrakos, "Economic Developments in the Balkan Countries and the Role of Greece: From Bilateral Relations to the Challenge of Integration". Athens, 1997.

No 65 C. Kanellopoulos, "Pay Structure in Greece". Athens, 1997.

No 64 M. Chletsos, Chr. Kollias and G. Manolas, "Structural Economic Changes and their Impact on the Relationship Between Wages, Productivity and Labour Demand in Greece". Athens, 1997.

No 63 M. Chletsos, "Changes in Social Policy - Social Insurance, Restructuring the Labour Market and the Role of the State in Greece in the Period of European Integration". Athens, 1997.

No 62 M. Chletsos, "Government Spending and Growth in Greece 1958-1993: Some Preliminary Empirical Results". Athens, 1997.

No 61 M. Karamessini, "Labour Flexibility and Segmentation of the Greek Labour Market in the Eighties: Sectoral Analysis and Typology". Athens, 1997.

No 60 Chr. Kollias and St. Makrydakis, "Is there a Greek-Turkish Arms Race?: Evidence from Cointegration and Causality Tests". Athens, 1997. Published in: Defence and Peace Economics, vol. 8, 1997, 355-379.

No 59 St. Makrydakis, "Testing the Intertemporal Approach to Current Account Determi-nation: Evidence from Greece". Athens, 1996. Published in: Empirical Economics, vol. 24, no. 2, 1999, 183-209.

No 58 Chr. Kollias and St. Makrydakis, "The Causal Relationship Between Tax Revenues and Government Spending in Greece: 1950-1990". Athens, 1996. Published in: The Cyprus Journal of Economics, vol. 8, no. 2, 1995, 120-135.

No 57 Chr. Kollias and A. Refenes, "Modelling the Effects of No Defence Spending Reductions on Investment Using Neural Networks in the Case of Greece". Athens, 1996.

No 56 Th. Katsanevas, "The Evolution of Employment and Industrial Relations in Greece (from the Decade of 1970 up to the Present)". Athens, 1996 (In Greek).

No 55 D. Dogas, "Thoughts on the Appropriate Stabilization and Development Policy and the Role of the Bank of Greece in the Context of the Economic and Monetary Union (EMU)". Athens, 1996 (In Greek).

No 54 N. Glytsos, "Demographic Changes, Retirement, Job Creation and Labour Shortages in Greece: An Occupational and Regional Outlook". Athens, 1996. Published in: Journal of Economic Studies, vol. 26, no. 2-3, 1999, 130-158.

No 53 N. Glytsos, "Remitting Behavior of "Temporary" and "Permanent" Migrants: The Case of Greeks in Germany and Australia". Athens, 1996. Published in: Labour, vol. II, no. 3, 1997, 409-435.

No 52 V. Stavrinos, V. Droucopoulos, "Output Expectations Productivity Trends and Employment: The Case of Greek Manufacturing". Athens, 1996. Published in: European Research Studies, vol. 1, no. 2, 1998, 93-122.

No 51 A. Balfoussias, V. Stavrinos, "The Greek Military Sector and Macroeconomic Effects of Military Spending in Greece". Athens, 1996. Published in N.P. Gleditsch, O. Bjerkholt, A. Cappelen, R.P. Smith and J.P. Dunne: In the Peace Dividend, , Amsterdam: North-Holland, 1996, 191-214.

No 50 J. Henley, "Restructuring Large Scale State Enterprises in the Republics of Azerbaijan, Kazakhstan, the Kyrgyz Republic and Uzbekistan: The Challenge for Technical Assistance". Athens, 1995.

No 49 C. Kanellopoulos, G. Psacharopoulos, "Private Education Expenditure in a "Free Education" Country: The Case of Greece". Athens, 1995. Published in: International Journal of Educational Development, vol. 17, no. 1, 1997, 73-81.

No 48 G. Kouretas, L. Zarangas, "A Cointegration Analysis of the Official and Parallel Foreign Exchange Markets for Dollars in Greece". Athens, 1995. Published in: International Journal of Finance and Economics, vol. 3, 1998, 261-276.

No 47 St. Makrydakis, E. Tzavalis, A. Balfoussias, "Policy Regime Changes and the Long-Run Sustainability of Fiscal Policy: An Application to Greece". Athens, 1995. Published in: Economic Modelling, vol. 16 no. 1, 1999, 71-86.

No 46 N. Christodoulakis and S. Kalyvitis, "Likely Effects of CSF 1994-1999 on the Greek Economy: An ex Ante Assessment Using an Annual Four-Sector Macroeconometric Model". Athens, 1995.

No 45 St. Thomadakis, and V. Droucopoulos, "Dynamic Effects in Greek Manufacturing: The Changing Shares of SMEs, 1983-1990". Athens, 1995. Published in: Review of Industrial Organization, vol. 11, no. 1, 1996, 69-78.

No 44 P. Mourdoukoutas, "Japanese Investment in Greece". Athens, 1995 (In Greek).

No 43 V. Rapanos, "Economies of Scale and the Incidence of the Minimum Wage in the less Developed Countries". Athens, 1995. Published: "Minimum Wage and Income Distribution in the Harris-Todaro model", in: Journal of Economic Development, 2005.

No 42 V. Rapanos, "Trade Unions and the Incidence of the Corporation Income Tax". Athens, 1995.

No 41 St. Balfoussias, "Cost and Productivity in Electricity Generation in Greece". Athens, 1995.

No 40 V. Rapanos, "The Effects of Environmental Taxes on Income Distribution". Athens, 1995. Published in: European Journal of Political Economy, 1995.

No 39 V. Rapanos, "Technical Change in a Model with Fair Wages and Unemployment". Athens, 1995. Published in: International Economic Journal, vol. 10, no. 4, 1996.

No 38 M. Panopoulou, "Greek Merchant Navy, Technological Change and Domestic Shipbuilding Industry from 1850 to 1914". Athens, 1995. Published in: The Journal of Transport History, vol. 16, no. 2, 159-178.

No 37 C. Vergopoulos, "Public Debt and its Effects". Athens, 1994 (In Greek).

No 36 C. Kanellopoulos, "Public-Private Wage Differentials in Greece". Athens, 1994.

No 35 Z. Georganta, K. Kotsis and Emm. Kounaris, "Measurement of Total Factor Productivity in the Manufacturing Sector of Greece 1980-1991". Athens, 1994.

No 34 E. Petrakis and A. Xepapadeas, "Environmental Consciousness and Moral Hazard in International Agreements to Protect the Environment". Athens, 1994. Published in: Journal Public Economics, vol. 60, 1996, 95-110.

No 33 C. Carabatsou-Pachaki, "The Quality Strategy: A Viable Alternative for Small Mediterranean Agricultures". Athens, 1994.

No 32 Z. Georganta, "Measurement Errors and the Indirect Effects of R & D on Productivity Growth: The U.S. Manufacturing Sector". Athens, 1993.

No 31 P. Paraskevaidis, "The Economic Function of Agricultural Cooperative Firms". Athens, 1993 (In Greek).

No 30 Z. Georganta, "Technical (In) Efficiency in the U.S. Manufacturing Sector, 1977-1982". Athens, 1993.

No 29 H. Dellas, "Stabilization Policy and Long Term Growth: Are they Related?" Athens, 1993.

No 28 Z. Georganta, "Accession in the EC and its Effect on Total Factor Productivity Growth of Greek Agriculture". Athens, 1993.

No 27 H. Dellas, "Recessions and Ability Discrimination". Athens, 1993.

No 26 Z. Georganta, "The Effect of a Free Market Price Mechanism on Total Factor Productivity: The Case of the Agricultural Crop Industry in Greece". Athens, 1993. Published in: International Journal of Production Economics, vol. 52, 1997, 55-71.

No 25 A. Gana, Th. Zervou and A. Kotsi, "Poverty in the Regions of Greece in the late 80's. Athens", 1993 (In Greek).

No 24 P. Paraskevaides, "Income Inequalities and Regional Distribution of the Labour Force Age Group 20-29". Athens, 1993 (In Greek).

No 23 C. Eberwein and Tr. Kollintzas, "A Dynamic Model of Bargaining in a Unionized Firm with Irreversible Investment". Athens, 1993. Published in: Annales d' Economie et de Statistique, vol. 37/38, 1995, 91-115.

No 22 P. Paraskevaides, "Evaluation of Regional Development Plans in the East Macedonia-Thrace's and Crete's Agricultural Sector". Athens, 1993 (In Greek).

No 21 P. Paraskevaides, "Regional Typology of Farms". Athens, 1993 (In Greek).

No 20 St. Balfoussias, "Demand for Electric Energy in the Presence of a two-block Declining Price Schedule". Athens, 1993.

No 19 St. Balfoussias, "Ordering Equilibria by Output or Technology in a Non-linear Pricing Context". Athens, 1993.

No 18 C. Carabatsou-Pachaki, "Rural Problems and Policy in Greece". Athens, 1993.

No 17 Cl. Efstratoglou, "Export Trading Companies: International Experience and the Case of Greece". Athens, 1992 (In Greek).

No 16 P. Paraskevaides, "Effective Protection, Domestic Resource Cost and Capital Structure of the Cattle Breeding Industry". Athens, 1992 (In Greek).

No 15 C. Carabatsou-Pachaki, "Reforming Common Agricultural Policy and Prospects for Greece". Athens, 1992 (In Greek).

No 14 C. Carabatsou-Pachaki, "Elaboration Principles/Evaluation Criteria for Regional Programmes". Athens, 1992 (In Greek).

No 13 G. Agapitos and P. Koutsouvelis, "The VAT Harmonization within EEC: Single Market and its Impacts on Greece's Private Consumption and Vat Revenue". Athens, 1992.

No 12 C. Kanellopoulos, "Incomes and Poverty of the Greek Elderly". Athens, 1992.

No 11 D. Maroulis, "Economic Analysis of the Macroeconomic Policy of Greece during the Period 1960-1990". Athens, 1992 (In Greek).

No 10 V. Rapanos, "Joint Production and Taxation". Athens, 1992. Published in: Public Finance/Finances Publiques, vol. 3, 1993.

No 9 V. Rapanos, "Technological Progress, Income Distribution and Unemployment in the less Developed Countries". Athens, 1992. Published in: Greek Economic Review, 1992.

No 8 N. Christodoulakis, "Certain Macroeconomic Consequences of the European Integration". Athens, 1992 (In Greek).

No 7 L. Athanassiou, "Distribution Output Prices and Expenditure". Athens, 1992.

No 6 J. Geanakoplos and H. Polemarchakis, "Observability and Constrained Optima". Athens, 1992.

No 5 N. Antonakis and D. Karavidas, "Defense Expenditure and Growth in LDCs - The Case of Greece, 1950-1985". Athens, 1990.

No 4 C. Kanellopoulos, The Underground Economy in Greece: "What Official Data Show". Athens (In Greek 1990 - In English 1992). Published in: Greek Economic Review, vol. 14, no.2, 1992, 215-236.

No 3 J. Dutta and H. Polemarchakis, "Credit Constraints and Investment Finance: No Evidence from Greece". Athens, 1990, in M. Monti (ed.), Fiscal Policy, Economic Adjustment and Financial Markets, International Monetary Fund, (1989).

No 2 L. Athanassiou, "Adjustments to the Gini Coefficient for Measuring Economic Inequality". Athens, 1990.

No 1 G. Alogoskoufis, "Competitiveness, Wage Rate Adjustment and Macroeconomic Policy in Greece". Athens, 1990 (In Greek). Published in: Applied Economics, vol. 29, 1997, 1023-1032.